Generation of Complex Verbal Morphology in First and Second Language Acquisition: Evidence from Russian

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Goals of the Study

This study explores the structure of the mental lexicon and the processing of Russian verbal morphology by two groups of speakers, adult American learners of Russian and Russian children aged 4-6, and reports the results of 2 matching experiments conducted at the University of Maryland, USA and St. Petersburg State University, Russia. The theoretical framework for this study comes from research on the structure of the mental lexicon and modularity in morphological processing. So far, there are very few studies investigating the processing of complex verbal morphology, with most of the work done on Icelandic, Norwegian, Italian, and Russian (Chernigovskaya and Gor 2000, Gor and Chernigovskaya 2002a, b, Ragnasdóttir, Simonsen, and Plunkett 1997, Orsolini and Marslen-Wilson 1997, Orsolini et al. 1998, Matcovich 1998, Simonsen 2000). The current views are shaped predominantly by research on English regular and irregular past-tense inflection, which has been conducted within two competing approaches.

According to the dual-system approach, regular and irregular verbs are processed by two distinct mechanisms or modules. Regular verbs 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, 1994, Prasada and Pinker 1993). This so-called dual-system view holds that since irregular verbs are retrieved from associative memory, they will be frequency-sensitive. Thus, high-frequency forms will be better remembered than low-frequency forms. Unlike irregular verbs, regular verbs will show no frequency effects.

The opposite single-system approach in its two variations, the connectionist (MacWhinney and Leinbach 1991, Plunkett and Marchman 1991, 1993, Rumelhart and McClelland 1986) and the network (Bybee 1985, 1995, Langacker 1987, 1988) approaches, holds that both regular and irregular verbs are processed by one single mechanism in associative memory. In other words, the single-system approach claims that no symbolic rules are used in morphological processing, only memory-based associations. Consequently, it predicts that both regular and irregular verbs

will show frequency effects. It is clear that the properties of English past-tense inflection with only one regular verb class and with no developed conjugational paradigm cannot be readily generalized to other languages with developed inflectional morphology. Two developmental studies of child first language (L1) acquisition of complex verbal morphology, one in Norwegian and Icelandic and the other in Italian, recorded the influence of both type and token frequencies on their subjects' responses. The results of these studies, which assessed the influence of input frequencies through the rates of overgeneralizations, are in conflict with the predictions made by the proponents of the dual-system approach (Ragnasdóttir, Simonsen, and Plunkett 1997, Matcovich 1998).

This study investigates the processing of verbal morphology in Russian, a language with numerous verb classes differing in size and the number and complexity of conjugation rules. It assumes that instead of a sharp opposition of regular and irregular verb processing, a gradual parameter of regularity may be more appropriate for Russian. Therefore, the issue of symbolic rule application versus associative patterning can take on a new meaning for Russian, possibly, with the distinction between default and non-default processing replacing the regular-irregular distinction.

The study tests the hypothesis that adult second language (L2) morphological processing shaped by formal learning is different from child L1 morphological processing. It addresses the following issues:

1. Is there a developmental tendency in child L1 acquisition of complex verbal morphology?

2. Does morphological processing in beginning adult second language (L2) learners match the processing in any of the child age groups?

3. Which population, children or L2 learners, relies more on associative patterning?

Additionally, it explores the role of the testing material in the processing of complex verbal morphology.

Russian Verbal System

According to the one-stem description developed by Jakobson and his followers (Jakobson 1948), Russian has 11 verb classes, each with its own suffix (verbal classifier). The suffix determines all the parameters of

the conjugational paradigm, which include: conjugational type, consonant mutations, stress shifts, and suffix alternations.
The features of the Russian Verbal System include:

- Numerous verb classes;
- Developed conjugational paradigm;
- No sharp division between regular and irregular classes;
- Several regular classes in addition to default;
- Infinitives of many verb classes have unrecoverable stems due to the truncation of the stem-final consonant before consonantal endings. Thus, the default pattern(s) has unrecoverable stem in the infinitive.

Table 1. Morphological Processes in the Stems Included in the Experiments

Verb classes	**-aj-** High-frequency, productive, default	**-a-** Low-frequency, unproductive	**-i-** High-frequency, productive	**-ova-** High-frequency, productive
Conjugational type	1	1	2	1
Conson. deletion before conson. endings	√			
Vowel deletion before vowel endings		√	√	√
Consonant mutation		√	√	
Stress shift		√	√	
Suffix alternation				√

Table 1 lists the morphological processes ("processing rules") shaping the conjugational patterns of the 4 stems chosen for the experiment. The -aj- stem has only one rule, that of consonant deletion, in its paradigm. Our previous research has demonstrated that the -aj- pattern is the default pattern in Russian (Chernigovskaya, Gor 2000). The -a-, and -i- stems have three. The -ova- stem has two. Thus, the overwhelming majority of verbs have regular inflection, but at the same time, conjugational patterns vary in morphological complexity, or the "degree of regularity." The largest classes -aj-, -i-, and -ova- are productive in Russian.

Experiment 1 with American Learners

The data for Experiment 1 were collected from 20 volunteer students at the University of Maryland at the end of their second semester of Russian. The experiment was conducted orally and individually with each subject, and recorded on audio tape. The subjects met with the

experimenter and received the printed version of the test assignment, which included written instructions. The experiment with American learners (and Russian children as well) consisted of two parts, which were administered with a one week interval. In the first part, the verbal stimuli were in the past tense plural form, while in the second, they were in the infinitive. The subjects were asked to generate the non-past 3rd person plural and 1st person singular forms of the verbal stimuli. All the verbs were embedded in simple carrying sentences, which together with follow-up questions formed a quasi-dialogue:

Past Tense

Experimenter: Yesterday they _____. And what are they doing today?
Subject: Today they _____.
Experimenter: And you?
Subject: Today I _____.

Infinitive

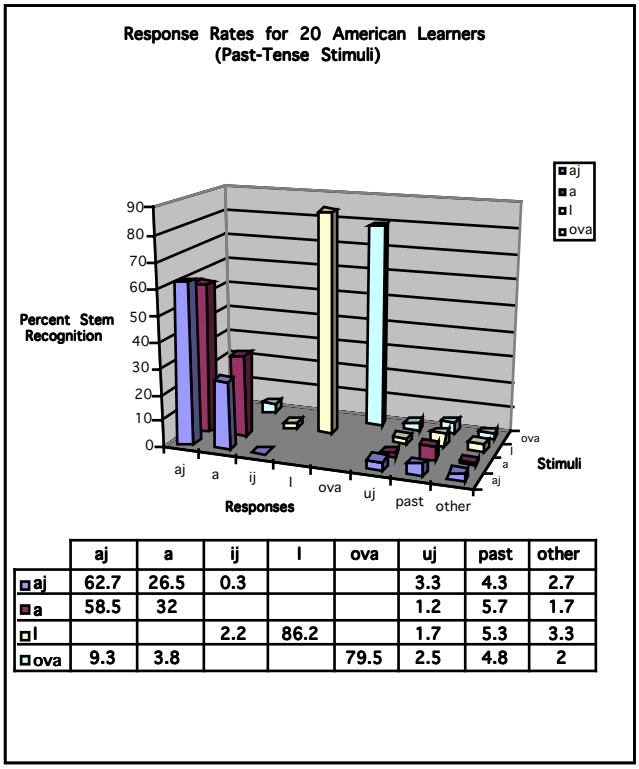
Experimenter: I want to _____.
Subject: Me too, I want to _____.
Experimenter: And what are you doing today?
Subject: Today I _____.
Experimenter: And Mary and Peter?
Subject: Today they _____.

The testing material consisted of 60 verbs belonging to 4 classes (based on the one-stem verb system, Jakobson, 1948):

-aj- gul'at' (gul'-aj), "to walk"
-a- pisat' (pis-a-), "to write"
-i- nosit' (nos-i-), "to carry"
-ova- probovat' (prob-ova-), "to try"

In each class there were 5 high-frequency real Russian verbs, 5 low-frequency real Russian verbs, and 5 nonce verbs created by manipulating the initial segment of the high-frequency real Russian verbs.

Figure 1 shows that the American learners reliably identified the -i- and -ova- verbs. As for the "symmetrical" classes -aj- and -a-, which had unrecoverable stems, the subject had to guess the underlying stem, as most of the verbs were unknown to them. As you can see from the chart, they did not make any distinction between the two stems and identified them as default (the -aj- pattern) twice as often as the unproductive -a- pattern.



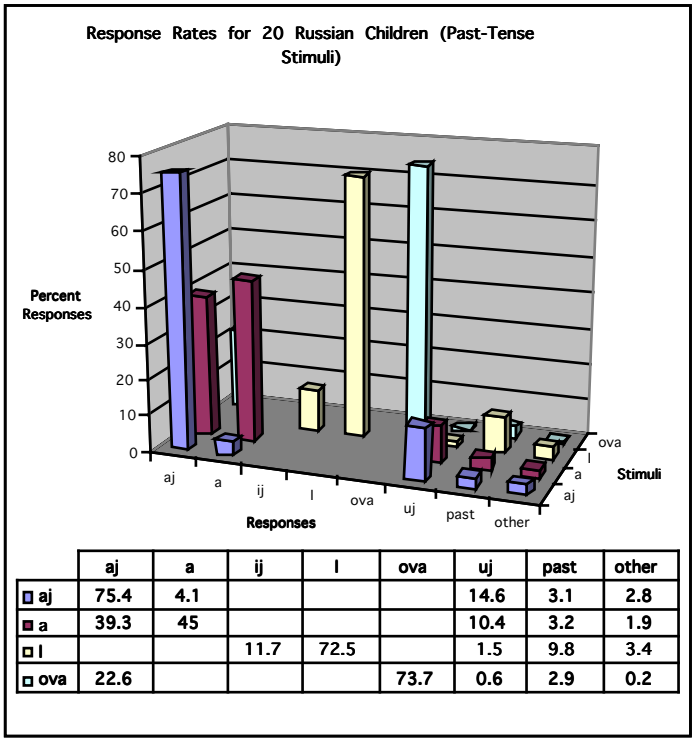
	aj	a	ij	I	ova	uj	past	other
aj	62.7	26.5	0.3			3.3	4.3	2.7
a	58.5	32				1.2	5.7	1.7
I			2.2	86.2		1.7	5.3	3.3
ova	9.3	3.8			79.5	2.5	4.8	2

Figure 1 Rates of Stem Recognition in American Learners (Past-Tense Stimuli)

Experiment 2 with Russian Children

Experiment 2 was conducted at a kindergarten in St. Petersburg, Russia with 20 Russian children with normal language and cognitive development, and no hearing problems. There were 5 children aged 4, 9 children aged 5, and 6 children aged 6 in the group of subjects. The testing material and experimental procedure were exactly the same as in the experiment with American learners.

Figure 2 demonstrates that Russian children also showed high rates of stem recognition for the -i- and -ova- verbs, though they are somewhat lower than in American learners. Unlike American learners, children made a distinction between the -aj- and -a- verbs, which is understandable: they knew most if not all of the real verbs. However, one can see that the default -aj- pattern was more dominant in child L1 than in American learners' responses. One other type of responses was much more prominent in children than in L2 learners: the use of the -uj- pattern, especially for the -aj- and -a- stems. The -uj- pattern does not exist in Russian by itself, but the allomorph with this suffix appears in the non-past tense as a result of suffix alternation -ova-/-uj-.



	aj	a	ij	l	ova	uj	past	other
aj	75.4	4.1				14.6	3.1	2.8
a	39.3	45				10.4	3.2	1.9
l			11.7	72.5		1.5	9.8	3.4
ova	22.6				73.7	0.6	2.9	0.2

Figure 2 Rates of Stem Recognition in Russian Children (Past-Tense Stimuli)

1. Since we have tested the children of three age groups, averaging the child data could have masked certain developmental tendencies. And indeed, when at the next step we analyzed the child data grouped by age, several facts emerged: 5 and 6-year-olds use the default -aj- less than 4-year-olds. Apparently, at age 4 this is a predominant pattern, and other children depend on it less.
2. The rate of -a- and -i- responses increases with age. These non-default patterns are still developing in younger children.
3. There is an abrupt jump in the rates of stem recognition for the -ova- class between the ages of 4 and 5. It appears that this is the time when the pattern is acquired and used with more confidence.

Therefore, one can say that the older the children the less they use the default pattern and the more they rely on the non-default -a- and -i- patterns. The active use of the -ova- pattern at age 5 probably triggers the overgeneralization of the -uj- pattern to the -aj- and -a- stems that we have observed earlier.

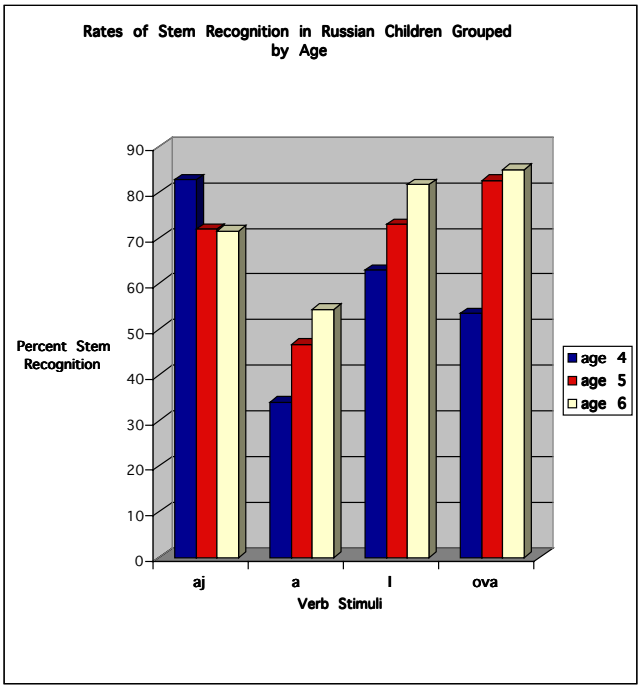


Figure 3 Rates of Stem Recognition in Russian Children Grouped by Age

Figure 4 compares the rates of stem recognition observed in L2 learners with the children of the three age groups. To control for the verb familiarity factor, it uses only the data on nonce verbs.

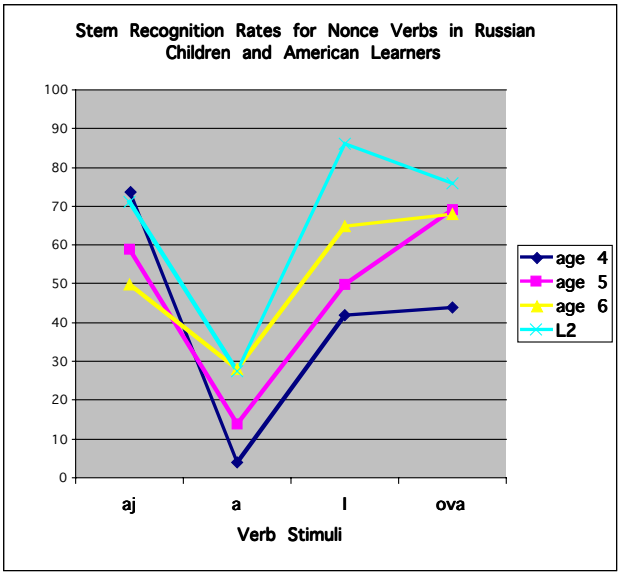


Figure 4 Rates of Stem Recognition in Russian Children and American Learners (Nonce Verbs)

One can see that American learners did as 4-year-olds on the default -aj- verbs, as 6-year-olds on the -a- verbs, and better than any age group on the -i- and -ova- verbs. In other words, it is apparent that the Americans' responses do not match any of the child age groups. Thus, though we have not collected any longitudinal data on L2 learners, we can still see that their response pattern differs from children.

This same developmental tendency of moving away from the default to the non-default pattern can be observed if we compare the child responses to the nonce symmetrical stems -aj- and -a- broken down by age.

Table 2 Stem Recognition for Nonce Verbs, "Symmetrical" Stems -aj- and -a-

	L2 Learners		Children age 4		Children age 5		Children age 6	
	aj	a	aj	a	aj	a	aj	a
aj	**71**	22	**74**	8	**59**	5.6	**50**	13.3
a	65	**27.5**	68	**4**	38.9	**14**	30	**28**

Table 2 shows a gradual decrease in the use of the default -aj- pattern both in response to the -aj- and -a- stems. At the same time, the child results indicate that children did not treat the nonce verbs derived from the -aj- and -a- stems in the same way. This means that they were to a certain extent aware of the phonological similarity of the nonce verbs to their real verb prototypes. For the Americans, the picture with nonce verbs was the same as for the whole sample. Their responses were practically not influenced by phonological similarity.

Comparison of L1 and L2 Responses: Conjugation Type and Consonant Mutation

We have seen that children clearly show a developmental tendency, and that the American learners' data do not match the response pattern for any of the age groups. Two additional data sets, error rates in conjugation type and consonant mutations, further demonstrate the differences between the child and L2 data.

1. Errors in Conjugation Type

In Russian, there are two conjugation types, 1st and 2nd, which differ by the thematic vowel in the inflections. The conjugation type is part of the overall conjugational pattern, and is therefore determined (by the verbal suffix. Generally speaking, 1st conjugation is much more common, as out of the 11 stems, only 3 belong to 2nd conjugation, including the -i- stem and

2 other small unproductive classes. Given such a distribution, one can put forward two opposite hypotheses concerning verbal processing.

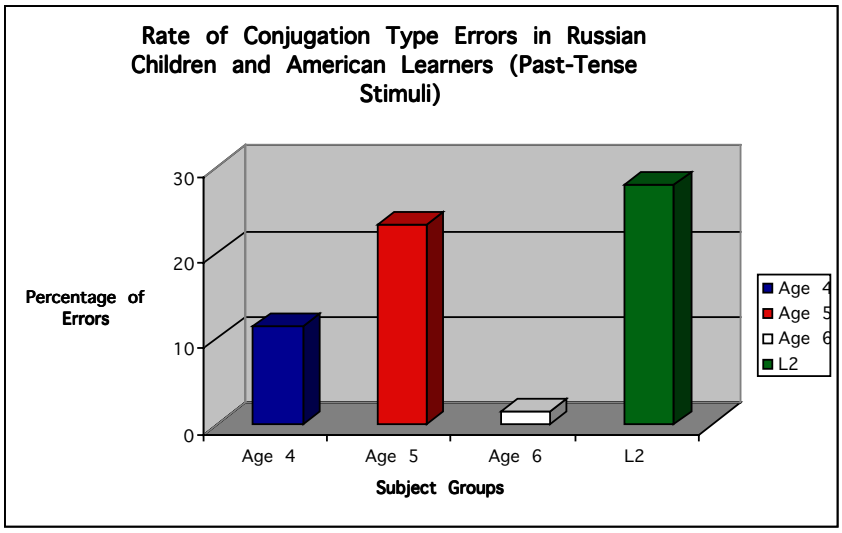


Figure 5 Conjugation Type Errors in Russian Children and American Learners

a) If conjugation type is part of the conjugational pattern determined by the verb classifier, then once the speaker figures out the conjugational pattern, s/he will match the conjugation type with the overall pattern.
b) Since 2nd conjugation is much less common, speakers with incomplete proficiency (such as young children and L2 learners) will generalize 1st conjugation to 2nd conjugation -i- verbs.

Figure 5 represents the rates of conjugation type errors in Russian children and American learners. It shows that younger children indeed made errors in assigning 2nd conjugation to the -i- verbs, however, this type of error became insignificant by age 6. At the same time, the errors in assigning 1st conjugation were virtually nonexistent. L2 speakers, however, produced a much higher rate of incorrect conjugation type errors than even the 5-year-olds. Thus, while L2 learners recognized the -i- stem better than any age group, they made more mistakes in conjugation type than children.

2. Errors in Consonant Mutation

We analyzed the rates of missed consonant mutations in the -i- verbs, where they are obligatory in the 1st person singular. As with conjugation type, consonant mutations are part of the overall conjugational pattern, and are fully predictable for the -i- verbs, since they occur automatically in certain consonants.

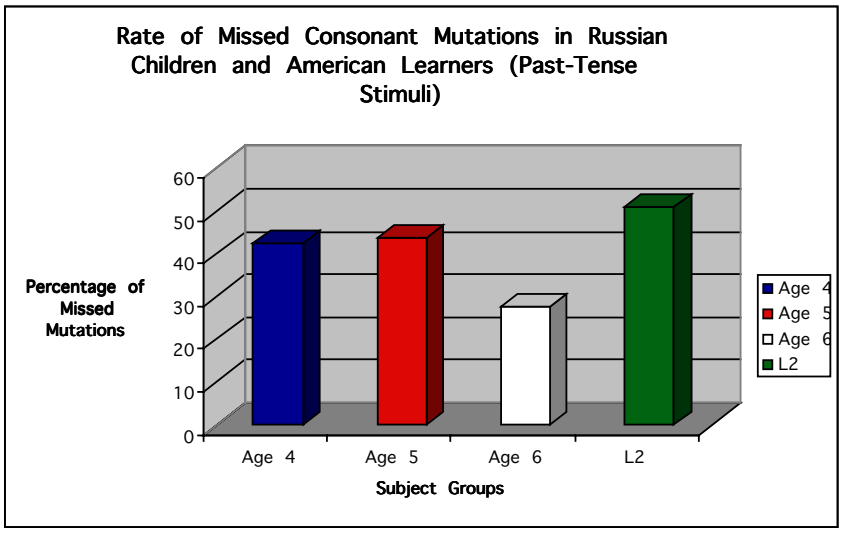


Figure 6 Errors in Consonant Mutations in Russian Children and American Learners

Figure 6 displays the same tendency for missed consonant mutations as for conjugation type errors, only it manifests itself to a lesser degree. Children show a drop in the rate of missed mutations at age 6, while L2 learners demonstrate the highest rate of missed mutations.

Role of the Testing Material: Past Tense Versus Infinitive Stimuli

Sometimes research on the processing of verbal morphology conducted by different teams produces conflicting results. One possible explanation for those discrepancies in the results has to do with the structure of the testing material. In order to evaluate the impact of this factor on our own results, we will compare the results obtained for children and L2 learners in two sets of experiments, with past tense and infinitive stimuli.

First of all, it is important to note that the past tense and infinitive verb forms contain exactly the same information about the verb stem. If it is recoverable, than it will be present in both types of verb forms, if it is unrecoverable, neither verb form will have it. This happens because the –j- of the suffix becomes truncated before consonantal endings.

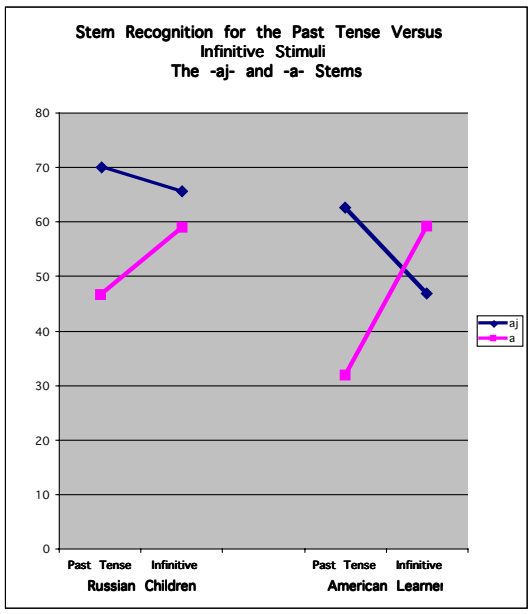


Figure 7 Stem Recognition for the Past Tense Versus Infinitive Stimuli: Russian Children and American Learners

To generate the non-past-tense forms of such stimuli one needs to apply exactly the same procedure:

- Drop the infinitive or past-tense plural inflections. In our experiments, the infinitive inflection is "-t'" (it is non-syllabic), and the past-tense inflection is "-li" (it is syllabic).
- Recover the stem based on morphological cues (if present) and/or statistical probabilities.
- Add the appropriate non-past inflections. This procedure includes several steps: choice of the conjugation type, application of the truncation rule and the consonant mutation rule (if needed).

All this means that one should not expect any significant differences between the results of the two experiments with past tense and infinitive stimuli. However, the responses of both groups of subjects do not support this prediction. Figure 7 represents the rates of stem recognition for two "symmetrical" stems, -aj- and -a-. For Russian children, the rate of the default -aj- responses is higher for the past-tense condition, while the rate of the -a- stem responses is higher for the infinitive condition. And this tendency is even much stronger for the American learners.

Discussion

Taken together, the facts that L2 learners have the highest rates of stem recognition, but produce more errors in conjugation type and consonant mutations than children, indicate that L2 learners do not fit into the developmental tendency observed in children. These differences in child and L2 response rates seem to point to certain differences in the underlying processing mechanisms between children and L2 learners. Children have more problems with the identification of the conjugational pattern and the use of the morphological cues, they can get side-tracked to the use of an unpredictable pattern, such as the -uj-. In nonce verb processing, children's response rates are influenced by phonological similarity to real verb prototypes. But once they opt for a certain pattern, they apply it more and more accurately as they become older. L2 learners, unlike children, seem to recognize the morphological cues better. In nonce verb processing they are not sensitive to phonological similarity to real verbs, since most of these verbs are not part of their lexicon. But for L2 learners the conjugational pattern is less fixed, they make more errors in its application. Also, generally speaking, L2 learners are better at nonce verb processing than children.

These differences in child L1 and adult L2 processing seem to be connected to the differences in the input received by these two populations of speakers, and to the processing strategies they use. Children receive more input, and this input is natural, also, they get more chances to use the verbs themselves, which means the statistical characteristics (input frequencies) should approximate those found in native colloquial speech. They certainly do not receive any explicit instruction in verb conjugation.

Beginning adult L2 learners, who study L2 in a formal classroom, receive very limited input with the differences between input frequencies for different classes much weakened than in native Russian input (see Chernigovskaya and Gor 2000). However, unlike children, formal L2 learners typically receive massive explicit training in the application of conjugation rules for different verb classes. As a result, beginning L2 learners are better at some analytical procedures, such as deriving the basic stem from nonce verbs based on morphological cues. However, they do not apply all the rules shaping the conjugational pattern in a consistent way, thus their high rates of errors in conjugation type and consonant mutations. Thus, it appears that child L1 processing tends to rely more on the application of the whole conjugational pattern and is sensitive to phonological similarities. At the same time, adult L2 processing singles out discrete rules shaping the conjugational pattern, is not sensitive to

phonological similarity, and relies less on associative patterning than on discrete rule application.

As to the differences in the rates of stem recognition for the two experimental conditions—with past tense and infinitive stimuli—there are at least two possible explanations for this effect. First, these differences may be caused by the phonological, or more exactly, syllable structure of the stimuli. The subjects tend to match the syllable structure of the stimuli in their responses. The past-tense plural stimuli have one extra syllable and thus trigger the responses with the same syllable structure, therefore, the preference here is for the default -aj- pattern. The infinitive, on the opposite, triggers shorter responses, and therefore favors the -a- pattern.

Another possible explanation is that the processing of past-tense stimuli is costlier than the processing of infinitives, as infinitive is the citation form, and it may be stored in a decomposed way, or more readily stripped off its inflection. If this logic is correct, then it makes sense that the subjects rely more on the default pattern with more complex past-tense stimuli.

Why were L2 learners more sensitive than children to this difference? While L2 learners were better than children at stem recognition, they were worse at rule application. If L2 learners were not very confident in the actual implementation of the rules shaping the conjugational pattern, then they could have opted for default when faced by the processing difficulties, or become influenced by the syllable structure of the stimuli. From the practical standpoint, this difference in the processing of past tense and infinitive stimuli emphasizes the importance of taking into account the experimental design when interpreting any data on morphological processing.

Conclusions

1. This study has demonstrated that child L1 and adult L2 processing had several features in common:
    - Both children and L2 learners generalized the default -aj- pattern to the non-default irregular -a- class.
    - Both used the morphological cues and identified the -i- and -ova- stems.
    - Both made errors in conjugation type and consonant mutations.
2. However, a closer look at the data leads to the following observations:
    - There is a developmental tendency in child L1 processing of verbal morphology.

- Morphological processing in beginning adult L2 learners does not match the processing in any of the child age groups.

3. Child L1 verbal processing depends more on associative patterning, while adult L2 processing depends more on the application of discrete rules.

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