The role of speech perception in the adaptation of loanwords

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ABSTRACT

The discovery in second language acquisition that a learner's native language (L1) has considerable influence on the perception of the learned language (L2), has been largely ignored by loanword research. Where the issue of perception is discussed, there is disagreement about the perception of segments; the role of the native phonotactics in perception, however, is agreed to be irrelevant.

To gather empirical evidence concerning this issue, the adaptation of Russian initial consonant clusters by native speakers of English in production and perception is examined. The production data (repetition and orthographic representation) show high variability between clusters in terms of the preferred method of adaptation as well as a tendency of adaptations towards greater acceptability in English.

In a perception study, claims that speakers analyse the incoming signal phonotactically in terms of their native language has not been confirmed, although there is evidence that Russian and English listeners perceive the cluster sequences differently.

1 BACKGROUND

A major part of learning a new language is the acquisition of sounds that are not part of the learner's native phoneme inventory. In second language acquisition research, the perception of these phonemes has been shown to be influenced considerably by the learners' native phonology and thus to be a major source of mistakes and difficulties with the phonological system of the learned language. For example, learners tend to project new phones onto phonemes of their first language, e.g. French learners often perceive English [θ] as /s/ (Rochet 1995; for further examples see Best 1995, Flege 1995, Kuhl and Iverson 1995). Research on loanwords, on the other hand, which are also created from a clash of the native and a foreign system, has to date not taken perception into account to a great extent. Its main focus has instead been on the grammatical differences between the two languages and the mechanisms that transform the representation of the input (which is taken to be the word as it is pronounced in the donor language) to the representation of the output (the pronunciation in the recipient language). This is done without examining speech perception, i.e. the source of the input representation in the adapter's mind. Thus research to date has only been concerned with the boxed part in figure1:

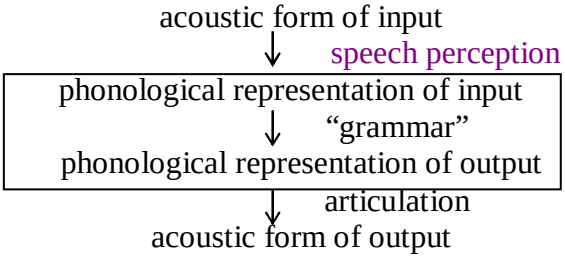

Figure 1: The path of foreign words in a borrowing language

One extreme point of view expressed in the literature, however the one implied by most of the work on loanwords, is that expressed by Jacobs and Gussenhoven (2000), who claim that humans possess a "universal phonological vocabulary", i.e. perceive sounds from other languages without mistake, and thus that perception plays no role in adaptation. In contrast, Silverman (1992) maintains that foreign *segments* are adapted at the perceptual stage. Both agree, however, that phonotactic differences between two languages, which are those concerning the possible combinations of phonemes, do not influence the perception of foreign words. Conversely, Rochet (1995) cites anecdotal evidence that French speakers do not perceive /θ/ as /s/ before /ɹ/, but instead as /f/, since the sequences /sɹ/ and /sʁ/, respectively, are illegal in English as well French. Thus phonotactic restrictions seem to influence the perception of a foreign sequence, although here it is not clear whether these are the native or the foreign language's restrictions.

To examine whether perception plays a decisive role in the way and the extent in which foreign words are adapted, I am conducting experiments testing how perception influences English speakers' adaptations of Russian words containing initial consonant clusters. The motivation for choosing Russian as a source language is its wealth of consonant clusters, the majority of which are illicit in English, e.g. initial /dv/ and /zb/. Furthermore, there is no considerable body of loanwords from Russian and thus no established routine of adaptation (such as the convention /θ/ > /s/ in Japanese). By avoiding existing loanwords, it is possible to exclude effects of previous adaptations in other languages and of orthography. Thus it is advisable to consider hypothetical rather than actual loanwords in order to discover the origin of the adaptation mechanisms at work.

2 PHONOTACTICS IN PRODUCTION

Initially, it was necessary to determine the kinds of adaptation that occur when English speakers attempt to produce a Russian-sounding word, as there are no Russian to English loanword data available. To this effect, production experiments with Russian pseudo-words containing initial clusters, most of which are illegal in English, were performed.

2.1 Production experiments

These consisted of a repetition task, in which participants were instructed to repeat sequences they heard, and an orthographic task, in which the participants had to give orthographic

representations of what they heard[1]. The expectation was that correct response rates would be higher with English legal and marginal clusters, and lower with English illicit clusters. Furthermore, the rate of correct responses was expected to rise with sonority distance (SD), since this has been the traditional measure of the legality of clusters, and English has been described as requiring a minimal SD of 2 (excepting s-initial clusters)[2]. Any adaptations were predicted to result in an improvement of the clusters – from an English point of view – either by changing the cluster to a legal sequence, be it a cluster or a single onset, or by increasing SD.

The results of the repetition task, however, can reflect not only perceptual, but a number of factors including articulation, phonotactic wellformedness *and* perception. Therefore the orthographic task was meant to exclude articulation-based adaptations, and to zero in on the role of perception. The expectation was that, if articulation is not the major factor, the results of the two tasks would only differ to a small extent.

2.1.1 Method 1: The repetition task

Materials. The Russian pseudo-words used in the experiments contained 22 initial consonant clusters of various types (e.g. stop-stop, fricative-stop, fricative-fricative). Of these clusters, two are licit in English (/sp, fr/), three are marginal in English (/sf, ʃp, ʃm/), and 17 are illegal in English (/pn, sr, zr, vr, vl, tv, dv, ps, ʃv, sv, zv, vz, pt, fp, vb, zb, ʒb/). Five pseudo-words were designed for each cluster, with the stress on the second syllable, and the vowels (/u, i, ʌ, ɛ/) were chosen such that no palatalisation of the consonants occurred (A list of the target words can be found in the appendix). These words were recorded by a female Russian speaker (Ekaterinburgh accent), digitised and randomised. One target word was excluded, as the first consonant could not be detected in the spectrogram. This resulted in a sum of 109 target words.

Participants. 10 native speakers of British English (with no knowledge of Russian), recruited at the University of Edinburgh.

Procedure. The stimuli were presented via headphones, in randomised orders. In the first part participants were presented with a computer screen showing a carrier sentence with a gap marked for the target word, and were asked to read out the sentence including the target after hearing the target word twice. The sentence was designed such that it was impossible to syllabify C_1 with the last syllable of the word preceding the gap. The second part consisted of merely repeating the stimuli without a carrier sentence after hearing it once. The following target word was activated by the experimenter after the response was complete.

Analysis. The responses were recorded and digitised, and analysed auditorily as well as with the use of wide-band spectrograms.

Results. As shown in figure 2, the most frequent repair strategies overall were found to be vowel epenthesis (/ʒbedom/ > [ʒəbedom]) and segment changes of one or both consonants (/fpurot/ > [spurot], /vledil/ > [fledil]), followed by deletion (/vzana/ > [zana]). Within the

[1] This might have been problematic in the case of a focus on vowels because of the nature of the English orthography, however with the consonants used here the transcriptions were unambiguous.

[2] For a description and further references see Davidson (2001)

segment change repairs, for about half the tokens the result was a legal cluster in English. For the other half there was an improvement in that the sonority distance between the two consonants was increased, e.g. /ʒbedom/ > /ʃbedom/. However, the results showed large differences between the clusters in terms of percentage of correct responses, for which SD was also not a good predictor, as well as in terms of the preferred adaptation. Targets with initial /dv/ were mostly epenthesised, /zb/ was frequently altered to /sb/, whereas /vz/ clusters were reduced to /z/ almost without exception.

Method 2: The orthographic task

Materials. The same materials as above were used and recorded onto DAT tape in randomised order, with two repetitions each.

Participants. A second group (11 speakers), as above.

Procedure. Participants were asked to listen to the two repetitions of each word from DAT player via headphones and to write down an orthographic representation that best fit the stimuli. There was no instruction of a specific notation system. The experiment was self-timed.

Results. This experiment yielded similar results, as shown in figure 2, with slightly higher correct responses overall. In figure 3, an overall comparison of the types of changes that occurred in the different tasks shows that phonotactically triggered changes still occurred in about 50% of the responses. This suggests that perception is influenced by phonotactic constraints to some extent.

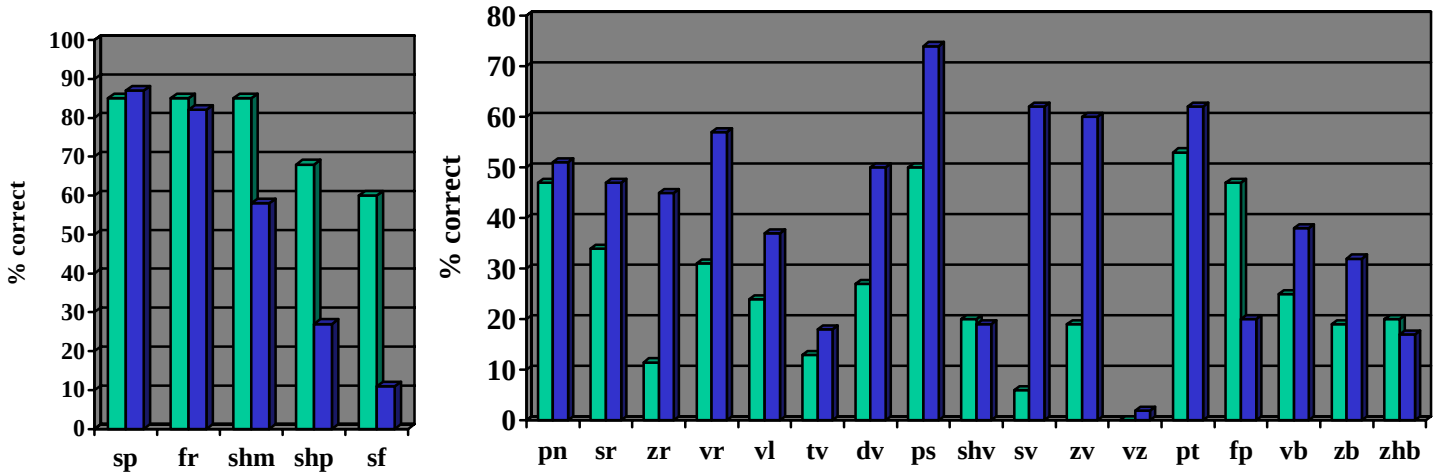

Figure 2. Production performances for licit and marginal (left) and illicit clusters (right) in the repetition tasks (green) and the orthographic task (blue). Note the different scales.

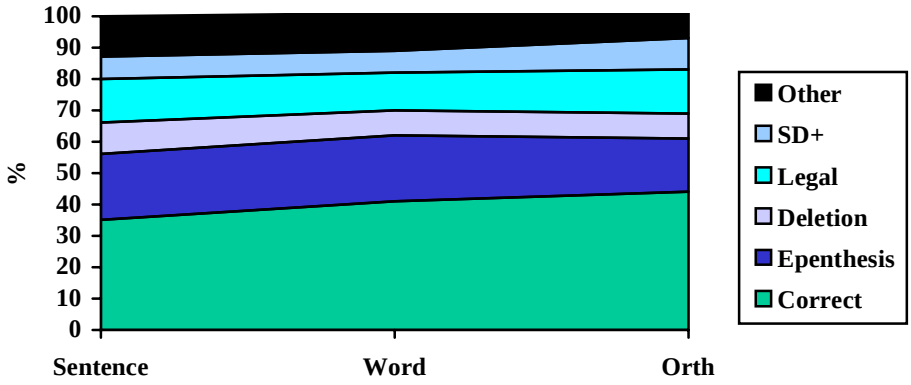

Figure 3. How illegal clusters are changed: a comparison of parts 1&2 of the repetition (Sentence, Word) and the orthographic task. Note that epenthesis, deletion, change into a legal cluster (Legal) and increase of sonority distance (SD+) improve the clusters phonotactically.

3 PHONOTACTICS IN PERCEPTION

By showing that the differences between repetition and orthographic representation are so small and thus that the impact of mere production difficulties is a minor one, the production results suggest that perception does have some influence on how foreign segments are adapted. Nevertheless, there might still be an effect of the grammar that comes into play between perception and the forming of an orthographic representation of the auditory stimulus. Therefore a method is needed that tests perception directly. One such method is the categorical perception task, which tests identification and discrimination abilities for points along an acoustic continuum, the end points of which are minimal pairs, e.g. /b/-/p/. For further information about categorical perception, see Repp (1984).

3.1 Previous work

Dupoux et al. (1999) conducted categorical perception experiments with Japanese and French speakers to test whether the Japanese phonotactics, i.e. in their case the prohibition on consonant clusters, has an effect on Japanese listeners' perception of words containing clusters. Their stimuli were continua with end points such as /ebzo/ vs. /ebuzo/, recorded by native speakers of Japanese and French and then modified to exclude traces of vowel between the two consonants. They found that French participants reported the presence of a vowel in a gradually rising fashion, starting from around 10% at the /ebzo/ end, whereas Japanese had a very high rate of reported vowels, ranging from 70% to 90% across the continuum. Dupoux et al. conclude that this is a case of native phonotactics changing the perception of a sequence that is impossible in the listener's first language: Japanese is predominantly a CV language, and consequently consonant clusters are broken up by an intervening vowel, even in perception.

The methodological issue with Dupoux et al.'s study is that Japanese has a wealth of loanwords, mainly from English, in which consonant clusters are always adapted in the same

way, that is by epenthesis of a vowel. This means that any Japanese speaker is aware of this convention of adaptation, and this knowledge might play a dominant role in this automatic assumption of a vowel between two consonants by Japanese listeners.

3.2 Categorical perception experiment

A categorical perception experiment was carried out to improve on the production experiment as well as on Dupoux et al.'s study: it gives direct evidence about perception by excluding effects of the native phonology occurring after perception, and it eliminates effects of an established convention.

3.2.1 Method

Materials. In this experiment, for each cluster the continua run from the original cluster to different kinds of adapted forms, e.g. from /vz/ to /vəz/ and to /z/, and from /ʒb/ to /ʒəb/ and to /ʃb/. The chosen cluster was /fp/, with the other end point being the adaptation /sp/. The SenSyn formant synthesiser (for a description see Klatt 1979) was used to synthesise continua of eleven steps between the syllables /fpo/ and /spo/ as well as between the sounds /f/ and /s/. The latter continuum was used as a control, as these sounds are part of the English as well as the Russian inventory. For the discrimination task pairings with a difference of three steps were used (e.g. points 2 & 5), which means there were 8 pairs of stimuli along one continuum. There were five different randomisations for each set of stimuli.

Participants. There were three Scottish participants, and four Russian participants as controls, recruited in Edinburgh. Scottish speakers were chosen as a result of the necessary choice of /o/ as the vowel in the target syllables (to avoid a lexical bias in experiments with the other adaptations of /fp/, namely /p/ and /fəp/), which is a native vowel in Scottish, but not in other varieties of British English.

Procedure. Participants performed an ABX discrimination task for the /f-s/ continuum and the /fpo-spo/ continuum, and an identification task between /fpo-spo/, in different orders, and with 2 different randomisations for each participant. There were 128 tokens for the ABX discrimination (8 pairings x 2 orders x 2 outcomes x 2 repetitions x 2 randomisations) and 176 tokens for the identification task (11 points x 8 repetitions x 2 randomisations), i.e. 16 data points for each point or pair.

3.2.2 Predictions

The hypothesis was that, if perception is influenced by phonotactics, the responses of Russian and English participants would differ. Russian listeners' responses would show more categorical perception along each continuum. Alternatively, if the response of the Russian listeners was gradual (similar to the French listeners in Dupoux's experiment) because of the differing element being a fricative, the responses are nevertheless expected to be close to 0% identification as /spo/ at the /fpo/ end and close to 100% at the /spo/ end of the continuum. In the discrimination function, Russians are more likely to have a clear peak, at the point of the sharpest rise in the discrimination function.

Scottish speakers, on the other hand, were expected to respond in a less categorical manner and skewed towards the acceptable (i.e. the adapted, here: /sp/) form. This would show as a

lack of a peak in the discrimination function and, in identification, a high /spo/ response even near the /fpo/ end of the continuum. For the fricative continuum, Russian and Scottish responses are expected to be the same.

3.2.3 Results

The results showed, contrary to expectation, little difference between languages in the identification task (figure 4), but differences between languages as well as between tasks in the discrimination tasks (figure 5). An analysis with ANOVA showed no effect of the native language could be found in the identification function. Significant effects were shown for the discrimination results ($F(2,84)=19.942$; $p=.000$). A post-hoc Tukey test revealed that for both Russian ($p=.000$) and Scottish participants ($p=.002$) there were more correct responses in the discrimination of the fricatives only as compared to the discrimination of the whole syllables. Furthermore, syllable discrimination by Russian participants was significantly lower than in the other three discrimination tasks (with Russian fricatives: $p=.000$, with Scottish fricatives: $p=.002$, with Scottish syllables: $p=.000$). As expected, no difference between Russian and Scottish was found on the fricative continuum ($p=.111$). One of the Russian participants was excluded as an outlier.

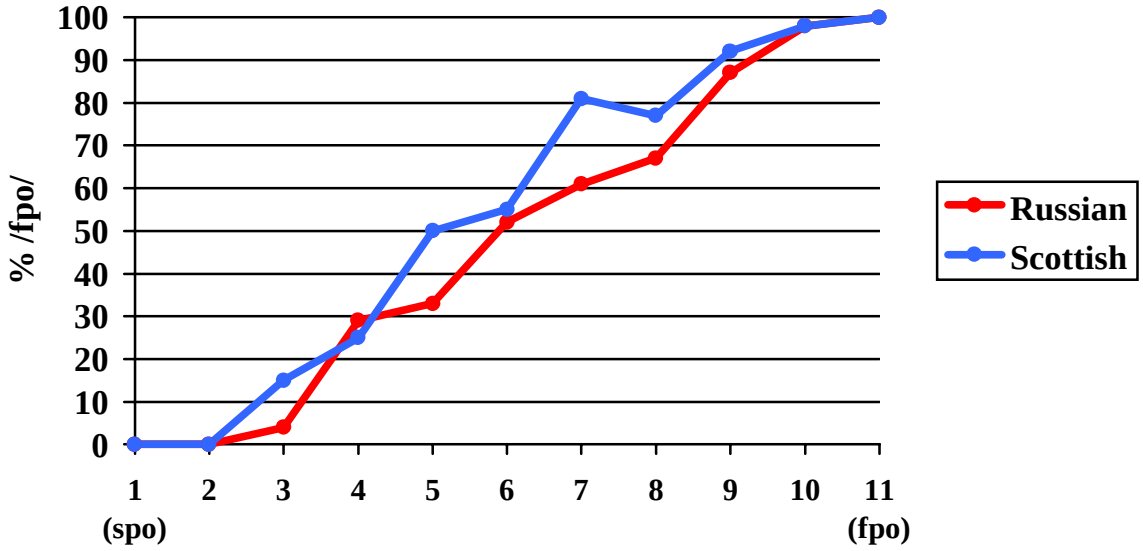

Figure 4. Identification responses of Russian and Scottish speakers

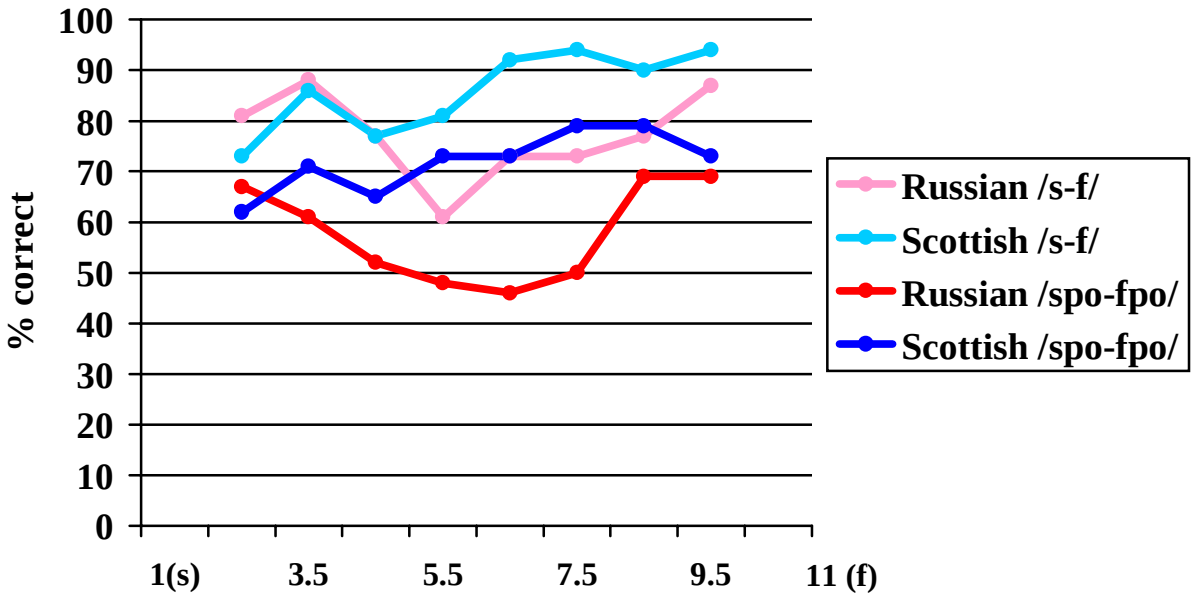

Figure 5. Discrimination responses for Russian and Scottish speakers.

3.2.4 Discussion

At first glance, these results appear to support the null hypothesis – Russian and Scottish speakers identify initial /fp/ and /sp/ very much the same, although Russian phonotactics allow both, whereas in English only /sp/ is possible. However, the discrimination results show a different picture: the fact that both English fricative only and syllable discrimination are on a par with Russian fricative discrimination, whereas Russian syllable results are significantly lower, suggests that the performance of the Russian speakers was lowered by the added information in the whole syllable, whereas this added information did not have an effect on the Scottish native speakers, which was caused by the prohibition on /fp/ in English. The Scottish participants performed better instead of worse than the control group by disregarding the problematic final part of the syllable, [-po] (which was unchanging over many repetitions), and concentrated instead on the "trouble-free" fricatives, thus raising their performance up to the level of fricative discrimination. This suggests that native phonotactics is, if not a perceptual filter selecting only sequences that are well-formed in L1, certainly a factor in perception.

4 OUTLOOK

The foremost future work is the extension of this experiment to the other adaptations of /fp/, which are /p/ and /fəp/, as well as to the other illegal clusters of the production experiment, mainly those of different types, e.g. stop-initial clusters, to test the role of the fricative as the differing element in the perception task. Furthermore, it will be advisable to use other methods of testing perception, which include less repetition and a situation closer to real-life borrowing, such as priming. This would vary the segmental environment (as opposed to [-po] throughout) and also avoid influencing participants' expectations: in the reported identification task, for example, participants are given the choice between /sp/ and /**fp**/, thus alerting them to a possibility that they might not have considered otherwise.

Once the role of perception in adaptation is established, further issues to be investigated are the effect of L2 knowledge, i.e. the question at which stage of familiarity with the donor language the native system's influence might be reduced, and the effect of other factors on perception, such as salience, perceived similarity (and how it is influenced by the native language), and further characteristics of the recipient language. For example, a pure CV language must adapt clusters by deletion or vowel epenthesis, whereas in the case of English an illegal cluster may be converted to a legal cluster. Whether this is a question of perception must be investigated.

Appendix: Target words in the production experiments

1a	Вбана́я	/vbʌnajə/
1b	Вбына́рь	/vbɨnar/
1c	Вболто́	/vbʌlto/
1d	Вбучи́ст	/vbutʃist/
1e	Вбэки́сть	/vbɛkist/
2a	Взана́	/vzʌna/
2b	Взыдо́й	/vzɨdoj/
2c	Взода́я	/vzʌdajə/ (excluded)
2d	Взуго́в	/vzugof/
2e	Взэю́т	/vzɛjut/
3a	Власка́я	/vlʌskajʌ/
3b	Влыго́сть	/vlɨgost/
3c	Влоси́бо	/vlʌsibə/
3d	Влуби́ст	/vlubist/
3e	Влэди́ль	/vlɛdil/
4a	Впаи́во	/fpʌjavə/
4b	Впыли́р	/fpɨlir/
4c	Вполи́га	/fpʌlagə/
4d	Впуро́т	/fpurot/
4e	Впэво́й	/fpɛvoj/
5a	Вради́нка	/vrʌdʲenkə/
5b	Врыно́ч	/vrɨnotʃ/
5c	Вроша́ть	/vrʌʃatʲ/
5d	Вруёс	/vrujos/
5e	Врэби́ский	/vrɛbiskɨ/
6a	Двади́л	/dvʌdʲel/
6b	Двырьи́	/dvɨrja/
6c	Двони́ц	/dvʌnʲets/
6d	Двури́ть	/dvuritʲ/
6e	Двэло́т	/dvɛlot/
7a	Жбатри́	/ʒbʌtra/
7b	Жбыда́ть	/ʒbɨdatʲ/
7c	Жбоми́ль	/ʒbʌmilʲ/
7d	Шбусе́во	/ʒbusʲevə/
7e	Жбэдо́м	/ʒbɛdom/
8a	Зване́цка	/zvʌnʲetskɨ/
8b	Звыта́я	/zvɨtajə/
8c	Звору́ль	/zvʌrulʲ/
8d	Звуша́д	/zvuʃat/
8e	Звэво́е	/zvɛvoje/
9a	Зрата́ва	/zrʌtavə/
9b	Зрыпа́л	/zrɨpal/
9c	Зроки́ва	/zrʌkivə/
9d	Зрубы́й	/zrubɨj/
9e	Зрэна́ска	/zrɛnaskə/
10a	Пнаве́сть	/pnʌvʲestʲ/
10b	Пныда́ть	/pnɨdatʲ/
10c	Пнори́ст	/pnʌrist/
10d	Пнуло́ш	/pnuloʃ/
10e	Пнэби́ч	/pnɛbʲitʃ/
11a	Псаре́ст	/psʌrʲest/
11b	Псыто́к	/psɨtok/
11c	Псово́д	/psʌvod/
11d	Псулу́т	/psulut/
11e	Псэди́на	/psɛdʲinə/
12a	Птари́на	/ptʌrʲinə/
12b	Птыно́мка	/ptɨnomkə/
12c	Птола́д	/ptʌlat/
12d	Птузи́ть	/ptuzʲitʲ/
12e	Птэя́тка	/ptɛjatkə/
13a	Сбано́р	/zbʌnor/
13b	Сбына́ть	/zbɨnatʲ/
13c	Сбоче́го	/zbʌtʃevə/
13d	Сбумья́	/zbumja/
13e	Сбэро́ш	/zbɛroʃ/
14a	Свадо́м	/svʌdom/
14b	Свыло́й	/svɨloj/
14c	Сволу́ть	/svʌglutʲ/
14d	Свуша́л	/svuʃal/
14e	Свэри́ть	/svɛrʲitʲ/
15a	Спавно́	/spʌvno/
15b	Спыми́рь	/spɨmʲirʲ/

15c	Спочáл	/spʌtʃal/
15d	Спутёр /	sputʲor/
15e	Спэнкáя	/spɛnkaja/
16a	Сравóдка	/srʌvotkə/
16b	Срыни́е	/srɨnʲije/
16c	Сроют	/srʌjut/
16d	Срумёт	/srumʲot/
16e	Срэскóл	/srɛskol/
17a	Сфаёт	/sfʌjot/
17b	Сфыби́ль	/sfɨbʲilʲ/
17c	Сфори́те	/sfʌrʲitʲe/
17d	Сфудá	/sfuda/
17e	Сфэму́	/sfɛmu/
18a	Тваню́т	/tvʌnut/
18b	Твыгóй	/tvɨgoj/
18c	Твондáш	/tvʌndaʃ/
18d	Твурёт	/tvurʲot/
18e	Твэнáя	/tvɛnaja/
19a	Франу́ть	/frʌnutʲ/
19b	Фрыши́е	/frɨʃije/
19c	Фробóй	/frʌboj/
19d	Фрудóсть	/frudostʲ/
19e	Фрэчóк	/frɛtʃok/
20a	Швассóл	/ʃvʌsol/
20b	Швычи́нка	/ʃvɨtʃinkə/
20c	Швонёта	/ʃvʌnʲetə/
20d	Швурби́на	/ʃvurbʲinə/
20e	Швэтро	/ʃvɛtro/
21a	Шмадóй	/ʃmʌdoj/
21b	Шмылóтка	/ʃmɨlotkə/
21c	Шмове́к	/ʃmʌvʲek/
21d	Шмуни́ский	/ʃmunʲisʲkʲi/
21e	Шмэкáня	/ʃmɛkanʲə/
22a	Шпавóта	/ʃpʌvotə/
22b	Шпыре́нно	/ʃpɨrʲennə/
22c	Шпокнó	/ʃpʌkno/
22d	Шпуни́р	/ʃpunʲir/
22e	Шпэгóра	/ʃpɛgorə/

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