Production and perception of vowel harmony:

Phonological predictors of ratings and on-line adaptations of

Russian vowels in Yakut (Sakha)

by

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Abstract

This dissertation investigates phonological input predictors of the Russian vowels /a, e, i, o, u/ in on-line adaptations among modern Russian-Yakut bilingual speakers in the Republic of Sakha (Yakutia) in the Russian Federation, with a particular focus on the production and perception of vowel harmony. Vowel harmony in Yakut involves backness harmony that requires complete agreement of vowels within words in backness, and rounding harmony, where rounded vowels spread their roundedness feature from left to right, with restrictions regarding the height of the vowels involved. Unlike Yakut, Russian does not have vowel harmony. Previous research indicates that earlier loanwords, adapted when most Yakuts were monolingual, underwent complete vowel harmony and were fully nativized. Thus, considering the context of increasing bilingualism among Yakuts and distinct vowel systems between the source (Russian) and borrowing (Yakut) languages, I examine the most-frequent adaptations of the five Russian vowels and also investigate phonological characteristics of input vowels and words that lead to vowel harmony application and Yakut-likeness in bilingual speakers' on-line adaptations of input disyllabic borrowed, nonce, and un-borrowed words that contain different combinations and stress variations of the five Russian vowels.

Thirty-seven Russian-Yakut bilinguals spontaneously adapted the input words in a frame sentence on-line after reading each word silently in the production task. In addition, the bilingual speakers, as well three Yakut monolinguals, rated Yakut nonce words on Yakut-likeness after hearing each word in recorded audio files. I hypothesized that the input characteristics of vowels and words that include backness and roundness, height, the quality of an individual vowel input, stress, vowel sharedness between the languages (shared and unshared vowels), vowel reduction and the syllables where these features occur, are significant in driving adaptations of the input vowels. I tested this primary hypothesis using linear mixed-effects model analyses to reveal the input predictors of vowels and words that predict vowel harmony and Yakut-like adaptations.

The main findings suggest that vowel harmony is robust in adaptations, especially backness harmony, which appeared in 81.06% of produced words. The phonological input predictors backness, roundness and height are shown to be significant in driving vowel harmony and Yakut-like adaptation: Russian back vowels (which are also rounded) and non-high vowels were better overall triggers of vowel harmony than front and high vowels, respectively. Moreover, harmony was better achieved in harmonic input words sharing the same features than in disharmonic input. Consistent with the native phonology's rightward directionality of vowel harmony spreading, a first syllable input vowel's features were important in predicting more uniform vowel adaptations and a general rightward propagation of vowel harmony. The speakers were also generally efficient in judging grammatical and non-grammatical nonce words in perception, however, rounding harmony violations were more tolerated than violations of backness harmony. The most-frequent adaptations of the five input vowels /a, e, i, o, u/ in their unstressed forms as /ɑ, ɛ, i, ɒ, u/ show categorical approximation in adaptation, and the stressed vowels, adapted as /ɑː, iɛ, iː, uɒ, uː/, suggest consistent reflection of stressed vowels' phonetic characteristics.

I conclude that phonological characteristics of input vowels and words are essential in predicting vowel harmony and Yakut-likeness in on-line adaptations produced by Russian-Yakut bilinguals. An Optimality Theory (OT) analysis using alignment and faithfulness constraints is shown to account well for the harmonic outputs, but is not necessarily reflective of the less frequent disharmonic adaptations that occurred systematically, contingent on the characteristics of input vowels and words.

Preface

This thesis is an original work by Lena Vasilyeva. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board 1, Short Study Title "Phonological study of Russian loanwords into Yakut", Complete Study Title "Yakut loanword phonology with respect to borrowing Russian words", Study ID: Pro00049053, June 23rd, 2014. I was the principal investigator on this ethics application.

DEDICATION

To my father,
Vladimir Georgievich Vasilyev (1955-2017)

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Chapter 1: Introduction

Yakut[1] (Sakha) is a Siberian Turkic language, which is classified as belonging to the north-eastern branch of the language group (Johanson, 1998) with 450,140 speakers in the Russian Federation (based on the Russian Census of 2010, 2010a: 143). Yakut is mainly spoken by ethnic Yakuts within the territory of the Republic of Sakha (Yakutia) which is populated by 962,835 permanent residents as of January 1st, 2017 (Federal State Statistics Service), which qualifies the republic as "the largest subnational subject of the Russian Federation" (Ferguson, 2016: 142).

The first arrival of the Russians was stated as the early 1600s (Anderson, 1995; Krueger, 1962/2012; Pakendorf & Novgorodov, 2009; Sleptsov, 2008; Sunderland, 1996), and since then there has been a substantial impact of the Russian language on Yakut, and especially since the breakout of the Russian Revolution in 1917, which marks the commencement of the Soviet period (Dyachkovskiy, 1962; Sleptsov, 1964, 2007). Subsequently, most Yakuts have become bilingual in Russian,[2] especially in urban areas, where bilingualism among ethnic Yakuts had already reached almost a 100% in the late 1980s (Anderson, 1995).

Yakut started to borrow Russian words when contact was first made, so Sleptsov (1964: 12) specified 2,797 loanwords that had already been adapted before the Russian Revolution. One of the main characteristics of earlier loanwords was their full assimilation in accordance with the native phonology and application of vowel harmony (e.g., Anderson, 1995; Böhtlingk, 1851/1964; Kharitonov, 1950: 235; Kulakovskiy, 1946: 16; Sleptsov, 1964: 71; Sleptsov, 2007). Note that most early loanwords (more than 80%) were nouns (Kharitonov, 1947: 25; Sleptsov, 1964: 122; Sleptsov, 2007: 97). However, since the beginning of the 20th century with an increasing rate of bilingualism among the Yakuts, more Russian words have been adapted violating the rules of the

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[1] In this dissertation, I use the term 'Yakut' instead of the ethnonym 'Sakha' for two reasons: First, it is the most known term in the English-language literature (as noted by Pakendorf, 2007: 1) and linguistics in general. Second, considering that the dissertation topic is about adaptations from Russian, the term 'Yakut' is appropriate to the context, as it continues to be the dominant term in the mainstream popular Russian discourse. Nevertheless, recent studies published in English have started to use the ethnonym 'Sakha', e.g., Ferguson (2013, 2015, 2016); Pakendorf (2007, 2008); and Petrova (2011), which may indicate a trend over time toward the use of 'Sakha' from *saχa tɯla* 'Sakha language'.

[2] As the data of the Russian Census of 2010 (2010b: 218) indicate, of 466,492 ethnic Yakuts residing in the Republic of Sakha, 416,780 speak Russian (89.3%), and 401,240 speak Yakut (86.01%). Note that some ethnic Yakuts are monolingual in either Yakut or in Russian. Furthermore, from the total of 466,492 ethnic Yakuts in the Republic of Sakha, 438,664 consider Yakut as their native language (94.03%), and 27,027 consider Russian as their native language (5.8%) (The Russian Census of 2010, 2010c: 296).

native (borrowing) language phonology and vowel harmony in particular (Anderson, 1995; Sleptsov, 1975; Sleptsov, 2007). Thus, a growing linguistic interest in Russian loanwords in Yakut had occurred in the early 1960s. Dyachkovskiy (1962) and Sleptsov (1964) presented detailed descriptions of vowel and consonant adaptation patterns in the established (integrated) loanwords[3] for the first time; however, in the context of the rapidly developing bilingualism among Yakuts, up to this day there has been no further comprehensive phonological or phonetic study of Russian loanwords.

The dissertation seeks to address the following main research question: What are the phonological input predictors driving realizations of the Russian vowels /a, e, i, o, u/ in on-line adaptations by modern Russian-Yakut bilingual speakers? The main research question consists of the following successive research sub questions: Firstly: What are the most-frequent adaptations of the five Russian vowels? And secondly: What are the phonological characteristics of input vowels and words that drive applications of vowel harmony and Yakut-like adaptations?[4] How sensitive are modern bilingual and monolingual Yakut speakers to vowel harmony variations? The purpose of this dissertation is to reveal phonological predictors of input vowels and words that affect vowel adaptations and drive applications of vowel harmony in on-line adaptations among the bilingual speakers. Specific research questions and hypotheses that address the dissertation's main research question are provided separately in Chapters 8, 9, 10, 11, and 12.

The original contribution of this dissertation is that it is the first empirical study of vowel adaptations and applications of vowel harmony in on-line adaptations of Russian vowels and words by bilingual Russian-Yakut speakers. The results of the dissertation will shed light on the role of input characteristics of the source language that lead to native or non-native like adaptations among bilinguals who are familiar with the phonology of the source language.

The vowel harmony system in Yakut involves backness harmony and rounding harmony. Whereas Russian permits flexibility when it comes to combinations of vowels within a word, Yakut imposes strict rules pertaining to vowel combinations due to the rules of vowel harmony (Kharitonov, 1947: 29). Yakut has eight vowel phonemes /i, y, ɛ, œ, ɯ, u, ɑ, ɒ/ where each of the

[3] The loanword data were collected primarily based on dictionaries and periodicals, including manuscripts, surveys, and personal observations.

[4] In this dissertation, I use the term 'Yakut-like adaptation (YLA)' as an umbrella term to signify compliance with the vowel harmony rules and non-use of Russian vowels and Russian stress (the shared vowels /i/ and /u/ are not regarded as intrinsically Russian).

vowels has a long contrastive correspondent, in addition to the phonemic four diphthongs /iɛ, yœ, ɯɑ, uɒ/ (e.g., Krueger, 1962/2012). There are no transparent (neutral) vowels in Yakut, unlike other backness harmony languages, like Finnish (e.g., Ringen & Heinämäki, 1999) or Hungarian (e.g., Ringen & Kontra, 1989), so both back and front vowels in Yakut are harmonic. In the harmonic system of Yakut, backness harmony implies backness agreement of all vowels within a word, including suffixes, prompted by the backness value of the first vowel (e.g., Finch, 1985), as in the words *bɯtarχaj* 'tiny' with all back vowels, and *sɛbirdɛχ* 'leaf' with all front vowels. In the rounding harmony system, rounded vowels are followed by rounded vowels, as in *sudurgu* 'simple', *kœlœ* 'vehicle' and *œrœbyl* 'day-off', or rounded vowels are followed by low unrounded vowels as in *yksɛ* 'most' or *turar* 'stands', for example (see Krueger, 1962/2012: 49). Thus, spreading of rounding is conditioned by height restrictions for triggers and targets of rounding harmony (see Kaun, 1995), which is discussed in Section 4.4.2. Directionality of the spreading of features [back] and [round] is from left to right.

Considering that most established loanwords follow vowel harmony and vowels within words get adapted to conform to the native language phonology (as shown in Dyachkovskiy, 1962, Sleptsov, 1962), despite distinct phonological systems between Yakut and Russian (Kharitonov, 1947: 28; 1950; Samsonova, 1959), I focus on vowel adaptations and application of vowel harmony in established loanwords and novel loans. Unlike Russian consonants, which tend to be mapped onto acoustically similar correspondents[5] (despite major differences in the consonant inventories between Russian and Yakut), vowels undergo considerable modifications in adaptations due to the strict regularities of vowel harmony in Yakut (Kharitonov, 1947: 29), and I regard the complexity of the latter as deserving special attention in linguistic research. Hence, in the two key studies by Dyachkovskiy (1962) and Sleptsov (1964) that shed light on patterns of vowel (and consonant) adaptations in Russian loanwords, Dyachkovskiy focuses exclusively on stressed vowels and their realizations, and Sleptsov describes adaptations of stressed and unstressed vowels. Both studies identify several factors that affect vowel adaptations and application of vowel harmony in loanwords: the vowel's position within a word, stress, palatalization of surrounding consonants, and other individual variations. Particularly, a notable role of Russian stress was pointed out in several earlier studies. Monolingual Yakut speakers

[5] "Many consonants in Yakut and in Russian, from the acoustic and articulatory perspective, are extremely close and in certain positions within a word are almost identical." [my translation] (Sleptsov, 1964: 87).

tended to use the backness feature of stressed vowels as a cue to determine backness for the entire word (Böhtlingk, 1851/1964; Kulakovskiy, 1946). Based on Sleptsov's descriptions, one can conclude that overall, adaptations of first vowels, and especially if they are stressed, are mapped onto predictable Yakut vowels, whereas vowels in the following syllables of the input Russian words tend to be affected by the quality of first or stressed vowels, or the quality of surrounding consonants.

However, these earlier studies of vowel adaptations in Russian loanwords have not investigated phonological predictors of input vowels and words of the source (donor) language which affect adaptations. Dyachkovsiy and Sleptsov focus on each of the Russian vowel phonemes and their adaptations in Yakut by output vowel correspondences and descriptions of the contexts of their realizations without further analyses of the complex interactions of the phonological characteristics of the input vowels that may also involve backness, roundedness, height, for instance. Moreover, the two studies focus on established loanwords, borrowed when adaptations were perception-based[6] (Sleptsov, 1964: 71) due to the general monolingualism of the Yakuts before 1917, and have not addressed loanword adaptations by bilinguals. Regarding phonological analyses of established loanwords, Peperkamp (2004: 342) views them as "a diachronic interpretation", since words change when being adapted by the borrowing language. As an alternative to established loanwords, Peperkamp recommends on-line adaptations and regards them on a par with established loanwords, since established loanwords are reflections of speakers' on-line adaptations and their first introductions of words, although she acknowledges that the source and borrowing languages have also changed since the time loanwords were first introduced (p. 342). Bearing in mind that on-line adaptations recreate the way loanwords get adapted by speakers of the borrowing language, a few studies have investigated on-line adaptations (e.g., Haunz, 2007; Shinohara, 2000; Vendelin & Peperkamp, 2006); however, this method of loanword data elicitation has received little attention. A substantial body of research in loanword phonology is primarily based on analyses of corpora containing predominantly established loanwords (e.g., Kenstowicz & Louriz, 2009; Paradis & LaCharité, 2011).

In the context of bilingualism among the modern Yakuts in the Republic of Sakha, and taking into consideration the differences between vowel inventories of Yakut and Russian, I focus on on-line adaptations of the five Russian vowel phonemes /a, e, i, o, u/ presented in different

[6] Only about 2% of the Yakut population was literate before 1917 (Sleptsov, 2008: 405).

combinations within Russian words and subsequent applications of vowel harmony by Russian-Yakut speakers. These speakers have access to the phonology of the source language, unlike predominantly monolingual Yakut speakers in the pre-Soviet era. Morphologically, as most established loanwords are nouns (Kharitonov, 1947: 25; Sleptsov, 1964: 122, etc.), I include Russian disyllabic nouns.

In this paragraph, I review the main findings of the dissertation with regard to the main research question. Although it might be expected that the bilingual Russian-Yakut speakers would produce more disharmonic adaptations than previous monolingual Yakut speakers, I found that vowel harmony in general remains remarkably pervasive in Yakut: out of the total of 5,160 produced words, 4,183 words (81.06%) follow rounding harmony and 3,554 words (68.9%) are Yakut-like adaptations, and out of 3,265 words where rounding harmony is applicable, 2,167 words (66.4%) follow rounding harmony. Results of the rating study also indicated that modern speakers are sensitive to vowel harmony violations. Furthermore, I show that back vowels and non-high vowels are better triggers of vowel harmony application, unlike front vowels and high vowels, respectively. As for the individual vowel phonemes, the input high-mid vowel /o/ is an exceptionally good trigger of vowel harmony. Vowels especially in first syllables display consistent adaptations with little variability; stressed high and low vowels lengthen, and unstressed vowels become short. That is, overall the stressed /a, e, i, o, u/ are commonly adapted in Yakut as the /ɑː, iɛ, iː, uɒ, uː/, and the unstressed correspondents are realized as the short /ɑ, ɛ, i, ɒ, u/, respectively. The vowel adaptations of each of the five vowels suggest that the bilingual speakers systematically adapt the Russian vowels as Yakut vowels, and attend to stress variations to reflect them in adaptations.

This dissertation is divided into the following chapters: Chapter 2 reviews some of the major studies of loanword phonology by focusing on vowel adaptations, followed by Chapter 3, where I discuss vowel harmony studies including application of vowel harmony in loanwords. In Chapter 4, I present a brief overview of Yakut phonology and of Russian phonology in Chapter 5. Chapter 6 discusses studies of Russian loanwords in Yakut with an emphasis on vowel adaptations and application of vowel harmony in loanwords. In Chapter 7, I report the design and methodology of the production and rating tasks that provide the data for this dissertation. Results and reports on the linear mixed-effects model analyses based on the production and rating tasks start from Chapter 8, where I present patterns of most-frequent vowel adaptations and show the results of analyses of input predictors that drive variability of adaptations. Chapter 9 presents the results of analyses of phonological input predictors for the application of rounding harmony, rounding harmony and for Yakut-like adaptation, including the analyses of adaptations of harmonic and disharmonic input words and faithfulness to backness and roundness of input vowels. In Chapter 10, I show the results of analyses of stressed vowels' adaptations. Chapter 11 concerns the rating task, and I examine the phonological predictors of Yakut nonce words that affect the participants' ratings. Chapter 12 explains the sociolinguistic background information on the participants, and delivers the results of analyses of sociolinguistic factors that affect Yakut-like adaptations and ratings. Finally, Chapter 13 discusses the findings of the dissertation followed by the conclusion.

Chapter 2: Studies on loanword phonology of vowel adaptations

The general motivation to study loanword adaptations is summarized by Paradis and LaCharité (2011: 757), "In a broader perspective, by studying the loanword adaptation patterns in many different languages, phonologists can get a better idea of how phonology functions cross-linguistically and universally".

Moreover, studies on loanword phonology have essentially been revolving around the key question of whether loanword adaptation is phonetic or phonological. There have been a series of studies that support the phonetic approach to loanword adaptation (Davidson, 2007; Peperkamp & Dupoux, 2003; Peperkamp, Vendelin & Nakamura, 2008; Vendelin & Peperkamp, 2004, for instance), while phonological loanword adaptation was shown in other studies (e.g., Jacobs & Gussenhoven, 2000; LaCharité & Paradis, 2005; Paradis & LaCharité, 1997, 2001, 2011; Paradis & Prunet, 2000; Uffmann, 2006). Thus, proponents of the phonetic and phonological approaches claim that loanword adaptation is driven by phonetic and phonological aproximation, respectively. In this section, I review the basic findings in studies of loanword adaptation, specifically focusing on vowel adaptations.

2.1 Phonological adaptation

Phonological adaptation involves categorical approximation of the source language's phonemes in the borrowing language (see e.g. Paradis, 1996; LaCharité & Paradis, 2005). It is regarded to be predominantly employed by bilinguals (as they are familiar with the phonology of the source language). For instance, Paradis and LaCharité (1997) investigated segment adaptations in 1,036 attested forms based on 545 French loanwords with the focus on segments and syllables in Fula, which is spoken in West Africa. Paradis and LaCharité claim that the main adapters are bilinguals who do not fully deactivate the source language and that they can compare the borrowing language's phonology with the source language when borrowing. Further, the authors claim that in case segmental structures of the phonology of the borrowing language were not consistent with the phonology of the source language, different repair strategies were involved that included deletion and insertion. They point out the predictability of repairs that are based on the principles of Preservation (i.e., maximal preservation of segments), Minimality (i.e., repairs should be economical), and the Threshold Principles (i.e., two repairs are allowed, otherwise, it is deletion). Paradis and LaCharité do not distinguish two kinds of separate constraints that are applicable to loanwords and native vocabulary (contra, e.g. Silverman, 1992).

Paradis and LaCharité (2011) point out accessibility of phonemic categories of the source language by bilinguals who perform in bilingual mode during adaptation. Paradis and LaCharité state that bilinguals use the phonetic output of the source language to access the categories and structures of the source language, with the purpose of transferring them into the categories of the borrowing language (p. 755). They make an interesting claim that phonetic adaptation is, in fact, done by monolinguals or bilinguals performing in the native (borrowing) language mode who lack access to the source language's phonology, therefore surface phonetic representations of the source language are mapped onto categories of the borrowing language directly. Indeed, the role of bilingualism in adapting words phonemically rather than phonetically was also noted by Heffernan (2005). Another interesting note by Paradis and LaCharité concerning bilinguals is that a larger number of importations (non-adaptations) correlates with an increased number of bilinguals; for example, more importations were observed in the Montreal French corpus with a higher rate of bilingualism, compared to the Quebec City French corpus (p. 763).

Further support for the phonology-based adaptation was presented by Paradis and Prunet (2000). Their analysis of a large database of borrowings in eight different languages showed that segmental sequences that are illegal in the borrowing language were replaced by single segments in the borrowing language, like the vowel /y/, (which in government phonology is often viewed as consisting of /i/ and /u/), is realized as /u/ from the French /byro/ 'desk' as /buro/ in Spanish (p. 331), considering that the latter does not have front rounded vowels. The authors speculate that despite the presence of the diphthong /iu/ which is realized as [ju] in the borrowing language, the French /byro/ is not adapted as [bjuro] in Spanish, which supports the claim that ill-formed segmental sequences of the source language are mapped onto single segments. However, with respect to nasal vowels, they surfaced as oral vowels preceding nasal consonants in languages that do not have nasal vowels, as in the French loanword in Fula /kɔnsɛj/ 'advice' from the French /kɔ̃sɛj/ (p. 327). The study claims that contrastive nasal vowels universally contain two phonemes: an oral vowel and a nasal consonant, the presence of which is consistently reflected in loanwords. A similar study of loanwords with illegal segments existing in a database of English loanwords in French was conducted by Paradis and LaCharité (2001). They observed that the laryngeal segment /h/ from the source language was systematically deleted once adapted in French. The authors rely on the Non-Availability Hypothesis, that is, due to the nonexistence of phonological pharyngeal node characterizing articulation of pharyngeal and laryngeal gutturals /ħ, ʕ, h, ʔ/ for consonants in French phonology, the laryngeal segment /h/ from the source language underwent consistent deletion in the borrowing language. As a strong argument, the study shows that languages that have pharyngeal node consonants, but not /h/ (like Spanish, Bulgarian, Mandarin Chinese, Russian) adapt the English segment /h/ as velar or uvular fricatives. They predict that if the borrowing language has one of the guttural consonants /x, ɣ, χ, ʁ, ħ, ʕ, ʔ, q, ɢ/, instead of deletion of the laryngeal consonant /h/ of the source language, it gets adapted in the borrowing language (p. 269).

Next, LaCharité and Paradis (2005: 234) exemplify adaptation of the English vowels /ɪ/ and /ʊ/ in Mexican Spanish, where from the phonetic stance, considering acoustic measurement of formant values, the vowels were closer to the vowels /e/ and /o/ in the borrowing language. However, they surfaced as /i/ and /u/ in Mexican Spanish, which suggests adaptation as based on categorical proximity, rather than acoustic.

Jacobs and Gussenhoven (2000) argue that speech signals are analyzed by a larger "universal phonological vocabulary" (p. 198), meaning that speakers do perceive foreign sounds not represented in their native language, beyond the scope of their native phonological system. However, by referring to Smolensky (1996), Jacobs and Gussenhoven establish parallels to perception during child language acquisition in loanword adaptations. That is, the input is stored faithfully, since it is perceived as it is, and then that input undergoes competition to become the best underlying representation. In turn, the output (in production) is parsed through the phonological markedness constraints of the borrowing language. As for segment adaptations, they show that the French front rounded vowels as in /plyˈmo/ 'duster' and /ʃəˈvø/ 'hair' are adapted as the front unrounded vowels /plimo/ and /seve/ in Mauritian Creole (p. 203). Mauritian Creole has back rounded vowels but does not have front rounded vowels in its inventory, unlike French. They propose that when vowels have double articulations, like labial articulation for the French coronal and dorsal vowels, there is no set ordering of both articulations (i.e., which of the features comes first). Using an Optimality Theory (OT) account, they show that a set of ranked anti-association constraints outranking the constraint that ensures parsing of all input features explains the emergence of surface front unrounded vowels rather than back rounded vowels. Those anti-association constraints in Mauritian Creole represent dorsal coronal, coronal labial and labial vowels, and such vowels are precluded from surfacing in production due to their phonological markedness in the borrowing language, meaning that no vowel can contain both respective features simultaneously.

In sum, the phonological stance of adaptation is adaptation based on phonological/featural proximity. It is often linked with bilingualism as noted by Paradis and LaCharité (2011), as bilinguals know the source language's phonological categories, which further predetermines phonological adaptation.

2.2 Phonetic adaptation

The phonetic stance views loanword adaptations to be taking place in perception and claims adaptations to be phonetic per se, and regards loanword adaptation as *not* a premise of the computation of the borrowing language's phonological grammar (Peperkamp & Dupoux, 2001, 2003). In the spirit of the phonetic stance of loanword adaptation, the perceptual assimilation model (PAM) primarily proposed by Best (1991), views acoustic or articulatory-gestural properties to be at play at discriminating and assimilating non-native sounds in relation to the phonemes of the native language in perception (see also Best, McRoberts, and Goodell, 2001).[7]

In a ground-breaking study supporting phonetic adaptation, Silverman (1992) investigated English loanwords in Cantonese. His main claim is that the phonological representation of loanwords is not accessible to Cantonese speakers, and incoming borrowings are perceived acoustically purely by native Cantonese speakers. Silverman proposed two levels of the loanword phonology: firstly, the perceptual level (Scansion One) and secondly, the operative level (Scansion Two). The perceptual level is concerned with parsing an input acoustic signal of the source language into segments within the constraints of native phonology. In other words, Silverman suggests that at the perceptual level, Cantonese speakers analyze incoming foreign acoustic signals within the constraints of native segments' inventory, as loanwords are incorporated in the Cantonese language setting, which also concerns bilinguals who have proficiency in English. Thus, feature matrices of input English segments that are not present in Cantonese are mapped onto articulatorily and acoustically close native segments (p. 296). To support the hypothesis that segments are incorporated within the constraints of the language setting, Silverman refers to

[7] I would like to thank an external reader of this dissertation, Dr. Gunnar Ólafur Hansson, for his comments and suggestions.

Elman, Diehl, and Buchwald's (1977) study showing that bilinguals' perception of individual syllables was greatly contingent on the language in which the experiment was conducted.

The operative level is about the raw segmental materials undergoing phonological processes to conform to the native prosodic constraints that define the structures of syllables and metrics. At the operative level, Silverman describes applications of phonological and prosodic processes distinct to the loanword phonology. Analyses of truncated forms in English loanwords support Silverman's claim that perceptually salient segments, like vowels as sonority peaks and the postvocalic /s/, are regarded as syllabic segments (see also Yip, 2002, on the adaptation of English loanwords in Cantonese). That is, those salient perceived segments obtain syllable nodes, for instance, the English input *tips* is parsed as [t^hips] in Scansion One where the vowel /i/ and the consonant /s/ receive syllable nodes to subsequently (and preferably) form a binary foot. In Scansion Two, the output of Scansion One [t^hips] complies with the constraints of the native phonetic and prosodic processes and surfaces as [t^hipsi] (p. 319), considering that neither complex codas nor complex onsets are acceptable in Cantonese (p. 294). However, Kertész (2006: 8) pointed out some issues in Silverman's model, like the deletion of the perceptually accessible acoustic signal /t/ from the input *lift* as [lif] in Scansion One (as /t/ is present in the Cantonese inventory). Kertész says that the sequence /ft/ is just phonotactically ill-formed and could possibly be dealt at the operative level. She also points out that Silverman does not explain why, depending on positions, certain segments are recovered and others are deleted (or not perceived) by Cantonese speakers, for instance.

Similar to Silverman, Peperkamp and Dupoux (2003) define loanword adaptations as "phonetically minimal transformations" (p. 367). The authors suggest a phonetic decoding module that concerns mapping of incoming strings of foreign signals onto the closest, from the phonetic point of view, native forms, described as "the phonetic surface form" or "discrete representation" (p. 368). By 'close' they imply acoustic and articulatory gestural proximity. In turn, mapping of those phonetic surface forms onto underlying forms takes place within a phonological decoding module. In other words, the process of phonetic decoding, according to Peperkamp and Dupoux, is the process of mapping of input acoustic signals onto available phonetic categories of the borrowing language that are acoustically or articulatory gesturally close to the native sounds. Moreover, mapping of non-native speech signals onto the borrowing language's phonetic categories also involves the loss of the source language's sounds' fine-grained acoustic details or contrastive features (p. 368). That is, frequent unfaithful mapping of the sounds of the source language occurs during phonetic decoding, mainly because the borrowing language lacks certain contrastive features or acoustic information of the source language's sounds. Peperkamp and Dupoux claim that two non-native sounds are mapped onto one phonetic category of the borrowing language if they are both phonetically close to that category, which may lead to the difficulty in contrast perception among listeners. For example, Korean listeners perceive [liːd] as [riːd] (p. 367-368), which is due to the lack of the segmental contrast between [l] and [r] in Korean. Thus, the authors reject the notion of 'phonological deafness' when listeners are unable to discriminate contrasts of non-native sounds. Instead, they propose that non-perception of non-native sounds' contrasts (i.e. 'deafness') is due to phonetic decoding which operates within the restrictions of the borrowing language.

Vendelin and Peperkamp (2004) explain the process of loanword adaptation to be based on the principle of minimal phonetic distance in perceptual assimilation and phonetic details and their variations from one source language to the other to affect adaptation. By referring to Peperkamp and Dupoux's framework (2003), Vendelin and Peperkamp clarify the notion of 'perceptual assimilation', when phonological structures of the source language's segments, suprasegments and phonotactics of syllables undergo systematic distortion in perception, in other words, loanword adaptation is a reflection of perceptual assimilation that takes place in the process of phonetic decoding (p. 2). They found that phonetic details and variation in length, intensity and release in two different source languages affected perception among Japanese speakers. The authors compared the word-final /n/ in their stimuli, which were non-words spoken by French and American English speakers. Previously, on-line adaptations and established loanwords in Japanese showed that French loanwords with an input ending in /n/ were adapted with an epenthesized vowel word-finally, as in [duanːɯ] 'customs' from the French [dwan], whereas English loanwords with /n/ word-finally in the input never showed a vowel epenthesis following /n/, as in [napɯkiɴ] from the English *napkin* (p. 2). Vendelin and Peperkamp found that monolingual Japanese speakers sensed the difference of length, intensity and release in the word-final /n/ presented mostly in non-words in both languages in a forced choice task, which showed evidence that the established loanwords and on-line adaptations were adapted to phonetically closest surface candidates that are legal in their native language. Specifically, an epenthetic vowel was perceived more often in the stimuli produced by French speakers due to its acoustic greater length, intensity and release. In an extension of this study, Peperkamp, Vendelin and Nakamura (2008) confirmed that native Japanese speakers, both monolingual and bilingual, perceived a word-final /n/ in non-words spoken by a French speaker as followed by the Japanese vowel /ɯ/ due to its strong vocalic release in the French pronunciation in this context. By contrast, the same word-final /n/ in non-words spoken by an English speaker was associated with a moraic nasal consonant. Epenthetic vowels in loanwords due to phonetic adaptation have also been attested in other recent studies (e.g., Davidson, 2007; Kang, 2003).

The above studies recognize loanword adaptation to be based on phonetic proximity. Unlike studies on phonological adaptation, studies supporting phonetic adaptation do not reference the role of bilingualism. Overall, in the phonetic stance of adaptation, the role of phonetic distance is especially emphasized, which serves as a determining factor of mapping one sound and form to the other from the source language onto the borrowing language.

2.3 Adaptation based on phonology and phonetics

Despite different stances between the two views on loanword adaptation, whether it involves phonetic or phonological mappings, some studies support the idea that adaptation is based on both approaches.

Adaptations of the phonologically identical German and French mid front rounded vowels /œ/ and /ø/ in Japanese confirmed both phonetic and phonological grounds (Dohlus, 2005). Considering that Japanese does not have front rounded vowels it is expected that they are replaced by other vowels in loanwords. Dohlus demonstrates that the German /œ/ and /ø/ were adapted as /e/ in Japanese, as the German *Röntgen* 'X-ray' [ˈrœntgən] is realized as *rentogen* or the German *Goethe* 'Goethe (personal name)' [ˈgøːtə] is adapted as *gête* (p. 121), which is a phonological approximation. The German /œ/ and /ø/ are [-high], [coronal], [labial], whereas the Japanese /e/ is [-high][8], [coronal]. So by mapping the vowels onto /e/, Japanese keeps the distinctive phonological features of the input vowels, as the role of the feature [labial] is negligible in the Japanese phonology, so retaining the input rounding is not crucial in Japanese. In a perception experiment, Japanese listeners identified the German mid rounded vowels mainly as /u/; the phonetic characteristics of the Japanese /u/ are considerably fronted and centralized with a weaker lip

[8] Note that I use the traditional binary distinction system to signify vowel height throughout the dissertation.

rounding. Moreover, acoustic measurements of the formant frequencies showed that F2s of both Japanese vowels /e/ and /u/ are close to the F2s of the German /œ/ and /ø/, and yet the Japanese listeners perceived them as /u/ rather than /e/. Dohlus clarifies that German loanwords are mainly academic terms that were adapted through written media. Because of the absence of oral input, the adaptations were phonologically driven. Conversely, the French mid front rounded vowels /œ/ and /ø/ were mapped onto /u/ in Japanese. Considering that the Japanese listeners in her experiment perceived the German mid front rounded vowels as /u/, Dohlus concludes that adaptations of the French /œ/ and /ø/ are based on phonetic approximation, e.g.: the French *fleuret* 'foil (fencing)' [flœːˈrɛ] is *fur<u>û</u>re* in Japanese or the French *pot-au-feu* 'Pot-au-feu (dish)' [pɔtoˈfø] is *po to f<u>u</u>*, respectively (p. 125). Unlike German, most French loanwords were used in daily communications and came through fashion, cuisine and arts, for instance, which provided more opportunities to access oral input. The point of Dohlus's study is that although loanword adaptations were primarily phonetic, in the case of inaccessibility of oral input, phonological approximation took place.

Similarly, a complex interaction of both phonological and phonetic processes in adaptations was found in Japanese loanwords in Korean, shown in Ito, Kang, and Kenstowicz's (2006) study of corpus data which was compiled based on a dictionary. The Japanese vowels /i, e, a, o, u/ were mapped phonologically onto the corresponding Korean vowels, as the Japanese words /kagami/ 'mirror', /sebiro/ 'suit', /teɴpura/ 'tempura' are adapted as /kakami/, /sepiro/, /tenpura/ (or /tempura/) in Korean, respectively (p. 67). However, the Japanese vowel /u/ was systematically adapted as /ɨ/ after coronal sibilants, and the mapping onto /u/ was an elsewhere case, like the Japanese /susi/ 'sushi' was adapted as /sɨsi/ in Korean (p. 67). Ito et al. explain that the phonetic transcription of the Japanese /u/ is [ɯ] (due to the lack of lip rounding per se but rather vertical lip compression), and by following Homma's (1973: 352-3) and Fitzgerald's (1996) studies, they agree that when preceded by the sibilants [ts], [s], [z], the vowel turns into the centralized [ɯ̈], so adaptation in Korean reflects the allophonic variation. Ito et al.'s summaries of formant value measurements of the phonetic Japanese [ɯ] are shown to be closest to the Korean [ɨ], and the Japanese vowel [u] was systematically mapped onto its Korean correspondent [u], except for the context when the allophonic [ɯ̈] occurs. This finding is in line with Dohlus (2005), who claims that acoustic similarities between vowels do not necessarily predict adaptations. Overall, Ito et al. suggest that the phonology of the borrowing language considers its native contrastive features, and when phonetic dimensions in the source language correspond to those contrastive phonological features, feature specifications are assigned to the vowels of the source language, for example, a feature specification [labial] (which is contrastive in Korean) is assigned to the allophonic centralized [ɯ̈] by specifying it as [-labial] and assigning [+labial] to the vowel [ɯ], respectively. Furthermore, Ito et al. mention that Japanese has a contrastive long and short vowel opposition, whereas the contrast in Korean is not reliable (p. 73). Yet, the corpus data showed that there was a fair preservation of vowel length. For instance, Japanese short vowels were not mapped onto long vowels in Korean. An asymmetry in adaptation was observed in the long Japanese vowel /eː/ that surfaced as /e.i/ in Korean as in the Japanese hiragana orthography. Yet the vowel /oː/ was never adapted as /o.u/ in accordance with the correspondent written form /o.u/, but it was primarily realized as /oː/ in Korean. The authors link this asymmetry to the actual pronunciation of these long vowels in the source language, where /eː/ is often produced as /e.i/ and /oː/ is never articulated as /o.u/ by Japanese speakers.

Lin (2008) showed consistent faithful mapping of the backness feature for back and front vowels in English loanwords in Standard Mandarin, including high vowels that were rarely mapped onto low vowels, or vice versa. Lin's study shows that variability in the realization of the perceptually ambiguous input mid and central vowels implies phonetic adaptation, and faithful mapping of high and low or front and back vowels suggests phonological adaptation (p. 378). In a subsequent paper, Lin (2009) concludes that features of more perceptually salient vowels tended to be faithfully adapted, that is, more peripheral vowels - tense (peripheral) vs. lax or high (peripheral) vs. mid vowels - had fewer mismatches in terms of faithful feature mapping.

Other studies have also claimed that both phonetic and phonological factors are involved in loanword adaptations (Chang, 2008; Davis & Cho, 2006; Kang, 2010a; Kochetov, 2008; Rose & Demuth, 2006; Shinohara, 2006, Yip, 1993). The phonetic-phonology stance of loanword adaptation is suggested to offer considerations of different factors: in some cases adaptation is phonetic, whereas in others it is phonological, rather than being categorical (phonetic versus phonological).

2.4 Adaptation of stress

There are several ways stress is adapted in loanwords that include vowel lengthening, segment deletion (truncation) and stress shift.

One of the most recent studies that sheds light on stress adaptation is presented by Kenstowicz (2007). Fijian native phonology allows the forming of bimoraic trochaic feet by parsing syllables from right to left with the predictable word or phrasal main stress' location to be the rightmost foot (p. 317). Kenstowicz points out the role of auditory salience in adaptation, when Fijian listeners consistently preserved the perceptually salient English main stress in loanwords. One of the repair strategies in regards to stress adaptation was lengthening of correspondent stressed vowels from English to form a bimoraic foot. In addition, epenthetic vowels in loanwords did not receive stress.

Broselow (2009) claims that stress adaptation takes place on the perception level, as shown in Huave and K'ichee'. He observed that stress from Spanish is preserved in Huave and K'ichee'. Driven by perception grammar of the borrowing language, Huave listeners interpreted Spanish stressed syllables as word-final syllables (i.e. word edges) and deleted Spanish post-tonic segments, since in Huave closed final syllables are stressed (when the final syllable is light, the penultimate gets stressed). The same tendency was observed in K'ichee'.

As for languages with fixed word-initial syllable stress like Finnish and Hungarian, two repair strategies were observed in American Finnish and American Hungarian loanwords: stress shift and deletion of unstressed initial syllables (Fenyvesi & Zsigri, 2006). The corpus analyses of loanwords from American English in both immigrant varieties showed that initial unstressed syllables without an onset were deleted most in both American Finnish and American Hungarian. For example, the Hungarian loanword [ˈmɛrikɛn] from the English *American* (p. 139) or the Finnish [ˈsesːari] from the English *assessor* (pp. 141). In contrast, no deletion of initial unstressed syllables with onsets occurs, as the English input *police*, which is adapted as [ˈpolits] in Hungarian (p. 140). Fenyvesi and Zsigri claim that English words were adapted perceptually through auditory input rather than visual one (due to a low English literacy rate among Finnish and Hungarian immigrants). Thus, onsetless syllables are less salient than the ones with onsets, leading to unstressed initial V-syllables to undergoing deletion in adaptation. The fact that less salient segments (e.g., liquids) underwent deletion was also observed in English loanwords into Cantonese (Yip, 1993).

Kang (2010b) recognizes different strategies employed in adapting stress, and expresses disbelief in rigid rules of stress adaptation, especially when they are linked to language typology.

Instead, Kang hypothesizes that a closer language contact (which means a higher bilingualism rate) with the source language leads to a better preservation of input stress (p. 2307-2308).

In general, as shown in the above studies, stress, being a salient feature (Kenstowicz, 2007), is shown to have a tendency to be reflected in loanwords in the form of lengthening or primary or secondary stress. Stress shift or deletion of unstressed syllables was observed when stress was strictly fixed in the native phonology as in Finnish and Hungarian (Fenyvesi & Zsigri, 2006).

2.5 Role of orthography in loanword adaptation

Orthographic influence in loanword adaptations has been investigated in several recent studies. Dohlus (2005: 130) states, "…orthography enables faithful perception due to hinting to the source phoneme and as a consequence triggers phonological approximation".

As for the role of orthography in general, Peperkamp and Dupoux (2003) state that orthography is likely to be at play when written input is provided to speakers or when they are familiar with the loanwords' spelling in the source language (p. 369). Although the importance of the role of orthography in adaptations was largely rejected by LaCharité and Paradis (2005) - despite occurrences of orthographically motivated loanwords like *buldiŋ* in Mexican Spanish from the English *building* in the loanword database, which they consider as "atypical" (p. 241) - other authors confirmed its relevance in adaptations. For instance, Detey and Nespoulous (2008) found that Japanese speakers inserted more vowels in CC-clusters of French non-words when they were provided by visual stimuli only rather than in the auditory and audiovisual conditions. Similarly, Smith (2006) in her data where she classified the sources of loanwords as auditory or orthographic, also discovered that more vowel epenthesis occurred in orthographic loanwords than in the auditory ones which exhibited more deletion repairs. She claims that because the information was provided by orthography, certain perceptually unavailable consonants in loanwords become accessible to Japanese speakers.

One of the most ground-breaking studies of the influence of orthography in loanword adaptations was conducted by Vendelin and Peperkamp (2006). In this study, French-English bilinguals were asked to adapt English non-words (verbs) mixed with some English low-frequency words and one French word. The words were CVC sequences that contained eight different vowel monophthongs in English, of which half did not occur in French. The stimuli were presented orally only in the first condition. In the second mixed condition, the participants saw written forms on the screen followed by an oral stimulus. In both conditions, the participants adapted non-words in French online, by inserting the novel verbs in carrier sentences in French. Findings from mixed condition adaptations reflected the bilinguals' grapheme-to-phoneme mappings as compared to oral condition results, where more variations were found.

Similarly, influence of orthography on loanword adaptations was established in Daland, Oh, and Kim's (2015) study. They examined English loanwords in Korean, specifically focusing on vowels. Vowel adaptations in a loanwords corpus were analyzed using information-theoretic statistics that computed measurements of orthography and perception's contributions in loanwords. It was found that both orthography and phonetics/phonology, i.e., perception, contributed to adaptations of vowels. Furthermore, it was shown that orthography contributed to the adaptation of unstressed vowels and a greater involvement of perception took place in respect to stressed vowels. The authors also conducted an experiment, methodologically similar to Vendelin and Peperkamp' s (2006) study, in which Korean speakers conducted on-line matchings of the English stressed vowels /ɛ/ and /æ/ in CVC non-words to the most similar Korean sounds. The choice to focus on the two English vowels /ɛ, æ/ was motivated by the complete articulatory merging of both vowels into the single vowel /ɛ/ in modern Korean. Moreover, a greater challenge in the perceptual discrimination between the English vowels /ɛ/ and /æ/ was informally observed among Korean students learning English. It was shown that in oral-only conditions the listeners did not perceive a perceptual contrast between the two vowels with an observed tendency to adapt the vowels as /æ/ more. In turn, in oral-written conditions, when cued by the English orthography ("a" for /æ/ versus "e" for /ɛ/), the listeners mapped the English /ɛ/ onto the Korean /ɛ/, and the English /æ/ was adapted as the corresponding vowel /æ/ in Korean.

As shown in the above studies, orthography plays a role in adaptation. Specifically, orthography provides additional information which may not be detectable perceptually, as seen in forced choice experiments (Daland, et al., 2015; Detey & Nespoulous, 2008; Vendelin & Peperkamp, 2006), where orthographic cues affected the participants' judgments and adaptations of the segments.

2.6 Summary

Proponents of phonological (e.g., Paradis & LaCharité, 2011) and phonetic (e.g., Peperkamp & Dupoux, 2003) stances of adaptation give arguments on whether loanword adaptation is purely phonetic, based on phonetic proximity, or phonological, based on categorical/featural proximity. As noted by Kang (2010a: 227), loanwords have been studied either based on (corpora of) established loanwords (see Chang, 2008; Kenstowicz & Louriz, 2009; Kochetov, 2008; Paradis & LaCharité, 2001, 2011; Uffman, 2006, among others) or on-line adaptations (Vendelin & Peperkamp, 2006; Peperkamp, Vendelin, & Nakamura, 2008, for instance). Reviews of the methodologies in the studies supporting phonetic and phonological adaptation reveal the tendency that most phonetic account studies are experimental in nature, and studies claiming pure phonological adaptation are mostly corpus studies of established and existing loanwords. Moreover, on-line adaptations are primarily based on nonce words with few incorporated actual words from the source language (as in Daland, et al., 2015; Vendelin & Peperkamp, 2004, 2006; Peperkamp, et al., 2008), leaving the question open how speakers would realize non-adapted actual words from the source language versus nonce words. Considering that phonological adaptation is initiated by bilingual speakers (e.g., Paradis & LaCharité, 1997), and that most studies claiming the phonological account of adaptation are based on analyses of corpus data of established loanwords, more experimental studies of on-line adaptations are needed, which should involve bilingual speakers (since they are familiar with the phonologies of the source and borrowing languages).

Regarding overall faithfulness to certain features in loanword adaptation, saliency is attested to affect adaptation, specifically, that features of more salient elements tended to be faithfully preserved, like vowels (Yip, 2002), peripheral vowels (Lin, 2008, 2009), or main stress (e.g., Kenstowicz, 2007).

Chapter 3: Studies on vowel harmony in loanwords

This chapter gives a brief review of the main theoretical frameworks that have been used in vowel harmony studies in loanwords. In Section 3.1, I present a brief overview of frameworks in vowel harmony studies; in Section 3.2, I review studies of vowel harmony specifically in loanwords, and their main findings that reveal certain factors at play in attaining *and* violating harmony.

3.1 Main frameworks used in vowel harmony studies

Considering that Optimality Theory (OT, Prince & Smolensky, 1993) has been a landmark theory in generative phonology, I discuss two periods of the frameworks used in the studies of vowel harmony hypotheses: before and after its arrival.

3.1.1 Phonological frameworks before the introduction of OT

This section overviews main frameworks that have been used in studies of vowel harmony before OT was introduced in the early 1990s. Studies of the typology of vowel harmony started to actively develop in the 1960s (Aoki, 1966, 1968; Lightner, 1965; Zimmer, 1967, etc.). The studies of this period were concerned with the question of whether vowel harmony was driven by assimilation rules or morphophonemic factors. There was a focus on signifying distinctive features of vowels with the purpose of arriving at the rules governing vowel harmony. For instance, by surveying the rounded vowels in roots and the quality of following suffix vowels, Korn (1969) posited that rounding (labial) harmony in all Turkic languages could be classified into eight types based on the number of rounded vowels that trigger rounding harmony. Each rounded vowel from the inventory of a Turkic language is shown followed by suffixes that contain the low vowels /ɑ, ɛ/[9] and suffixes that include the high vowels /y, i/. Korn then checks whether rounding optionally occurs or does not occur after each rounded vowel in the root, thus revealing a rounding harmony trigger vowel in a specific Turkic language.

Close attention to individual segments and the properties of vowels was indeed a premonition of the emerging autosegmental theory as a primary framework for analyzing vowel

[9] Korn does not specify the exact height of the transcribed vowels, instead, he broadly refers to them as 'high' and 'low'; I interpret the transcribed /ä/ as /ɛ/ for the purpose of this summary.

harmony in subsequent years. That is, in autosegmental theory, vowel harmony is viewed in 'a nonlinear model', where phonological representations are not just exhaustive unit sequences (linear); rather, they are strings of independent autonomous segments (autosegments) that determine coarticulation by binding those independent segments together, driven by an association relationship (Clements, 1976: 43-44). Overall, the association is realized through P-segments that represent a harmonizing feature (e.g., in Turkish backness harmony the P-segments are the features [+back], [-back]; or [+round], [-round] in rounding harmony); the P-bearing segments (i.e. vowels) are associated with a P-segment within the domain, i.e. a phonological word (Clements and Sezer, 1982: 217-218). An autosegmental approach was successfully used in the analyses of neutral vowels in Hungarian (Booij, 1984; Ringen, 1988), Pasiego (McCarthy, 1984), Mongolian, Finnish, and Hungarian (Goldsmith, 1985), or metaphony (when word-final or high stressed vowels serve as triggers of harmony) in the Asturias-Cantabria dialects of northwestern Spain (Hualde, 1989).

Inspired by the central notion of autosegmental theory with feature representations as units, an extension of the theory as the feature geometry model was proposed by Clements (1985). The feature geometry model views phonological representations as consisting of multiple tiers (functional units) where each tier containing segments represents sets of features organized independently in a hierarchical order (Clements, 1985: 226-227). For example, concerning vowel harmony, Clements states that segments on a separate tier may or may not be affected depending on the rule (p. 227; see also Halle, 1995). Välimaa-Blum (1999) showed that by using the feature geometry model one can account for the spreading of back (dorsal) versus front (coronal) feature values in Finnish disharmonic loanwords.

There has been a great interest in the notion of underspecification that poses the question whether certain features are underspecified underlyingly. Pulleyblank (1988: 236) cites Kiparsky (1982), who proposed that in Universal Grammar (UG) each distinctive feature has a paired default value, and that those default values are not specified in underlying representation motivated by the rules of redundancy. Archangeli (1988: 203) asserts that "some sort of underspecification is necessary in phonological theory". As noted by Archangeli, in vowel harmony, underspecification theory accounts for the behaviour of transparent vowels or consonants that are not affected by the rules, i.e., intervening segments that do not participate in harmony, since their features are unspecified (p. 198). Moreover, in a later study, Harrison (1999, Formal analysis of BH, para. 1), by referring to Steriade (1995), suggests that all post-initial vowels are underlyingly unspecified for the feature [back] in the Tuvan backness harmony system with the rightward spreading of backness from the initial vowel. That is, in vowel harmony studies, through the prism of underspecification theory, the following features in underlying representation appeared to be unspecified: [ATR] for high and low vowels in Yoruba (Archangeli & Pulleyblank, 1989); low vowels in Okpe (Pulleyblank, 1986); the [back] feature for neutral vowels in Hungarian (Ringen, 1988); and [-high] specification for Pasiego vowels (Vago, 1988). Furthermore, one of the key principles of the underspecification theory was the Locality Condition posited by Archangeli and Pulleyblank (1987) specifying the spreading process to be local, i.e. targets and triggers must be adjacent (as cited in Vago, 1988: 348). In harmony studies, the notion of 'trigger' implies a segment that spreads its feature specification onto 'target' segments, i.e., 'target' is a segment that undergoes harmonization induced by the harmonizing feature of the harmony trigger (see, e.g., Kaun, 1995, 2004; Walker, 2005). The principles of the local spreading of harmony were attested in subsequent studies of vowel harmony (e.g., Nevins, 2010; Ringen, 1988, etc.).

3.1.2 Phonological frameworks after the introduction of OT

Since the introduction of Optimality Theory (OT) by Prince and Smolensky (1993), the OT framework has been the most widely-adopted model for analyzing vowel harmony up until nowadays. Finley (2010) summarizes the central idea of the theory, "In OT, the set of possible languages is determined by the set of possible rankings of universal constraints." (p. 1549). In other words, within the input-output relationship, possible output candidates generated from the input compete to be the optimal winner by being evaluated based on the grammar of that language represented by the ranked violable markedness and faithfulness constraints. Krämer (2003: 50) notes that unlike other generative approaches, in OT, the constraints and their ranking are the grammar of a specific language, and infinite outputs are generated from a single input; the winning output incurs least violations of the most important language-specific constraints. An OT approach has been presented as a suitable framework of showing grammars at play in driving vowel harmony in different languages, e.g. Assamese in Mahanta (2012); Yoruba and Wolof in Pulleyblank (1996); Hungarian in Ringen & Vago (1998). In a study of vowel harmony in Turkish, Kirchner (1993) accounts for the feature spreading within harmony domains (which he regards as morphological categories comprising roots and words), as due to the alignment of a feature [F] affiliated to the rightmost and leftmost edges (syllables) within the morphological category (domain) (p. 6). To ensure that all vowels are affected by the feature specification expressed by the alignment constraints, Kirchner posits the gapped configurations condition which rules out a candidate that has a nucleus that is skipped to be associated for certain features (p. 6-7). Alignment constraints have also been crucial in accounting for vowel harmony in Yoruba and Wolof (Pulleyblank, 1996), and Kinande (Archangeli & Pulleyblank, 2002), for instance. Walker (2012) points to the particular importance of the interaction between alignment and faithfulness constraints. For example, the highest-ranked alignment constraint ensures that the feature [back] is aligned with the prosodic word's rightmost edge and outranks the faithfulness constraint requiring the feature [back] to be preserved faithfully from the input in the corresponding output. It explains attaining of backness harmony in Turkish from the input *sap-ler-in* (handle-PL-GEN) with two suffixal front vowels preceded by the back vowel in the first syllable to the winning output *sap-lar-ɯn* with all back vowels in the prosodic word (Walker, 2012: 577). As Walker's analysis demonstrates, since the faithfulness constraint is ranked below the alignment constraint, two violations of the former (the two vowels following the first one changed their backness feature) does not preclude the candidate *sap-la-rɯn* from winning. In other words, alignment of all [back] features with the rightmost syllable vowel is more important in attaining backness harmony than faithfulness to the feature [back] of the input. Note that the undominated alignment constraint, as shown in Walker's example, is suitable for languages that have inviolable vowel harmony.

In addition to alignment and faithfulness constraints, Walker's overview of different OT accounts of vowel harmony points out the importance of markedness (and agree) constraints. Markedness constraints penalize marked forms (segments and features) in the output (de Lacy, 2011), in other words, the notion 'marked' denotes structures that are avoided in a language (de Lacy, 2006). For instances, in Assamese [ATR] harmony, the markedness constraint *[-ATR][+ATR] indicates the avoidance of a sequence of a [-ATR] segment followed by a [+ATR] one (Mahanta, 2012). Furthermore, Mahanta employs agree constraints, which require that adjacent segments bear the same feature value. That is, the crucial ranking of the faithfulness (correspondence), agree and markedness constraints account for principles of [ATR] harmony in Assamese (Mahanta, 2012) and the ranking of alignment, faithfulness and markedness constraints explain [ATR] harmony in Yoruba and Wolof (Pulleyblank, 1996) and backness harmony in Hungarian (Ringen &Vago, 1998), for instance.

OT accounts of vowel harmony come in different flavours. Based on the constraint-based principles of the OT framework, Cole and Kisseberth (1994) posited the Optimal Domains Theory (ODT) approach. Cole and Kisseberth explain that harmony occurs within specific domains (F-domains) bearing a feature [F] which is realized on all anchors (elements) within that domain (p. 3). For instance, Cole and Kisseberth illustrate the ODT approach in analyses of rounding harmony in Turkish and Kazakh, where the harmonizing feature specification is [round] in 'the round domain', and anchors are vowel segments. That is, the ODT approach holds the principle that F-domains are parsed surface forms of underlying representations for a certain feature specification (Cole & Kisseberth, 1995: 25).

The principle of the Locality Condition of the spreading process, which proposes that vowel harmony operates within a certain domain, and autosegmental theory in general conditioned the emergence of Span Theory (McCarthy, 2004). According to McCarthy, spans are constituents of a word that represent different associations based on autosegmental features. Each span has a head segment with a value of a feature [F] that causes pronunciation within the span according to the span's head specified value for [F]. An exhaustive parsing of a word into spans explains the spreading process. In general, the theory disfavors multiple adjacent spans, for instance, in languages with strict harmony, each word consists of only one span. Nevertheless, Span Theory did not gain popularity in vowel harmony studies. In fact, Blumenfeld and Toivonen (2016) suggest the Agreement-by-Correspondence approach works better than Span Theory in accounting for vowel harmony. The Agreement-by-Correspondence approach is introduced by Rose and Walker (2004), who employ correspondence between segments (consonants in this case), as well as an operation of Identity constraints that ensure that corresponding consonants' features (in the output) are matched. In other words, the Identity constraints serve as a means of evaluating correspondence between two segments. For example, as shown by Rose and Walker, two consonants are in correspondence (despite the intervening vowels (and consonants)), when they share the same feature specification [αF], and the two consonants are coindexed to mark the correspondence relation (p. 476). Moreover, Rose and Walker claim that correspondence between segments is based on similarity, and similarity is established based on computations of shared and unshared features between two segments. Following Rose and Walker (2004), Hansson (2007: 396) summarizes the key principles of the Agreement-by-Correspondence approach as follows: There are two core components of the theory comprising the following families of constraints: a) CORR-C↔C constraints ensuring that two co-occurring consonant segments in a string of the output must be in a correspondence relation; b) IDENT[F] constraints that check that correspondent segments in CC-correspondent pairs match with respect to the specified feature [F]. He states that similarity thresholds are specified in CORR-C↔C constraints, and those thresholds are organized hierarchically. Hansson discusses nasal harmony in Yaka, where nasal harmony spreads rightward from the nasal segment, as from the input *bum-id-a* to the output $bum_i in_i a$ (note that /m/ and /n/ are coindexed for the feature [nasal]). However, spreading of nasality does not affect voiced fricatives and voiceless stops, as from the input *bum-iz-a* to the output $bum_i iz_j a$ (note different indexations for /m/ and /z/), as the two consonants are not in correspondence relation (p. 397). As shown by Hansson, in Yaka nasal harmony, if two consonants are [+voi, -cont], i.e., voiced stops, they need to be in a correspondence relation, and since /z/ is [+cont], it is not correspondent with /m/, and thus, does not undergo nasalization. Rhodes (2012) showed for the first time that the Agreement-by-Correspondence approach is also suitable in analyzing vowel harmony, specifically in the example of Khalka Mongolian rounding harmony and Finnish palatal harmony, considering that the approach was initially developed to effectively account for consonant harmony (see Hansson, 2007; Rose and Walker, 2004). Consequently, Blumenfeld and Toivonen (2016) claim that lateral consonants are part of vowel harmony in Votic, as established by the Agreement-by-Correspondence approach (lateral consonants are like vowels), and that certain features of vowels activate or remain neutral depending on the process, thus possessing "a double identity" (p. 1179).

To account for gradient optionality of ranking of constraints, Boersma (1997) posited Stochastic Optimality Theory. Stochastic OT offers probabilistic treatment of constraint rankings; a probability from 0 to 1 for each pair of constraints (A, B) is assessed between A and B to determine which constraint of the two is dominant (Hayes & Londe, 2006: 75). Hayes and Londe studied Hungarian vowel harmony within the Stochastic OT framework to analyze irregular patterns of vowel harmony. By employing probabilistic constraints with assigned values in Stochastic OT, based on the results of their participants' inflected forms of nonce stems in the dative case, Hayes and Londe generated output candidates (ordered based on frequencies) with different probabilities. That is, constraints with stochastic ranking revealed that low vowels are better triggers of front harmony, which is in line with the results of a preliminary Google survey of the Hungarian lexicon. For instance, as expected by the grammar, the form of the nonce word [haːdeːl-nɛk] (/-nɛk/ is the front-harmonic version of the dative suffix) has a probability of 62.4%

to win, and [haːdeːl-nɔk] has a probability of 37.6% to be generated as the winning output (p. 80). Hayes and Londe conclude that the speakers had an inherent sensitivity to plausible vowel harmony patterns, as well as their frequencies in Hungarian.

Beckman (1997) introduced the compelling notion of positional faithfulness constraints to vowel harmony studies. Beckman showed that in Shona, which has height harmony, vowel harmony is triggered by a vowel in the root-initial syllable. She claims that underlying lexical contrasts in certain positions are preserved to assists perceptual phonological contrast. Specifically, in Shona, the root-initial syllables are the prominent positions, where the height of an underlying root-initial vowel is always preserved. In other words, positional faithfulness denotes privileged prominent positions which have a distinctive status of being loci of vowel harmony triggers (Beckman, 1997; Lloret, 2007), and exhibit resistance to change of the feature specification (as noted by Walker, 2001: 1). Similarly, Lloret (2007) has shown that stressed mid vowels consistently spread their features to unstressed low vowels in Valencian (however, see Jesney, 2009, for an argument against the positional faithfulness approach). In contrast, Walker (2005) found that stressed mid vowels are targets, not triggers of vowel harmony in Veneto Italian, where perceptually weak post-stressed high vowels spread their height feature to preceding salient stressed vowels to reinforce their height identity in perception. In essence, Lloret concludes that the positional faithfulness approach inducing spreading of the harmonic feature from a prominent position to a weak one drives articulatory (gestural) vowel harmony (as seen in Beckman, 1997; Lloret, 2007), and the positional markedness approach implying spreading of a harmonic feature from a weak position to a prominent one drives perceptual vowel harmony (as seen in Walker, 2005).

A modified form of OT called Harmonic Serialism was initially proposed by McCarthy (2000). Since OT employs direct mapping of the input to the winning output through Gen (a function that generates candidates) and Eval (a function that evaluates candidates) without considering intermediate outputs (McCarthy, 2000), the approach is defined as a 'version of OT' (McCarthy, 2010). According to McCarthy (2010), Harmonic Serialism denotes a step-by-step derivation (meaning a one at a time change from the input, like one insertion or one deletion of a segment at a time in a single step) of candidates where each intermediate output candidate's form displays "monotonic harmonic improvement" (p. 1003), i.e. each intermediate output is more harmonic than the input chosen in the previous step. That is, sequences of derivations (the intermediate most optimal candidates) serve as inputs until determining the finite ultimate output candidate. In other words, McCarthy (2010) views the architectural mechanism of Harmonic Serialism as a "Gen-Eval loop" (p. 1002), meaning that candidate sets pass through Gen and Eval until the latest input and the most optimal candidate from that input converge. McCarthy (2009) briefly illustrated vowel harmony in Finnish within the principles of Harmonic Serialism.

3.1.3 Vowel harmony and perception

Some researchers view the source and purpose of vowel harmony as aiding perception (e.g., Kaun, 1995; Kimper, 2011; Suomi, 1983). This idea was initially proposed by Suomi (1983), who claimed that palatal vowel harmony (i.e. backness harmony) is the premise of languages with fixed word stress, like Finnish and Turkish, and other Uralic and Altaic languages, which allow 'weak'[10] vowels to appear *also* in non-initial syllables, where their features are susceptible to weaken due to their low perceptual salience. Suomi states that in palatal vowel harmony languages with fixed stress, weak vowels in non-initial syllables are signaled by the F2 of the vowel in the initial syllable, unlike languages that have moving or phonemic stress, which primarily disallow weak vowels to be unstressed, in order to aid perception of less salient segments. That is, by referring to Nearey's (1980) comment that both front/back and roundness distinctions affect F2 positions (the backness feature in perception of back vowels is reinforced by rounded vowels and that of front vowels is reinforced by unrounded vowels), Suomi hypothesizes that initial vowels signaling F2 of the whole word facilitate perceptual accuracy of the word's general vowel quality and liberates the listener from attentively concentrating on the characteristics of F2 in non-initial syllables, since F2 differences are less detectable in perception than F1 differences. Moreover, Suomi claims that the listener especially attends to vowels in the first syllable, since they indicate the preceding word's completion or are occasionally cued by fixed word stress (p. 32), as in languages with fixed stress in first syllables. Kaun (1995) clarifies that the height contrast, which is acoustically manifested by F1, is more robust in perception than the contrast in backness and rounding, which is acoustically manifested by F2. Moreover, based on Linker (1982) and Terbeek (1977), Kaun concludes that the lip-rounding gesture has a greater magnitude for high vowels than for low

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[10]Suomi refers to Crother's (1978) classification of vowels, who distinguished 'interior' (or 'weak'), i.e. all centralized vowels, as /y, ɯ, ə/, and the five 'peripheral' (or 'strong'), cross-linguistically most common, vowels /i, e, a, o, u/ with respect to their position in the acoustic space.

vowels, and also for back vowels, as opposed to front vowels. Therefore, roundedness of non-high and front vowels is less salient perceptually. Considering that the feature [round] is not at all equal with respect to vowels of different heights, for instance, Kaun proposed the uniformity constraint, which requires that the autosegment [+round] be linked to a uniform gesture in the phonetics (e.g. the autosegment [+round] targets slots of the same height to achieve a uniform gesture), meaning a direct mapping of phonology onto phonetics. Subsequently, in line with Walker's (2005) claim about weak vowels that increase their perceptual saliency by being harmony triggers in Veneto Italian, Kaun (2004) suggests that perceptually less salient rounded non-high and front vowels are potentially good rounding harmony triggers, as their contrastive values are prone to be misidentified leading to perceptually advantageous harmony, as opposed to relatively stable high and back vowels. To test whether harmony facilitates better perception, Kimper (2011) conducted a discrimination task and a phoneme recall task among native North American English speakers. Kimper's findings suggest that harmony aids perception and is advantageous - stimuli with harmonic nonce words facilitated a better performance among the participants than stimuli with disharmonic ones.

In sum, studies that support the idea that vowel harmony is perceptually motivated show that feature sharing between vowels induces better perception (as in Kaun, 1995; Kimper, 2011). Suomi's and Kaun's discussion imply the possibility that listeners better perceive height contrast cued by F1 movements than contrast in backness and rounding cued by F2, since the distinction of the latter is less salient. A relative difficulty in perceiving the contrast in backness and rounding, which is acoustically manifested in F2 movements, is suggested to have motivated the emergence of backness (and rounding) harmony per se (Kaun, 1995; Suomi, 1983).

3.1.4 Summary

Generally, for the past 20 years, studies have widely analyzed vowel harmony within the OT framework (e.g., Kenstowicz, 2009; Pulleyblank, 1996; Walker, 2012, etc.). The major constraints invoked in vowel harmony studies within the OT approach, as summarized by Walker (2012: 576) include "Alignment, Spreading, Agree, and Correspondence". However, the strict constraint ranking requirement of OT initiated some modifications of OT to allow more leeway for variations of output candidates, like in Stochastic OT. However, all these models, like the Optimal Domains Theory (Cole & Kisseberth, 1994), Span Theory (McCarthy, 2004), the Agreement-by-

Correspondent approach (Rhodes, 2012), Harmonic Serialism (McCarthy, 2009), Stochastic OT (Hayes & Londe, 2006), base their analyses upon the principles of the OT framework with ranking of constraints to reveal the optimal winning candidate that represents the most plausible and frequent output form in a language.

3.2 Application of vowel harmony in loanwords

Research interest in the application of vowel harmony in loanwords started in the 1980s (e.g., Kontra & Ringen, 1986). However, up to now there have been very few studies that shed light on the way loanwords harmonize once borrowed in vowel harmony languages. Particularly, it was observed that loanwords in those languages tended to violate native phonology, particularly, they allowed disharmony in the roots (Harrison, 1999; Kertész, 2003; Ringen & Heinämäki, 1999; Ringen & Kontra, 1989, etc.).

3.2.1 Effect of stress and other salient features

In loanwords, several features of vowels have been suggested to affect the degrees of attaining or violating vowel harmony.

Most studies of vowel harmony in loanwords focus on the effects and behaviour of neutral vowels, which means that their relevance and application to Yakut, which does not have neutral vowels, is somewhat limited. I review findings in studies of vowel harmony in languages with neutral vowels by concentrating on potential generalizations that could also be relevant to vowel harmony languages without neutral vowels.

In languages that have neutral vowels, like Finnish or Hungarian, there has been a special attention to how those vowels behaved in regards to loanwords. Neutral vowels are the non-harmonising segments that are either opaque i.e. they block harmonization; or transparent, when neutral segments are skipped and do not participate in harmonization (Pulleyblank, 1996; Sy, 2006).

Hence, Ringen and Kontra (1989) studied the neutral transparent vowels in loanwords in Hungarian that has root-suffix harmony. In addition, as mentioned above, Hungarian has harmonic back and harmonic front vowels. In native phonology, both roots and suffixes agree in backness. When roots have only neutral vowels in them, vowels in suffixes are front, and when roots do not end with a neutral vowel, the suffixes harmonize with the last vowel of the root. However, in attested loanwords when roots are disharmonic (both front and back vowels), vowels in suffixes tend to harmonize with backness of the last harmonic vowel in the root by neglecting the neutral vowels even if the latter end the root. To test whether this is a consistent pattern of harmonization empirically, Ringen and Kontra asked native Hungarian speakers to inflect a set of loanwords in sentences. Their findings suggest that facts like stress and number of syllables, and position of neutral vowels within roots are determining factors of selecting certain suffixes (see also Kontra & Ringen, 1986).

Sy (2006) found an effect of length and stress in French loanwords in Wolof, which has [ATR] harmony. French tense vowels are mapped onto [+ATR] vowels and lax vowels are mapped onto [-ATR] vowels in Wolof. Sy suggests that more salient features in loanwords, like contextually (but not contrastively) long input vowels in closed or stressed word-final syllables, lengthen and retain their relative tongue root feature based on tenseness in French, which results in disharmonic outputs.

Effects of stress and sonority were revealed by Ringen and Heinämäki (1999) in a study of disharmonic loanwords in Finnish. Finnish has neutral transparent front vowels /i, e/ in addition to harmonic front and harmonic back vowels. Just like Hungarian, there is complete backness harmony within the roots themselves, except the contexts when the neutral vowels co-occur with either front or back vowels. Like Hungarian, Finnish has root-suffix harmony. Ringen and Heinämäki asked native Finnish speakers in a series of experiments to inflect disharmonic loanwords in sentences. The authors propose that the quality of stressed vowels (primary and secondary) influenced the choice of a certain vowel in the suffixes, meaning that the backness features of vowels with primary stress (which occurs in initial syllables) affected the suffix choice. Moreover, the lower the harmonic front vowels were in roots, the more front vowels were chosen in suffixes by the participants, for example, there were more front suffixes in roots with /æ/ than with /y/. That is, more sonorous lower vowels in the roots are better harmony triggers. The authors explain the variations in suffix vowel selection when the root word has a final front vowel through an OT account using alignment constraints. The vowel quality for suffixes is determined by unranked constraints that are linked to stress and sonority. Ringen and Heinämäki claim that the variation data cannot be explained by an analysis using fixed constraints, instead, a grammar that allows unranked constraints is suggested as an optimal way in this case. Ringen and Heinämäki also propose *output* underspecification instead of the more acknowledged *input* underspecification. Subsequently, Kimper (2011) replicated the critical part of Ringen and Heinämäki's study by asking native Finnish speakers to select suffixes with front versus back vowels for nonce disyllabic disharmonic loanwords to establish a harmony trigger vowel. Kimper also found an effect of vowel height: the suffix choices were influenced by the backness feature of low vowels. In addition, a significant effect of vowel length was found: there were more back suffixes after short front vowels than after long front vowels in disharmonic roots. Regarding the effect of low vowels in triggering harmony, Kimper claims that "[b]ecause lower vowels are more poorly cued along the front/back dimension than their high counterparts, they have a greater impetus to spread their feature value and reap the perceptual rewards of harmony" (p. 192-193). That is, following Benus and Gafos (2007), Kimper proposes that high vowels are perceptually more stable to be identified as front vowels, thus, they allow more sub-phonemic co-articulation and retraction as opposed to low vowels, which need to undergo less articulatory retraction in order to remain identifiable as front vowels in perception (p. 195). For instance, due to the sub-phonemic co-articulation without a categorical change, of the high vowel /i/ with a preceding back vowel, the frontness of the former is less than the frontness of an /i/ after a front vowel, thus, high vowels tend to be neutral vowels (Kimper, 2011: 195).

A similar experimental study of loanwords in Finnish was conducted by Välimaa-Blum (1999), where she critiques the OT account that was used by Ringen and Heinämäki (1999). Välimaa-Blum based an experiment on the theoretical concept of feature geometry which is a part of autosegmetal phonology. She asserts the significance of the place feature in driving vowel harmony. The coronal (i.e. front) and dorsal (i.e. back) vowels were assigned individual tiers to establish a more relaxed nature of the back precedence constraints (when a vowel is back in the root, a suffix with a back vowel occurs). Specifically, she suggests that the spreading of the coronal feature is local, i.e. it cannot continue spreading when there is an intervening dorsal vowel. In contrast, the spreading of the dorsal feature is extended; that is, the dorsal feature *can* continue spreading regardless of the intervening subsequent coronal vowels. The study suggests to equate the Finnish neutral vowels with front vowels specifically in loanwords.

3.2.2 Harrison's (1999) study

A special attention should be drawn to Harrison's (1999) paper about vowel harmony and disharmony in loanwords (including from Russian) in other Turkic languages spoken in Siberia — Tuvan and Tofa. Harrison mainly reviews these two languages that are typologically very similar to Yakut, including the ways harmony and disharmony are applied in loanwords. Like Yakut, both languages have backness and rounding harmonies. Harrison (1999: Introduction, para. 2) claims, "Many harmony languages not only tolerate disharmony, but can also generate it in a productive manner". He states that the two harmony systems (backness and rounding) have a complex interaction yielding disharmony patterns (Vowel harmony, para. 1). Backness harmony is based on the natural classes of height, backness and rounding in Tuvan and Tofa, just like in Yakut, and overall the vowel harmony systems in the presented Tuvan examples are analogous to the ones of Yakut. Following Chomsky and Halle (1968), Harrison regards the feature [back] as "an equipollent feature" (Formal analysis of BH, para. 1), meaning that there is no distinction in regards to the extents of activeness between the features [-back] and [+back], as evidenced in Tuvan. Since backness harmony is considered as based on the feature spreading process from the initial vowel in the root, referring to Steriade (1995), he suggests that the feature [back] in all post-initial vowels is underspecified. The theoretical framework employed by Harrison to account for backness harmony in Tuvan is OT, specifically, alignment constraint ensuring that all vowels' features [back] are aligned with the word domain's edge. Rounding harmony rules in Tuvan are also in complete agreement with Yakut, where Harrison cites Kaun's (1995) models of 'triggers' and 'targets' of rounding harmony. Moreover, he concludes that the feature [-round] is an active participant of rounding harmony. As in Yakut, Tuvan high vowels, when they follow rounded vowels, become rounded, e.g., *møltʃyktʃy* from (Old) Mongolian *mølʐigtʃi* 'exploiter'. There is also a leftward spreading of roundedness, i.e. regressive rounding harmony, e.g., *bydygyːlyk* from (Old) Mongolian *bidegyːlig* 'primitive' (Rounding harmony in loanwords, para. 1). Note that leftward spreading of roundedness is not observed for epenthetic high vowels, for instance, in *pɯlɒf/pɯlɒp* from Russian *plof* 'rice pilaf' (Epenthesis-driven harmony, para. 1). In addition, patterns of de-rounding occur with rounded vowels in loanwords that are not results of rounding harmony, e.g., *alʐɯːr* from (Old) Mongolian *altʃuːr* 'napkin' (Rounding harmony in loanwords, para. 1).

Moreover, Harrison views disharmony as "an expected part of the harmony system not an exception to it" (Disharmony, para. 1), which tends to result from active, productive processes in the language morphology. He discusses eight typologies of disharmony scenarios mainly based on Altai-Sayan Turkic languages, and signifies the following triggers of disharmony: optional harmony triggers; input words disharmonic in backness; consonant glides inducing vowel frontness; morphology-based disharmony; transparent-like behavior of front vowels or opaque-like behavior of high vowels; co-articulation; and vowel shift of surface vowels.

3.2.3. Loanwords as stratified lexicon

Some researchers suggested that language is a stratified phenomenon and loanwords are operated on a specific stratum within the lexicon (e.g., Cabré, 2009; Cohen, 2013; Itô & Mester, 1999; Kertész, 2003). Treating the lexicon as consisting of different strata was initially motivated by Karlsson (1983). In a similar vein, Itô and Mester (1999) subdivide the lexicon into four sublexica: 1) native; 2) established loans; 3) assimilated foreign; 4) unassimilated foreign (p. 64) thus establishing the structure of the lexicon as a core-periphery relationship between the strata. Within the OT approach, they propose individual sets of indexed faithfulness constraints (with the index specifying the stratum). That is, each stratum has its own individual grammar where an indexed faithfulness constraint for that specific stratum is ranked in regards to the other constraints.

This view of loanwords as belonging to a different stratum in the lexicon is exemplified in Kertész's (2003) study of vowel harmony in loanword adaptations in Hungarian (specifically, English verbs in regards to their attached derivational suffixes). Following Itô and Mester's (1995) convention, she views the Hungarian lexicon as subdivided into two strata: native (core) and foreign (peripheral); where the latter allows disharmonic stems whereas the former does not (p. 67-68). She speculates that whether loanwords attain vowel harmony or not is possibly correlated with syllable weight. Specifically, Kertész observed that loanwords ending in heavy syllables have both harmonic and disharmonic suffixes attached to them.

The opposite case, when vowel harmony emerges in loanwords for a language that does not have vowel harmony, is presented by Cohen (2013). He observed 'the emergence of the unmarked', i.e. although Hebrew does not have vowel harmony per se in its native core stratum, vowel harmony tended to apply to English loanwords. Cohen shows that the targets of harmony in English loanwords were the input schwas and epenthetic vowels. Whereas the 'full' vowels (not schwas nor epenthetic) potentially served as triggers of harmony. Moreover, higher vowels had a greater probability to be harmony triggers as opposed to lower vowels. Cohen accounts for harmonization in loanwords in Hebrew within an OT approach by including alignment constraints, where harmonization operates within the (specific) domain of the word, which minimal size is one syllable. He demonstrates that in loanwords there is a preference for a rightward spreading of vowel harmony, which is attributed to the alignment constraint, ensuring expansion of the left-hand domain of harmony. Cohen suggests vowel harmony with the rightward spreading and the greater potential of high vowels to be triggers of harmony to be linked to UG predispositions.

By the same token, following Itô and Mester's (1999) core-periphery structured model, Cabré (2009) also found evidence that loanwords in Eastern Catalan operate on different strata, organized hierarchically with respect to the core stratum. In line with Cohen's (2013) study, she observed that loanwords attained vowel harmony which is not present in Catalan. Using an OT approach with rankings of markedness and faithfulness constraints, Cabré accounts for the observed emergence of [ATR] harmony in loanwords when post-tonic [+ATR] mid vowels spread their [+ATR] feature onto the preceding stressed mid vowel within a single trochee is leftward harmony, opposite to rightward harmony that Cohen proposed to be universal.

The view of loanwords as belonging to a different stratum in the lexicon with its own grammars is highly supported by the above studies, where loanwords followed different rules unattested or inactive in the native phonology. Moreover, 'the emergence of the unmarked' phenomenon displaying vowel harmony at play in loanwords of non-harmonic languages, attested in Hebrew (Cohen, 2013) and Eastern Catalan (Cabré, 2009), suggests to treat loanwords as distinct lexemes that may activate grammars beyond the grammar of that specific language.

3.2.4 Summary

The above studies of vowel harmony in loanwords suggest several factors to be considered when predicting whether loanwords succeed to follow or in turn, violate vowel harmony. Two of the most prominent factors at play are stress and vowel length since stressed or long vowels in the input or in the output instigated both harmony and disharmony (Cabré, 2009; Ringen & Heinämäki, 1999; Ringen & Kontra, 1989; Sy, 2006). Another vowel quality that appeared to be active in driving harmony was vowel height; specifically, the triggers of harmony appeared to be high in Hebrew (Cohen, 2013) or low in Finnish (Kimper, 2011). Factors in the roots like vowel backness in Finnish (Välimaa-Blum, 1999) or syllable weight in Hungarian (Kertész, 2003) were suggested to be important in causing more variability of suffix choices, thus creating disharmony.

Studies emphasizing vowel harmony motivated by perception (e.g., Suomi, 1983; Kaun, 1995) suggest the distinction of F1 and F2 to be crucial in word recognition perceptually. Thus, differences in auditory salience may have an effect on the emergence of harmony triggers and targets.

In sum, the conditions under which vowel harmony is attained or violated in loanwords in harmonic languages are individual from one language to the other. However, special attention should be paid to factors like vowel stress, length, height and backness to reveal specific causing factors of vowel harmony compliances and violations.

Chapter 4: Yakut (Sakha) phonology

The first linguistic description of Yakut was published in 1851 by Otto Böhtlingk in the book *Über die Sprache der Jakuten*.[11] Indeed, Böhtlingk's book has become one of the foundational references of many following linguistic studies of the Yakut language. Among the subsequent major phonological studies of Yakut are descriptions of phonetics and morphology (Kharitonov, 1947; Dyachkovskiy, 1971, 2000), phonology and morphology (Krueger, 1962/2012), historical phonology (Anderson, 1998), linguistic and genetic perspectives (Pakendorf, 2007), and rounding harmony (Kaun, 1995).

This chapter is a brief summary of the highlights of the Yakut phonology. The Yakut phonemic inventory includes twenty-eight phonemes with eight vowels and twenty consonants (Kharitonov, 1947). All eight vowel phonemes have long counterparts, and there are four diphthongs (Krueger, 1962/2012). Long vowels in Yakut are contrastive with their short correspondents. Similar to vowels, consonants also appear long (or geminated).

Yakut is an agglutinative language and the rich suffixation system leads to both vowel and consonant alternations across morpheme boundaries (see Kharitonov, 1947).

Stress in Yakut is consistently word-final except for minor exceptions (Anderson, 1995, 1998; Kharitonov, 1947). However, Yakut stress is not very prominent (Samsonova, 1959), and is not marked in orthography in primary school texts, unlike in Russian. Vasilyeva, Arnhold, and Järvikivi (2016) found that due to word stress, vowels in the second (stressed) syllable of disyllabic words were consistently longer in duration in both short and long quantities, including noticeable rising F0 contours word-finally.

The most distinctive feature of Yakut phonology is the consistent regularity of both backness and rounding harmony (see Finch 1985; Kaun 1995; Sasa 2009).

4.1 Yakut with respect to the larger Turkic language family phonology

Yakut developed on its own in Eastern Siberia isolated from other Turkic tribes (Krueger, 1962/2012), and it has undergone many phonetic changes distinct from the general Turkic pattern (Krueger, 1962/2012: 32-33). Considering the Yakut long vowels, Dmitriev (1955: 194) agrees that long vowels and diphthongs are distinct properties specific to the Yakut language, where he

[11] 'About the language of the Yakuts' [German].

refers to their origin. Kharitonov (1947: 82-83) summarizes the most distinctive phonetic characteristics of Yakut from other Turkic languages. He includes a regular occurrence of long vowels unlike other Turkic languages, where long vowels are not common. This statement is similar to Poppe's (1959: 672) description in that regard, who also points out the more complex phonology of Yakut. Dmitriev (1955: 192-193) confirms that some Yakut long vowels or diphthongs have short correspondents in other Turkic languages, like Yakut /sɑːs/ 'spring' and Old Turkic /jɑz/, /ʐɑz/; Yakut /biɛr/ 'give' and Old Turkic /ber/, /bir/, /ver/. Kharitonov notes uncommon or unknown, in other Turkic languages, features in Yakut: the four widening diphthongs (/iɛ/, /yœ/, /ɯɑ/, /uɒ/), prominent vowel harmony rule, absence of common to other Turkic languages consonants /z/ and /ʂ/ and instead the presence of unknown /ɲ, lʲ, h/. As well as a number of restrictions on the consonants, strong consonant assimilation, and an intervocalic shift of /s/ to /h/.

Krueger (1962/2012) notes that Turkic /tʃ/, /ʂ/, /z/ changed to word-final /s/ in Yakut. As far as the grammar is concerned, Krueger points to general assimilation and dissimilation, for example, the common Turkic morpheme /-lɑr/ exhibits at least sixteen variations in Yakut, like /-lɑr, -lɛr, -lɒr, -lœr/ (p. 33).

In addition, Anderson (1998) mentions the more advanced development of rounding harmony in Yakut compared to the "neighboring Turkic languages to the south and west" (p. 6). Anderson (1997) also found that Yakut exhibits a unique devoicing of /t/ in the intervocalic position that is not attested in correspondent cognates in other Turkic languages. He suggests that /t/ originates from the Proto-Yakut [θ] which in turn stems back from Old Turkic /ð/.

4.1.1 Origin of the Yakut long vowels

There have been several controversies about the origin of Yakut long vowels. In particular, Krueger (1962/2012: 34) speculates that essentially short vowels have same correspondents in Turkish (Osmanli), whereas long vowels stem from long vowels in the proto-language. Similarly, Poppe (1959: 673) states that short vowels in Yakut have direct correspondents in Old Turkic. Anderson (1998: 3) also claims that Yakut long vowels and diphthongs originate from Old Turkic in addition to different consonant changes evidenced by many cognates in other Turkic languages, especially in Turkmen and Xaladj. Dmitriev (1955), Kharitonov (1947) and Scherbak (1967) cite Radloff (1908), who claimed that the short and long contrast in Yakut emerged as a secondary development to distinguish between short and long vowels in base words that sound similar. In addition, Radloff described assimilation of consonants with vowels and contraction of two vowels separated by one consonant between syllables as a phonetic explanation (Dmitriev, 1955: 194; Kharitonov, 1947: 53-54; Scherbak, 1967: 34). However, the researchers agree on the conventional description of Yakut long vowels and diphthongs originating from either 'primary' or 'secondary' long vowels (Anderson, 1998; Antonov, 1961; Dmitriev, 1955; Kharitonov, 1947; Scherbak, 1967). Unlike the primary vowels, that have Old Turkic origin and are not the results of sound contractions, the secondary long vowels are based on later historic contractions of various vowel and consonant sound combinations (Antonov, 1961; Dmitriev, 1955). In particular, Kharitonov (1947: 54) summarizes secondary long vowels as the result of consonant deletion, as /sɑː/ 'bow/crossbow' from the old /jɑj/; primary long vowels, instead, are those vowels that have origins from the old times, for example, /ɑːs/ 'pass', whereas in Turkish it is /ɑs/. As an interesting note regarding Turkish, he mentions other opinions suggesting that the occurrence of the Turkish vowel length was due to a stress influence in the Turkish proto-language. As a Yakut example, parallel to those opinions, he gives the word /uɒt/ 'fire' originating from the long /ɒː/ in /ɒːt/ that stemmed from the stressed vowel in /ˈɒt/, which is the older form (p. 54). In conclusion, Kharitonov (1947: 55) recognizes the challenges of establishing the origins of Yakut long vowels and diphthongs due to the lack of compelling evidence whether long vowels per se were present in ancient Turkic languages, he also speculates that tonal stress was the cause of transitioning to long vowels.

Additionally, as a result of Yakut borrowing Russian words, many Yakut long vowels and diphthongs appeared as a reflection of Russian stressed vowels (Anderson, 1995: 369, 1998: 5; Finch, 1985: 3; Samsonova 1959: 19).

4.2 Yakut consonant inventory

As summarized by Kharitonov (1947), Yakut has twenty consonant phonemes. I present Krueger's (1962/2012: 55-56) arrangements of the consonants, long correspondent are also noted in the chart.

(1) Yakut consonants (chart is summarized based on Krueger's description, 1962/2012) [12]

	Bilabial	Alveolar	Postalveolar	Palatal	Velar	Uvular	Glottal
Plosive	p pː b	t tː d			k kː g		
Nasal	m mː	n nː		ɲ ɲː	ŋ ŋː		
Trill		r					
Fricative		s sː				χ χː ʁ	h[13]
Approximant				j j̃			
Lateral approximant		l lː					
Affricate			tʃ tʃː dʒ dʒː				

Consonants appear long similar to vowels. Additionally, some long consonants emerge across morpheme boundaries as a result of complete assimilation (Anisimov, 1975). However, unlike vowels, not all consonant phonemes have long correspondents. In particular, the consonants that do not appear long are /b, j, j̃, r, g, ʁ, d/ (Krueger, 1962/2012). Examples of minimal pairs contrasting long and short consonants are: /χɑtɑ/ 'luckily' and /χɑtːɑ/ 'dried out'; /bɑtɑs/ 'sword' and /bɑtːɑs/ 'push together'; /tɑmɑχ/ 'broad upper reaches of a big field/meaning of a word' and /tɑmːɑχ/ 'water drop'. Note that long consonants (geminates) occur in word-medial position only (as seen e.g. in Krueger, 1962/2012).

Krueger also notes that the consonants /ʁ, j, ŋ, r/ do not occur word-initially, and those that do not appear word-finally are /b, d, g, ʁ, dʒ, ɲ, tʃ/. It is noteworthy that the consonants /g, h, p/ appear word-initially in very rare, exceptional cases in Yakut (Kharitonov, 1947: 63). Furthermore, Kharitonov states that /h/ either precedes a vowel or is in the intervocalic position, as in /hɑj/ 'an exclamation used to herd cattle' and /ɑhɑː/ 'eat'.

4.2.1 Main allophonic variations of consonants

Yakut has few allophonic variations for the consonants, among which debuccalization of the sibilant /s/ is a good example. Particularly, word-initial /s/ is commonly pronounced as /h/ in many districts of the Republic of Sakha (Yakutia) (see Pakendorf, 2007, 2008). A diachronic loss of word-initial /s/ from Common Turkic was also observed (Kaluzhyn'ski, 1994). Yakut also has a tendency to alternate intervocalic /s/ to /h/ (Pakendorf, 2008). This phenomenon of intervocalic shift to /h/ was also attested by Krueger (1962/2012: 63).

[12] Krueger's place of articulation classification for some consonant phonemes is revised and modified.

[13] It is a more precise phonetic transcription; however, according to Krueger (1962/2012), it is articulated as pharyngeal.

Krueger notes, that /k/ and /χ/ are allophones of the same phoneme, and notes that each of the two consonants is distinct orthographically. They are in complementary distribution, as /χ/ occurs before /ɑ, ɒ/, and /k/ appears before all other vowels (p. 60). Examples are /χɑs/ 'how many?', /χɒs/ 'room', and word-initial */kɑ/ and */kɒ/ never occur (also in Kharitonov, 1947: 64-65). He also confirms that the consonants /ɲ, p, s/ appear in the geminated forms in intervocalic positions (p. 65), implying that they can only geminate in that specific environment. Krueger (2012: 64) mentions Barashkov's kymographic data (1953) that found voicing of /h/ intervocalically in the word /ɑhɑt/ 'feed!', and no voicing occurred in /kihi/ 'man'. I speculate that /h/ becomes voiced influenced by surrounding back vowels. Next, Yakut does not permit certain consonants to appear long, or word-initially, or word-finally including word-final complex codas (Krueger, 1962/2012). Based on Barashkov's (1953) study, Krueger states that all initial consonants are considerably aspirated in Yakut, in addition, word-initial/onset stops are plosive and become implosive word-finally. Also, all consonants for the most part get a palatal coloring influenced by front vowels when they are near /ɛ, œ, i, y/ (Krueger, 1962/2012: 55). Moreover, word-initial complex onsets do not occur in a Yakut word (Kharitonov, 1947: 62).

4.3 Yakut vowel inventory

Yakut has eight vowel phonemes (see Anderson, 1998; Finch, 1985; Krueger, 1962/2012). The vowels are perfectly symmetrical in the Yakut vowel inventory, where each unrounded vowel has a rounded correspondent (Sasa, 2009). The summary of the Yakut vowels is shown in (2):

(2) Yakut vowel inventory[14]

	Front	Back
High	i iː y yː	ɯ ɯː u uː
Low-mid	ɛ ɛː œ œː	
Low		ɑ ɑː ɒ ɒː

[14] Since Krueger (1962/2012) and Finch (1985) do not specify the degree of height of the Yakut mid vowels, (signifying the vowels as either [high] or [low]), I specify that the mid vowels are low mid [ɛ] and [œ].

The Yakut vowels are distinguished as front or back[15] with no central vowels, as high or low, and as rounded and unrounded. This three-dimensional vowel system is characteristic for Turkic languages (Kaun, 1995; Krueger, 1962/2012).

4.3.1 Main allophonic variations of vowels

In Yakut, some vowels get nasalized in interjections, like /ɛːχ/ 'confirmation'; /hɯ/ 'surprise' (Kharitonov 1947: 55). Nasalization is also attested in the exclamation /ɛhɛː/ 'Huh?' usually found in folktales (Krueger, 1962/2012: 64). Kharitonov also states that vowels get a nasalized coloring in words like /ɑjɑχ/ 'mouth', /ɑjɯː/ 'sin', /tujɑχ/ 'hoof', /tɑjɑχ/ 'elk', etc. (p. 55). These latter examples by Kharitonov to illustrate vowel nasalization all contain the palatal approximant /j/ intervocalically. Thus, I assume that in this special environment, vowels are slightly nasalized influenced by the glide.

4.3.2 Long and short vowel phonemes

All eight short vowel phonemes in Yakut have long counterparts as demonstrated in (2). This distinction between short and long vowels is phonemic, as exhibited by minimal pairs (Finch, 1985; Krueger, 1962/2012; Samsonova, 1959). Krueger claims that the Yakut short and long vowels are articulated identically with only length differences. The same claim is expressed by Samsonova (1959: 18), in addition she pointed at the more intensive pronunciation of long vowels compared to their short counterparts. I demonstrate examples of minimal pairs of the short and long vowel contrast for all the Yakut vowels:

(3) Minimal pairs showing the phonemic distinction between short and long vowels

Short	Minimal pair word	Long	Minimal pair word
ɑ	χɑr 'choke'	ɑː	χɑːr 'snow'
ɒ	ɒrɒn 'bed'	ɒː	ɒrɒːn 'take out'
ɛ	ɛhɛ 'bear'	ɛː	ɛhɛː 'grandfather'
œ	bœrœ 'wolf'	œː	bœrœː 'wrap!'
i	kihi 'man'	iː	kiːhi 'sable-SG.ACC'
y	yr 'blow'	yː	yːr 'expel'
ɯ	kɯl 'horse mane'	ɯː	kɯːl 'animal'
u	kus 'duck'	uː	kuːs 'hug'

[15] The old phonetic description used in Kulakovskiy (1946) and Böhtlingk (1851/1964) is 'hard' for back vowels, and 'soft' for front vowels.

Samsonova (1959: 17) mentions that the duration of Yakut short vowels is comparable to unreduced unstressed Russian vowels, and long vowels are even longer than stressed Russian vowels. A recent study by Vasilyeva et al. (2016) observed that both in Yakut spontaneous and read speech phonemically long vowels were significantly longer in both types of speech and in both syllables of the target disyllabic words.

4.3.3 Diphthongs

As summarized by Krueger (1962/2012: 48), Yakut has four diphthongs: /ɯɑ, iɛ, uɒ, yœ/. Diphthongs have a phonemic status, among other Turkic languages, only Yakut has phonemic diphthongs (Dyachkovskay, 2000: 26). Krueger states that the diphthongs can appear word-initially, word-medially, or word-finally. Kaun (1995) describes the Yakut diphthongs as "falling" (p. 26), since all the four diphthong's first segment is [+high] and the second segment is [-high], thus falling in height (but note that they are rising in terms of sonority). There is no vowel breaking in the diphthongs and the vowel sequences are closely articulated (Finch, 1985: 5).

Similar to the long vowels, diphthongs also occur in both base words and affixes (Samsonova 1959: 19). Also, diphthongs are written in double letters in Yakut orthography, as pointed by Krueger (1962/2012: 48).

Finally, Yakut does not have triphthongs (Krueger, 1962/2012: 48; Samsonova, 1959: 52).

Below (4) are examples of the monosyllabic words containing the diphthongs:

(4) Words with the diphthongs

/iɛ/	iɛs	'debt'	/uɒ/	uɒt	'fire'
/yœ/	kyœl	'lake'	/ɯɑ/	tɯɑl	'wind'

Ubryatova (1984: 10) regards diphthongs as the third case of long vowel formations in Yakut. She concludes that the diphthongs are a result of combinations of high and low vowels, such sequences lead to the emergence of diphthongs rather than long vowels.

4.4 Vowel harmony

Vowel harmony is one of the most prominent phonological properties of Yakut. There is an extreme regularity of combining and sequencing vowels within Yakut words. The Yakut vowel harmony patterns were first described by Böhtlingk (1851/1964), where he illustrated two rules according to which vowels harmonize depending on whether they are back or front and low or high. These early descriptions showed the harmonic factors involved in the language.

Induced by strict vowel harmony regularities, the Yakut vowels are combined according to the following system summarized by Kharitonov (1947: 60; my translation):

(5) Conditions of the Yakut vowels' sequencing within a word (Kharitonov, 1947: 60)

If it occurs in the first syllable	Then the next syllable has	Examples (conjugated forms of the verbs)
ɑ	ɑ or ɯ, ɯɑ	bɑr, bɑrɑr, bɑrbɯt, bɑrɯɑm 'go'
ɛ	ɛ, i, iɛ	kɛl, kɛlɛr, kɛlbit, kɛliɛm 'come'
ɒ	ɒ, u, uɒ	sɒt, sɒtɒr, sɒpːut, sɒtuɒm 'wipe'
œ	œ, y, yœ	kœr, kœrœr, kœrbyt, kœryœm 'see'
ɯ	ɯ, ɑ, ɯɑ	sɯt, sɯpːɯt, sɯtɑr, sɯtɯɑm 'lie'
i	i, ɛ, iɛ	bil, bilbit, bilɛr, biliɛm 'know'
u	u, ɑ, uɒ	tur, turbut, turɑr, turuɒm 'stand'
y	y, ɛ, yœ	tys, tyspyt, tyhɛr, tyhyœm 'come down'

In particular, Yakut has backness and rounding harmony. Below, Sections 4.4.1 and 4.4.2 introduce the details of vowel harmony rules at play.

4.4.1 Backness harmony

It was first attested by Böhtlingk (1851/1964: 103) that if the first vowel within a word or stem is back, all the following vowels are back too; alternatively, whenever the first vowel is front, then all the subsequent vowels are also front. Later, numerous studies confirmed that the first vowel in the initial syllable of the root conditions the specification of the feature [back] to the following vowels in Yakut (Anderson, 1998; Iskhakov, 1955; Krueger, 1962/2012; Sasa, 2009). Because Yakut is an agglutinative language, very long words may appear. Kharitonov (1947: 59) points out that despite the length of a word, all the vowels are back if the initial vowel in a word is back. For instance, /kœrsybɛtɛχtɛrɛ/ '(they) did not meet' (all front vowels), and /χɑltɯrɯːskɑj/ 'slippery' (all back vowels). To illustrate that inflectional morphemes are adjusted to the vowels' backness of the root, I take the word with all back vowels /χɒnuː/ 'field' and the other one with all front vowels /ɛhɛ/ 'bear' from (6) to present their plural forms where the plural morpheme -lɑr is affixed: /χɒnuːlɑr/ 'fields' and /ɛhɛlɛr/ 'bears'.

The pattern of backness harmony is exemplified in the data below:

(6) Backness harmony

All vowels are back		All vowels are front		Non-harmonic forms
χɒnuː	‘field’	kœmys	‘gold’	*χɒnyː
bɯlɯt	‘cloud’	kɛlin	‘late, later’	*kœmus
mɑnːɑ	‘here’	ɛhɛ	‘bear’	*bɯlit
sɑjɯn	‘summer’	ilːɛŋ	‘spare, free’	*kɛlɯn
ɑstɯk	‘great’	tiɛrgɛn	‘yard’	*mɑnːɛ
uɒrujɑχ	‘thief’	œrœbyl	‘Sunday’	
ulɑχɑn	‘big’	kyryœ	‘fence’	
ɯɑl	‘family’	syœgɛj	‘sour cream’	

The data illustrated in (6) affirm the consistency of the backness harmony rule in Yakut, where all the vowels are either back or front within the entire prosodic word depending on the backness feature specification of the first vowel. Non-harmonic forms are ill-formed as it is shown in (6), and Yakut does not permit such candidates.

4.4.2 Rounding harmony

Not all Turkic languages have rounding harmony, unlike backness harmony which is found in all Turkic languages except for Uzbek, and rounding harmony rules are different from one Turkic language to the other (Iskhakov, 1955: 138-139).

In Yakut rounding harmony, low rounded vowels /œ, ɒ/ spread their rounedness feature to following both underlying high /i, ɯ/ and low vowels /ɛ, ɑ/. However, high rounded vowels /y, u/ spread roundness *only* to following high vowels /i, ɯ/ (see Finch, 1985; Kaun, 1995; Sasa, 2009). In (7) I show nouns in the nominative and accusative cases with rounded vowels on the left and as a comparison, words with unrounded vowels are included on the right. In other words, using Sasa’s (2009) term, ‘total harmony’ is achieved when there are no low vowels following a rounded high vowel shown below (7):

(7) Rounded vowels followed by rounded vowels across morphemes (adapted from Kharitonov, 1947: 61)

Rounded vowels	Gloss	Unrounded vowels	Gloss
ɒʁɒ-nu[16]	‘child-ACC’	tɑbɑ-nɯ	‘deer-ACC’
ɒʁɒ-lɒr	‘child-PL-NOM’	tɑbɑ-lɑr	‘deer-PL-NOM’
ɒʁɒ-lɒr-u	‘child-PL-ACC’	tɑb-lɑr-ɯ	‘deer-PL-ACC’
bœrœ-ny	‘wolf-ACC’	ɛhɛ-ni	‘bear-ACC’
bœrœ-lœr	‘wolf-PL-NOM’	ɛhɛ-lɛr	‘bear-PL-NOM’
bœrœ-lœr-y	‘wolf-PL-ACC’	ɛhɛ-lɛr-i	‘bear-PL-ACC’

Kaun (1995) classifies the vowels as ‘triggers’ and ‘targets’ (undergoers) (see also Section 3.1.1).[17] Based on Kaun’s description, I suggest that in (7) the high vowels in the inflectional morphemes become the undergoers of rounding harmony. They also became rounded conditioned by the height of the trigger final rounded vowels of the roots. That is, in (7) the affixed word-final vowels become rounded, if the last vowel in the base is a high or low rounded vowel that spreads its roundness to the affixed underlying high vowel. To sum up, if the underlying vowel is rounded, it spreads its roundness from left to right, to the following underlying vowel, depending on the height of the latter. Kaun (1995: 23) observed a similarity of Yakut in terms of rounding harmony spreading with Kachin Khakass where there is an agreement between the trigger and target of harmony spreading based on height.

Hence, intervening low vowels following a rounded high vowel surface as the vowels [ɛ] or [ɑ] depending on the backness feature of the initial vowel, like in /byrɛ/ ‘ugly’ or /tʃugɑs/ ‘near’. In these two words, the second vowels are unrounded as the underlying trigger rounded vowels are high and they do not spread roundness to the following low vowels. Therefore, height of underlying vowels plays the crucial role in Yakut rounding harmony as shown in recent studies (Anderson, 1998; Finch, 1985; Kaun, 1995; Sasa, 2009). In (8) the examples show how the vowels /ɛ/ and /ɑ/ preclude the spreading of roundedness from the preceding high rounded vowels.

[16] Accusative case affix. The base morpheme of the accusative case is –ni (Krueger, 1962/2012: 80). For illustrative purposes, the affixes are separated by a hyphen
[17] Kaun (1995) determines Yakut rounding harmony as Korn’s Type VI language (1969), where high vowels serve as targets. She clarifies that in Yakut both triggers and targets must be either of the same height, or the height of the target must be high.

(8) Incomplete rounding harmony

kyːlɛ	'inner porch'
kylymɛn	'horsefly'
kubɑ	'swan'
*kyːlœ	
*kubɒ	

The examples in (8) confirm that the underlying low vowels do not become [+round] if the triggers of rounding harmony are high vowels, instead, they surface as unrounded /ɛ/ and /ɑ/. The illicit forms */kylœ/ and */kubɒ/ violate the rounding harmony rule, as the low vowels became [+round] triggered by the high vowels /y/ and /u/ which is not permitted in the Yakut rounding harmony system.

Diphthongs perform as high vowels in Yakut rounding harmony (Anderson, 1998; Finch, 1985; Kaun, 1995; Sezer & Wetzels, 1986) as exemplified by the words /syœgɛj/ 'sour cream' and /kuɒbɑχ/ 'hare' in (9) below. Most importantly, the distinctive feature specifications for the Yakut diphthongs are [back] and [round] (Finch, 1985: 6), as harmonic features in an autosegmental approach. Kaun speculates that the reason the diphthongs act as high vowels is due to their first [+high] segment in a diphthong which is in the syllable nucleus whereas the second [-high] segment is at the syllable margin. The evidence that the diphthongs perform as high vowels in rounding harmony is supported by examples from the Yakut lexicon like in (9):

(9) Diphthongs as high vowels in rounding harmony

syœgɛj	'sour cream'
kuɒbɑχ	'hare'
bytyœ	'will finish'
turuɒ	'will stand'
*syœgœj	
* kuɒbɒχ	

Clearly, as illustrated in (9), diphthongs have a status of high vowels in the rounding harmony system. The examples like /syœgɛj/ 'sour cream' and /kuɒbɑχ/ 'hare' show that the roundness feature does not spread on the following low vowels /ɛ/ and /ɑ/ which is consistent with the height restrictions on the spreading of roundness. Triggered by the high rounded vowels /y/ and /u/ in the initial syllables exemplified in the words /bytyœ/ 'will finish' and /turuɒ/ 'will stand', the underlying diphthongs underwent rounding harmony.

Below are the patterns of rounding harmony adapted from Sasa's (2009: 163)[18] summary of patterns with licit and illicit combinations of vowels in Yakut rounding harmony:

(10) Yakut rounding harmony patterns (adapted from Sasa 2009: 163)

	Attested			Not Attested
Front vowels	(both [+high/+round]) -y-y (e.g. *kynys* 'afternoon') -y-yœ (e.g. *kyryœ* 'fence') ([+high/+round]> [-high/-round]) -y-ɛ (e.g. *ylɛ* 'work')	([-high/+round]> [+high/+round]) œ-y (e.g. *œrys* 'river')	(both [-high/+round]) œ-œ (e.g. *kœmœ* 'help')	([+high/+round]> [-high/+round]) *y-œ
Back vowels	(both [+high/+round]) -u-u (e.g. *utuj* 'sleep') -u-uɒ (e.g. *buruɒ* 'smoke') ([+high/+round]> [-high/-round]) -u-ɑ (e.g. *kumaχ* 'sand')	([-high/+round]> [+high/+round]) ɒ-u (e.g. *ɒlus* 'very')	(both [-high/+round]) ɒ-ɒ (e.g. *sɒrɒχ* 'some')	([+high/+round]> [-high/+round]) *u-ɒ

In addition to table (10), it is important to emphasize that in the Yakut rounding harmony system, rounded vowels do not occur after unrounded vowels, for example, sequences like *i…œ or *ɑ…u are ill-formed. Regardless of the height, unrounded vowels are not permitted to occur before rounded vowels.

It is shown so far that directionality of rounding harmony in Yakut is rightward. However, as loanword adaptation data evidence, when Russian input words have an unrounded-rounded sequence, there are attested patterns when the [+round] segment is preserved and the preceding [-round] vowels also get rounded:

[18] Sasa (2009) uses different IPA transcriptions for the vowels: /ø/ instead of /œ/ and /o/ for /ɒ/.

(11) Leftward roundness spreading in loanwords

Russian input	Yakut output	
/petux/	bœtyːk	‘rooster’
/pero/	bœryœ	‘feather’
/samolʲot/	sœmœlyœt	‘plane’
/zavod/	sɒbuɒt	‘factory’
/zipun/	supːuːn	‘homespun coat’

The data in (11) illustrate that [+round] segments from Russian input surfaced faithfully to the roundness feature and showed leftward spreading. Russian loanwords like /kiːnɛ/ ‘movie’ from /kino/ or /biɛdɛrɛ/ ‘bucket’ from /vedro/ suggest that the order of [-round] vowels preceding [+round] vowel segments is more inclined to eliminate [+round] segments on the surface and result in containing all [-round] vowels in a prosodic word. However, when word-initial syllables have [+round] vowels in Russian input, they most likely will retain [+round] segments in loanwords and spread roundness from left to right, as in examples, /musuɒj/ ‘museum’ from /muzej/ and /suɒntʃuk/ ‘umbrella’ from /zontik/. In closing the discussion of directionality, one can assert that rightward spreading of roundness is *more* dominant in Yakut rounding harmony.

4.4.3 Summary

To sum up, Kharitonov (1947: 61) emphasizes that rules of vowel harmony in Yakut are inviolable without exceptions. In general, Yakut vowel harmony shows consistency of harmonic patterns for both backness and rounding. To achieve backness harmony, all vowels in a prosodic word agree with the initial vowel in backness; as for rounding harmony, there is a general tendency for rounded vowels to spread roundness from left to right depending on vowel height.

Chapter 5: Russian phonology

This chapter presents an overview of Russian phonology, specifically focusing on vowels with discussions of consonants and stress affecting the vowel quality.

5.1 Consonant inventory

I present a revised and adapted version of the Russian consonant inventory based on the summaries of Iosad (2012: 522-523) and Timberlake (2004: 53), displaying 37 consonants:

(12) Consonant inventory of Russian

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar
Plosive	p pʲ b bʲ			t tʲ d dʲ				k kʲ g gʲ
Nasal	m mʲ			n nʲ				
Trill				r rʲ				
Fricative		f fʲ v vʲ		s sʲ z zʲ	ʃʲː ʒʲː	ʂ ʐ		x xʲ
Affricate			ts		tʃʲ			
Approximant							j	
Lateral				l lʲ				

It is well attested that the major contrast between the Russian consonants lies in the distinction between palatalized and non-palatalized consonants (Bidwell, 1962; Hacking, Smith, Nissen, & Allen, 2016; Jones & Ward, 1969). In a recent study of Russian palatalized and non-palatalized consonants, Hacking et al. (2016) identify the following 12 non-palatalized consonants that have palatalized counterparts: /p, b, f, v, m, t, d, s, z, n, l, r/.[19] They state that the previous findings revealed the acoustic cues of the palatalized/non-palatalized consonant distinction to be "the formant transitions of adjacent vowels and characteristics of the consonant release bursts" (p. 99). Moreover, electropalatographic (EPG) studies and acoustic analyses of the recordings carried out by Hacking et al. revealed that native Russian speakers produced palatalized consonants with tongue contact of the palate in the posterior region, unlike non-palatalized consonants and the consonant release burst duration of palatalized consonants appeared to be longer than that of non-palatalized consonants. Earlier Jones and Ward (1969) noted a significant role of tongue contact with the hard palate in the production of palatalized consonants, they also mentioned the frequent appearance of 'off-glide' that is slight, forming a 'j-sound' following palatalized consonants. They describe an occurrence of "an i-like vowel gliding from the vowel into the consonant" (p. 82) that

[19] Note that they do not include the palatalized consonants /k, g, x/ that have a "restricted distribution" and are followed by /i, e/ or in rare occasions by /a, o, i/ based on Timberlake's (2004: 53) note.

takes place between a palatalized consonant and a vowel that they call an "on-glide" (p. 82). Similarly, Ordin (2011) summarizing palatalized consonants also signifies "an /i/-like articulatory gesture which overlaps the primary articulation of the consonant" (p. 550). Timberlake (2004: 57) shows the lack of palatalized versions of the following phonemes /ʂ, ʐ, ts/;[20] in turn, there are no non-palatalized counterparts among /j, tʃʲ, ʃʲː, ʒʲː/. He notes that there is freedom where to appear for non-palatalized consonants, the only position where they do not occur is before /e/, whereas there is a distribution restriction for palatalized consonants (for more details, see Timberlake, 2004). That is, the role of palatalization affecting vowels beyond the formant transitions is presented in Section 5.2.1 below.

5.2 Vowel inventory

Russian has five vowel phonemes contrasted in stressed syllables (Avanesov, 1972; Barnes, 2007; Jones & Ward, 1969; Iosad, 2012; Ordin, 2011; Padgett & Tabain, 2005; Vinogradov, 1971). The Russian phonemes are illustrated below:

(13) Russian vowel inventory

Russian vowel inventory[21]			
	Front	Central	Back
High	i	(ɨ)	u
High mid	e		o
Low	a		

There is an unresolved question among linguists of whether the high central vowel /ɨ/ contrasts with /i/ (Barnes, 2007; Lyakso & Gromova, 2005; Samsonova, 1959). Iosad (2012) argues that /i/ and /ɨ/ are in complementary distribution and that /ɨ/ is the result of a strong velarization effect on the preceding consonants before the front vowel. In addition, Samsonova (1959: 12) states that the Russian /ɨ/ occurs following non-palatalized consonants only. As well, Timberlake (2014) confirms that he followed "the "Moscow" approach" (p. 40) that posits five vowels in the stressed position and that also regards /i/ and /ɨ/ as related vowels. He mentions "the "Leningrad" approach" (p. 41), which argues that /i/ and /ɨ/ are separate phonemes based on "a

[20] The IPA symbols are adjusted to reach consistency.

[21] The Russian vowel inventory chart is based on the descriptions of Jones & Ward (1969), Barnes (2007) and Padgett & Tabain (2005). However, the table does not display the full array of the phonemes' allophones that hinge on the qualities of the onset and the coda for each specific phoneme.

number of heterogeneous considerations” (p. 41). Finally, Jones and Ward (1969) also describe /i/ as a phoneme, and /ɨ/ is considered as a formation of /i/. In this study, I adopt a 5-vowel system in Russian, treating /ɨ/ as an allophone of /i/.

5.2.1 Effect of palatalized consonant on vowels

Next, it is well attested that the high mid vowel /e/ generally appears after palatalized consonants only (Lyakso & Gromova, 2005); however, the vowel can also occur after the non-palatalized /ʂ, ʐ, ts/, which lack palatalized correspondents (Iosad, 2012). Avanesov (1972: 31) points out that there is a slight i-like onset of the phoneme /e/ particularly in the word-initial position and following palatalized consonants. Word initially /e/ is realized as its allophone /ɛ/ (Lyakso & Gromova, 2005). Hacking et al. (2016) found that the vowels before palatalized consonants appeared to have higher F2. Moreover, Bidwell (1962: 125) made an interesting claim, suggesting that “vowels following a palatalized consonant are higher, fronter, and tenser, while between two palatalized consonants the incidence of highness, frontness, and tenseness in the vowel is still stronger.” In another recent acoustic study, Ordin (2011), for instance, found that back vowels in CVC syllables between two palatalized consonants lengthen in duration; in contrast, front vowels reduced in this context, provided both consonants were palatalized. He also revealed that postvocalic palatalized consonants in the CVC syllable shape (when the onset consonant was not palatalized) did not trigger vowel lengthening per se. In contrast, when pre-vocalic consonants were palatalized and the coda consonants were not in the CVC syllables, back vowels increased their duration. Ordin also found that consonant palatalization also lowered both F1 and F0, thus increasing the height of vowels. In addition, his measurements of intrinsic vowel intensity indicated that palatalization in CVC syllables led to the reduction of vowel intensity. This effect on intensity was more vivid when pre-vocalic consonants were palatalized rather than postvocalic palatalized consonants which also triggered the effect but to a lesser degree compared to palatalized pre-vocalic ones.

To sum up, it is evident that consonant palatalization affects the vowel quality in production. Particularly, Ordin (2011: 552) points out the effect of following and preceding palatalized adjacent consonants on vowel quality and formation of major allophones for each vowel phoneme due to palatalization (also see Partridge, 1950: 245), when in a way vowels serve as a cue of the palatalized/non-palatalized consonant distinction.

5.2.2 Vowel reduction in Russian

Russian has a rich allophonic system and the quality of vowels changes depending on the onset, coda, stress and consonant palatalization. Vowel reduction occurs when in unstressed syllables some vowel contrasts are neutralized, thus the complete vowel inventory is discerned only in stressed positions (Barnes, 2007; Iosad, 2012; Padgett & Tabain, 2005). Stressed positions induce underlying vowels to surface faithfully (Iosad, 2012).

Therefore, it is necessary to consider the allophonic variations of the Russian vowels in reduced forms when vowels appear in unstressed syllables. A chart of reduced vowels in Russian is presented below:

(14) Inventory of Russian reduced vowels[22]

	Front	Central	Back
High	i[23]		u
Mid		ə	
Near low		ɐ	

It is well attested that the high mid vowels /o/ and /e/ undergo a complete neutralization in unstressed syllables (Barnes, 2007). An adapted summary of unstressed vowel neutralization based on Padgett and Tabain's (2005: 16) description is illustrated in (15):

(15) System of vowel reduction in Russian in unstressed syllables

Vowels that are the same in stressed and unstressed context:
/i/ → [i]
/u/ → [u]

After non-palatalized consonant, including the inherently palatalized /tʃʲ/:
/e/ → [i]
/o, a/ → [ə]

After a non-palatalized consonant in a syllable in the immediately preceding position before a stressed vowel:
/o, a/ → [ɐ][24]

[22] The chart is based on the description of Russian vowel reduction by Barnes (2007) and Padgett & Tabain (2005).
[23] I include the vowels /i, u/ although they do not reduce in unstressed position; however, Iosad (2012: 524) claims that even though both vowels do not change phonologically when unstressed, "they are significantly centralized" and transcribes the unstressed /i, u/ as their centralized counterparts.
[24] Padgett & Tabain (2005) state that /a/ is reduced to [ɐ] in pre-stressed syllables. Iosad (2012) agrees with this description, and transcribes the surface forms of reduced /a/ and /o/ as [ɐ] in the syllables preceding the stressed syllables by claiming that [ɐ] here represents Moscow Russian (Standard Russian). Similarly, Barnes (2007) notes that the neutralized /a/ is closer to [ɐ] in the IPA convention.

After a palatalized consonant:
/i/ → [i]
/u/ → [u]
/e/ → [i]
/o/ → [i]
/a/ → [i]

Degrees of vowel reduction are subdivided into two distinct categories. Thus, Iosad (2012: 523-524) following Crosswhite (2000), categorizes vowel reduction into 'moderate' and 'radical'. Crosswhite herself describes the two types of reduction based on their degrees of neutralization: moderate and extreme (p. 109). The distinction between the two degrees of reduction is often referred as 'sub-inventories' that emerge contingent on the position of the vowel within a word (Crosswhite, 2000; Iosad, 2012). Specifically, radical vowel reduction is explained by Barnes (2007) as based on the extents of centralization of the underlying /a/ and /o/ when they are reduced, thus ultimately compressing the vowel space (horizontally); whereas moderate vowel reduction involves keeping the low vowel /a/ (/ɐ/) which leads to vowel space to compress vertically (i.e. the vowels /e, o/ instead of being centralized as /ə/ move higher to surface as /i/, as shown in (x15)). Iosad determines the following contexts when moderate reduction occurs: 1) unstressed syllables immediately preceding stressed syllables; 2) syllables without an onset, regardless of their position in respect to the stressed syllable; 3) open syllables in unstressed positions phrase finally which *may* undergo moderate reduction, thus displaying "a gradient effect" (p. 524) (meaning that there is possibility of the occurrence of moderate reduction, but not obligatorily); 4) based on Timberlake's (2004) claim, when hiatus occurs in the form of different combinations between /a/ and /o/ or two successive /a/ or /o/ in open syllables (p. 524). All things considered, Iosad regards radical reduction "as the elsewhere case" (p. 524).

5.2.3 Stress

It is well acknowledged that Russian stressed vowels are longer in duration than unstressed ones (Avanesov, 1964; Timberlake, 2004). A prominent effect of the stressed vowel in a word on a phonetic level was noted by Timberlake (2004: 29-30) when the stressed vowel determines length of the other vowels in a word: vowels immediately preceding the stressed vowel are described to have an intermediate duration (between the length of stressed vowels and unstressed ones) and vowels further than the stressed vowels appeared to have considerably shorter duration.

On a similar note, Partridge (1950) observed that stress is a determining factor of the general vowel sound quality, whereas consonantal phonetic contexts drive the precise vowel quality in Russian. Also, Timberlake describes the stressed vowels to “have more extreme articulations; the tongue has the time to reach further to the perimeters of the vocal tract – to be pronounced higher and further front, or higher and further back, or lower down.” (p. 30). Tenser articulation of Russian stress was also noted by Samsonova (1959: 21). She characterizes Russian stressed vowels to be louder, including a more distinct articulation, unlike unstressed vowels (also see Avanesov, 1964: 15).

Russian has one stressed syllable per word, except for compounds, with an unpredictable position of the stress (Melvold, 1989: 12), i.e. free stress (Avanesov, 1964).

5.3 Summary

This chapter has shown that the five Russian vowel phonemes /a, e, i, o, u/ and their quality are strongly contingent on stress and the surrounding consonants, specifically the palatalization/non-palatalization distinction. Certain Russian vowels are subjugated to different degrees of reduction depending on the stress position, and due to palatalization of preceding or following consonants vowels change their quality.

Chapter 6: Studies on the adaptation of Russian vowels in Yakut

In this chapter, I overview the main findings in the previous studies in respect to vowel adaptations in Russian loanwords into Yakut, mainly focusing on Dyachkovskiy (1962) and Sleptsov (1964). Other studies of Russian loanwords in Yakut primarily concern lexical (Arakin, 1953; Fedorova, 2012; Nesterova, 2013, Sleptsov, 1990), consonantal (Jang, 2016), orthographic (Vasilieva, 2011), and etymological (Pakendorf & Novgorodov, 2009) analyses of the data.

Sleptsov (1964) establishes two distinctions regarding the kinds of vowel adaptations from Russian in Yakut. Hence, some most-frequent adaptations that determine vowel harmony application (by imposing their features on other vowels in the word) are realized relatively independently from other surrounding vowels or their adaptations are mainly motivated by Russian stress, adjacent consonants or syllable position within a word (called 'independent substitutes' by Sleptsov, 1964). Other most-frequent adaptations show consistent affectedness by the quality of other vowels within the word and vowels that determine vowel harmony application (named 'substitutes dependent on harmony' by Sleptsov, 1964). I review the two kinds of most-frequent adaptations, i.e. input-output correspondences of each of the five input Russian vowel in Sections 6.1 and 6.4. Note that neither of the two authors specify the default case of most-frequent adaptations reviewed below, i.e. no general rules of adaptations are explicitly stated. In other words, Dyachkovskiy's and Sleptsov's summaries exclusively specify the environments where most-frequent adaptations occur, without specifying the elsewhere cases.

6.1 Most-frequent adaptations affected by stress, consonants or syllable position

Some most-frequent adaptations are the ones that are generally not affected by the quality of other vowels within a word, which Sleptsov (1964) classifies as 'independent substitutes'. Instead, those most-frequent adaptations are realized influenced by such factors like stress, quality of surrounding consonants, which is mostly based on whether consonants are palatalized or not, acoustic similarity to Yakut phonemes and syllable position where the input vowels occur. Sleptsov, however, defines most-frequent adaptations influenced by those factors, as exclusively based on the acoustic and articulatory similarities of the Russian vowels to their Yakut counterparts. Since summaries of vowel adaptations presented by Dyachkovskiy (1962) and Sleptsov (1964) are based on overviews of the most robust adaptation patterns, i.e. most-frequent adaptations, in the lexicon and dictionaries, I review the most-frequent adaptation patterns for each of the five input Russian vowel phonemes discussed by the two authors by omitting irregular patterns, variations and exceptions.

I present an adapted version of Sleptsov's summary Table 6.1 below, where I review the most-frequent adaptation patterns of the five Russian vowel phonemes, according to Sleptsov. Irregular vowel adaptations classified by Sleptsov as 'rare' are not included in Table 6.1.

Table 6.1 Most-frequent adaptations (adapted from Sleptsov, 1964: 84)

Input vowel	**Stress**	**Most-frequent adaptation**
/a/	stressed	/ɑː/, /ɛː/, /ɑ/
/a/	unstressed	/ɑ/, /ɛ/
/e/	stressed	/iɛ/, /ɯɑ/
/e/	unstressed	/ɛ/
/i/	stressed	/iː/, /ɯː/
/i/	unstressed	/i/, /ɛ/
/o/	stressed	/uɒ/, /yœ/
/o/	unstressed	/ɒ/[25]
/u/	stressed	/uː/, /yː/
/u/	unstressed	/u/

According to Dyachkovskiy (1962: 14), the stressed Russian /a/ becomes the long /ɑː/ in Yakut, if it occurs in a word-initial syllable, e.g., /ˈ**a**dres/[26]→/**ɑ**ːdɯrɯs/ 'address' or when it is preceded by an unstressed non-front vowel, e.g., /buˈm**a**ʐnik/→/kum**ɑ**ːhɯɲːɯk/ 'wallet' (see also Sleptsov, 1964: 74). The Yakut /ɑ/ and the Russian /a/ differ in backness; whereas the former is back, the latter is characterized as 'central' (Samsonova, 1959: 7).[27] The stressed /a/ is adapted as /ɛː/ affected by preceding palatalized consonants, e.g., /ˈprʲ**a**ʐka/→/bir**ɛ**ːskɛ/ 'buckle' (Dyachkovskiy, 1962: 15; see also Sleptsov, 1964: 74). Whereas an unstressed /a/ is realized as /ɛ/ following a palatalized consonant, e.g., /obʲ**a**ˈzatelʲno/→/ɛb**ɛ**sɛːtinɛ/ 'necessarily' (Sleptsov, 1964: 75). When /a/ is stressed and is in the word-final position, then it surfaces as the short /ɑ/, e.g.,

[25] Sleptsov does not give an example of a frequent adaptation of an unstressed /o/, and classifies /ɒ/ as a rare case.
[26] All vowel transcriptions are phonemic and broad, without reflecting the reduced forms of /a, e, o/, since Dyachkovskiy's and Sleptsov's examples reflect adaptations of the phonemes mostly, with occasional examples of reduced forms of the underlying phonemes. In the cases when a transcription is based on the surface reduced form, reflection of the reduced vowel is provided, and I consistently reflect stress and palatalized consonants in the transcriptions, since they are relevant here. Note that the Russian vowel /a/ is regarded as 'non-front' by both authors.
[27] In this dissertation, following Jones and Ward's (1969:46) description of the Russian phoneme transcribed as /a/ and characterized as "open, front, unrounded vowel", I regard the Russian vowel phoneme /a/ as front.

/duˈg**a**/→/dug**ɑ**/ ‘arc’; the same adaptation is generally observed for the unstressed /a/ word finally too, e.g., /saˈl**a**zka/→/sɑl**ɑ**ːskɑ/ ‘sled’ (Sleptsov, 1964: 75). The adaptation of the unstressed reduced /a/ as /ɑ/ is observed in the word initial syllable position or when preceding a non-palatalized consonant in pre-stressed syllables, e.g., /m**ɐ**ˈnax/→/m**ɑ**nɑːχ/ ‘monk’ (Sleptsov, 1964: 75).

Diphthongization of the stressed /e/ as /iɛ/ occurs when the vowel is after a palatalized consonant, e.g., /ˈstʲ**e**penʲ/→/ist**iɛ**pɛn/ ‘degree’ (Sleptsov, 1964: 78); /ˈvrʲ**e**mʲa/→/bir**iɛ**mɛ/ ‘time’ (Dyachkovskiy, 1962: 18-19). Dyachkovskiy points that palatalization results in the perception of a short /i/-sound before the stressed /e/ following a palatalized consonant, thus establishing acoustic similarity to the Yakut diphthong /iɛ/. The stressed /e/ is adapted as the back diphthong /ɯɑ/ affected by the preceding non-palatalized consonants /ʐ, ʂ, ts/, e.g., /ˈts**e**pʲ/→/s**ɯɑ**p/ ‘chain’ (Dyachkovskiy, 1962: 19; see also Sleptsov, 1964: 78). Both authors note an acoustic similarity of the stressed /e/ to the diphthong /ɯɑ/ in this context. When an unstressed /e/ determines vowel characteristics of the word, e.g., /s**e**ˈnat/→/s**ɛ**nɛːt/ ‘senate’, or if there is already an adapted vowel of the stressed /e/ alongside, e.g., /t**e**ˈlega/→/t**ɛ**liɛgɛ/ ‘cart’, the vowel tends to be adapted as the short /ɛ/ (Sleptsov, 1964: 78). Note that in Sleptsov’s examples those adaptations of the unstressed /e/ are mostly in word-initial syllables of the input Russian words.

Yakut and Russian both have the high front vowel phoneme /i/ in their inventories (see Samsonova, 1959). The stressed /i/ in word-initial syllables lengthens, e.g., /ˈv**i**lka/→/b**i**ːlkɛ/ ‘fork’, or when it is preceded by a front vowel, for example, by /i/ in /brigaˈd**i**r/→/birigɛdʒ**i**ːr/ ‘brigadier’ (Dyachkovskiy, 1962: 20). Sleptsov (1964: 79) explains the tendency for the stressed /i/ to become the long /iː/ due to its (acoustic) similarity to the Yakut long counterpart, and does not specify its syllable position to be initial, unlike Dyachkovskiy. A realization of the stressed /i/ as the long /ɯː/ occurs when the vowel is preceded by the palatalized consonant /tʃʲ/ when in this context the vowel is articulated more widely, e.g., /ˈtʃʲ**i**n/→/tʃ**ɯ**ːn/ ‘rank’ (Sleptsov, 1964: 80; see also Dyachkovskiy, 1962: 20). Next, an unstressed /i/ remains as the short /i/ in Yakut, especially affected by front vowels within a word, e.g., /d**i**naˈmit/→/d**i**nɛmiːt/ ‘dynamite’ (Sleptsov, 1964: 80). In adaptations of Russian adjectives when an unstressed /i/ is in a word-final suffix preceded by bases with palatalized consonants, the vowel is realized as the short /ɛ/, e.g., /ˈkrʲepk**i**j/→/kiriɛpk**ɛ**j/ ‘sturdy’ (Sleptsov, 1964: 80).

The Russian vowel /o/ is mid, whereas the Yakut counterpart is the low /ɒ/ (see Samsonova, 1959: 13-14). The stressed /o/ in word-initial syllables, e.g., /ˈk**o**lokol/→/k**uɒ**lɑkɑl/ 'bell', or in the presence of other non-front[28] vowels, e.g., /zaˈk**o**n/→/sɒk**uɒ**n/ 'law', tends to be adapted as the diphthong /uɒ/ (Sleptsov, 1964: 76). The /u/-sound occurs before the stressed /o/ in the word-initial position or when preceded by a non-palatalized consonant, thus reflecting acoustic resemblance to the Yakut diphthong /uɒ/ (Dyachkovskiy, 1962; Kulakovskiy, 1946). In the same manner, due to the similarity to another Yakut diphthong, the stressed /o/ is adapted as /yœ/ when preceded by a palatalized consonant, e.g., /koˈvʲ**o**r/→/kœb**yœ**r/ 'carpet' (Dyachkovskiy, 1962: 17; see also Sleptsov, 1964: 77). As for the unstressed /o/, it is most often adapted as the short /ɒ/ when there is a stressed /o/ in a word, due to the acoustic similarity between the Russian /o/ and the Yakut /ɒ/, especially when borrowed from the dialects where /o/ is heavily rounded, e.g., /vojˈl**o**k/→/bɒːldʒ**ɒ**χ/ 'felt' (Sleptsov, 1964: 77).

Finally, the vowel phoneme /u/ is identical between Russian and Yakut (see Samsonova, 1959: 15). The stressed /u/ in a word-initial syllable and preceded by non-palatalized consonants is adapted as the long /uː/ in Yakut, e.g., /naˈt**u**ra/→/nɒt**u**ːrɑ/ 'nature' (Dyachkovskiy, 1962: 21) and /ˈp**u**lʲa/→/b**u**ːldʒɑ/ 'bullet' (Sleptsov, 1964: 82). Palatalization of the consonants affect the way the stressed /u/ is adapted, that is, it is realized as the front long /yː/ when preceded by a palatalized consonant e.g., /ˈtʲ**u**k/→/t**y**ːk/ 'bale' (Dyachkovskiy, 1962: 22) due to the presence of the /y/-sound in such a context (see also Sleptsov, 1964: 82-83). According to Sleptsov (1964: 83), the unstressed /u/ remains as /u/ in Yakut "in a firm vocalization of the word", e.g., /tr**u**ˈba/→/t**u**rbɑ/ 'chimney'.

To sum up, the stressed vowels /e, i, o, ʲo, ʲu/ are noted to bear an acoustic resemblance to the Yakut diphthongs and long vowels, which largely accounts for by their diphthongized and lengthened adaptations. Next, preceding palatalized consonants instigate the fronting of the non-front vowels /a, o, u/, thus causing their fronted adaptations, e.g. the stressed /a/ is adapted as /ɛː/ in /poˈrʲ**a**dok/→/bɛr**ɛ**ːdɛk/ 'order' (Sleptsov, 1964: 74). In turn, non-palatalized consonants tend to facilitate the change of the backness value of front vowels, so that they became back, e.g., /ˈts**e**lʲ/→/s**ɯɑ**l/ 'target/goal' (Dyachkovskiy, 1962: 19).

[28] Dyachkovskiy and Sleptsov describe the backness of other vowels that are not front as 'non-front'.

6.2 Adaptation of stress

An impact of stress in adaptations was noted by Kulakovskiy (1946: 16), who states that Yakut speakers focused on a prominent vowel within the word and generally tended to select a stressed vowel's backness feature for harmonization. Anderson (1995: 369) mentions, "Stressed vowels are generally replaced by long vowels or diphthongs, with the word-stress shifting to the last syllable, as word-final syllable stress is regular in Yakut. Unstressed vowels are frequently replaced by harmonically conditioned variants". Furthermore, Samsonova (1959: 19) also observed that Yakut speakers diphthongized the Russian stressed vowels in loanwords exemplified by the adaptations of the mid vowels /e/ and /ʲo/. Similarly, Sleptsov (1964: 86) asserts a significant role of Russian stress in determining vowel harmony due to the stressed vowels' greater (articulatory) precision and strength, whereas unstressed vowels are imprecise and reduced. Moreover, Table 6.1 above shows that the stressed high /i, u/ and low vowels /a/ tend to lengthen, whereas the stressed mid vowels /e, o/ are realized as diphthongs. Whereas overall, unstressed Russian short vowels tend to be adapted as short in loanwords (see Dyachkovskiy, 1962; Sleptsov, 1964).

To sum up, it was attested in the previous studies that, influenced by the prominence of the Russian stressed vowels, Yakut speakers generally tended to adapt them as either long vowels or diphthongs. Moreover, stressed vowels were suggested to be important in determining what vowels – stressed back or front – spread their features in the word (as in Kulakovskiy, 1946: 16; Sleptsov, 1964: 86).

6.3 Vowel harmony in loanwords

The vowels in Russian and Yakut operate differently, as Yakut vowels combine in words following strict rules due to vowel harmony, whereas Russian does not have it (Kharitonov, 1947: 29, 1950: 236). Thus, driven by the distinct Yakut phonology regarding the vowels, and vowel harmony, most Russian loanwords underwent complete vowel harmony and phonetic adaptation before the Russian Revolution of 1917 (Sleptsov, 1964).

As cited by Sleptsov (1964), the first scholar to describe Russian loanwords was Böhtlingk (1851/1964). That is, based on Sleptsov's (1964: 66) summaries, Böhtlingk first noted regularities in vowel adaptations driven by the rules of vowel harmony and he claimed that Yakut speakers first determined the prevalence of either front or back vowels in a Russian word. Similarly, Kulakovskiy (1946: 16) states that Yakut speakers were usually dictated by the prominent stressed Russian vowel's backness value for harmonizing the incoming words in Yakut, for example, due to the stressed back vowel /u/ in the word /ˈkruʐevo/ 'lace' the vowels in the Yakut adaptation /kuruhuɒbɑ/ are all back, or the front stressed vowel /e/ further caused the frontness of the vowels in the Yakut word /bɛbiɛrkɛ/ 'test/check' from the Russian word /proˈvʲerka/.

I present Sleptsov's (1964: 83-86) conclusions and examples on the regularities leading to vowel harmony application in loanwords:

(16) The vowels follow the output correspondence's backness of the stressed vowel in the word-initial syllable

Russian	Yakut		
ˈmʲelʲnitsa	miɛliŋsɛ	'mill'	
ˈspitʃʲka	ispiːskɛ	'match'	
ˈadres	ɑːdɯrɯs	'address'	(Sleptsov, 1964: 83-85)
ˈpolʲskij	buɒluskɑj	'Polish'	
ˈulitsa	uːluksɑ	'street'	

(17) An entire word's vowel characteristics are determined by the vowels /i/ and /e/ in the word-initial syllable, regardless of their stress

vinˈtovka	bintiɛpkɛ	'rifle'	
dinaˈmit	dʒinɛmiːt	'dynamite'	
ˈpʲerepisʲ	biɛrɛpis	'census'	
berˈdanka	bɛrdɛːŋki	'berdan rifle'	(Sleptsov, 1964: 85)

(18) Output correspondences in initial syllables become rounded influenced by the rounded vowels within a word

meˈʂok	mœhœːk	'bag'	
peˈtux	bœtyːk	'rooster'	
resˈpublika	œrœspyːbylykɛ	'republic'	
Petˈrov	bœtyryœp	'Petrov'	(Sleptsov, 1964: 85)

(19) Harmony determined by the dominance of the backness value based on acoustic and articulatory impression (usually adaptations of stressed vowels or vowels in word-initial syllables)

arˈxangel	ɑrχɑːɲːɑl	'archangel'	
poˈkojnik	bɒkuɒɲːuk	'deceased'	
kandiˈdat	χɑndʒɯdɑːt	'candidate'	
poˈvestka	bɛbiɛskɛ	'agenda'	
arˈxiva	ɑrkɯːbɑ	'archives'	(Sleptsov, 1964: 86)

Sleptsov highlights the importance of vowels in word-initial syllables and stressed vowels in driving vowel harmony in loanwords, since those vowels had greater perceptual clarity (p. 86, also shown in (16)). Sleptsov (1964: 71) claims, “Russian words of the given period are borrowed acoustically, and are basically characterized by a complete phonetic adaptation in line with the Yakut sound system’s requirements” [my translation]. The fact that Russian loanwords were produced consistent with the Yakut [phonetic] rules is also noted by Kharitonov (1950: 235).

However, Sleptsov (1975: 63) in his book analyzing Russian loanwords after the Russian Revolution of 1917 based on the written media noted some violations of Yakut vowel harmony, like in the adaptations /ɑgiːtsuːt/ and /mɛskuɒm/ derived from the Russian compounds /agitˈsud/ ‘propaganda court’ and /mestˈkom/ ‘the local committee of the trade union organization’, as these words have a slight pause between the truncated bases /ɑgit/ and /mest/ from /agitaˈtsionːɨj/ ‘agitational’ and /ˈmestnɨj/ ‘local’, respectively, and the bases /ˈsud/ and /ˈkom/, correspondingly. Also, among the consistent violations, Sleptsov (1975: 63) gives examples of loanwords that are presumably adapted this way with the purpose of achieving “euphony, aesthetics of the word” [my translation] – for instance, the Yakut word violating the rounding harmony /sɑbɑstuɒpkɑ/ ‘strike’ from the Russian word /zabasˈtovka/ or a disharmonic Yakut word /dʒiktɑtuːrɑ/ ‘dictatorship’ from the word /diktaˈtura/ in Russian.

Similarly, Anderson (1995) discusses russianisms in several Siberian Turkic languages, including Yakut. Anderson notes that due to an increased familiarity of Yakut speakers with the Russian language during the 20th century, the Yakuts started to pronounce Russian words exactly as they are in the source language. Sleptsov (2007: 111) essentially regards russianisms as incoming words that are used in Yakut in their unaltered forms. This tendency of code-switching to Russian in Yakut texts in newspapers is also mentioned by Sleptsov earlier (1975). Most importantly, Anderson (1995: 369) states that earlier loanwords violated backness harmony restrictions very rarely and never violated it when the stressed Russian vowels occurred in the word-initial syllable position.

Thus, the distinction of Russian loanwords before and after the Russian Revolution established by Kharitonov (1950, 1955) and Sleptsov (1964, 1975, 2007) reflects the important sociolinguistic factor that Yakut speakers started to become bilingual in Russian since the establishment of the Soviet Union in 1917. Therefore, the general bilingualism of the modern

Yakut speakers, specifically their knowledge of the source language phonology, is suggested to have a significant impact on how the speakers deal with Yakut adaptations of Russian words.

6.4 Most-frequent adaptations affected by other vowels within the word

Most-frequent adaptations that are contingent on other vowels and vowels that determine vowel harmony application (i.e. feature spreading) in the word, are defined as ‘substitutes dependent on harmony’ by Sleptsov (1964). Sleptsov notes that such adaptations are articulatory approximations of Yakut sounds conditioned by the vowel harmony restrictions (p. 73). That is, output correspondences that consider other vowels’ quality within the word in Dyachkovskiy’s (1962) and Sleptsov’s (1964) summaries may indicate that the vowels tended to harmonize, which could be driven by the vowel quality of the adapted preceding, following and other vowels within the word, and by the stressed vowel. Regarding the features that drive vowel harmony in loanwords, Dyachkovskiy (1962: 14) emphasizes the primary role of stressed vowels, whereas Sleptsov (1962: 86) acknowledges the role of vowels in initial syllables, in addition to stress.

I present an overview of the most-frequent adaptation patterns affected by other vowels within the word, based on Sleptsov’s summary, in Table 6.2. I indicate concrete preceding or following vowels that drive the vowel adaptations. Effects of consonants or other vowels in the word without a specific indication of the syllables in regards to the target vowel phonemes are not presented in the table below. The dashes in the cells in Table 6.2 specify cases that Sleptsov does not indicate.

Table 6.2 Most-frequent adaptations (adapted and adjusted based on Sleptsov, 1964: 74-87)

Input vowel	**Stress**	**Vowel**		**Most-frequent adaptation**
		Preceded by	Followed by	
/a/	stressed	/i/ or /e/	-	/ɛː/
/a/	unstressed	-	/ˈo/	/ɒ/
		/i/ or /e/	-	/ɛ/
/e/	stressed	non-front	-	/ɯɑ/
/e/	unstressed	-	-	/ɑ/
/i/	stressed	non-front	-	/ɯː/
		-	-	/ɯ/
/i/	unstressed	non-front	-	/ɯ/
		rounded non-front	-	/u/
/o/	stressed	/i/ or /e/	-	/iɛ/
/o/	unstressed	-	-	/œ/
/u/	stressed	front	-	/yː/
/u/	unstressed	-	-	/y/
		-	-	/ɯ/

Most-frequent adaptations discussed by Dyachkovskiy or Sleptsov primarily focus on the syllable position of the vowels that affect the input vowels' adaptation. Thus, when a stressed /a/ is preceded by the front vowels /i, e/, it is adapted as the long /ɛː/, e.g., /pidˈʐ**a**k/→/bins**ɛ**ːk/ 'suit jacket' (Dyachkovskiy, 1962: 16; see also Sleptsov, 1964: 75-76). An unstressed /a/ tends to be adapted as the back rounded /ɒ/ when there is a following stressed /o/, e.g., /n**a**ˈrod/→/n**ɒ**ruɒt/ 'people' (Sleptsov, 1964: 76). The front vowel /ɛ/ is realized when an unstressed /a/ is after the front vowels /i, e/, e.g., /ˈmisk**a**/→/miːsk**ɛ**/ 'bowl' (Sleptsov, 1964: 76).

The stressed /e/ is realized as the diphthong /ɯɑ/ affected by a preceding non-palatalized consonant, if there is a non-front vowel in a pre-stressed syllable, e.g., /proˈt**e**st/→/bɯrɑtʃ**ɯɑ**s/ 'protest' (Dyachkovskiy, 1962: 19; see also Sleptsov, 1964: 78). An unstressed /e/ tends to be adapted as the short /ɑ/ when it is articulated without lip rounding, e.g., /ˈord**e**n/→/uɒrdʒ**ɑ**n/ 'medal' (Sleptsov, 1964: 79).

When preceded by non-front vowels in pre-stressed syllables, a stressed /i/ is adapted as the long /ɯː/, e.g., /karˈt**i**na/→/χɑrt**ɯ**ːnɑ/ 'picture' (Sleptsov, 1964: 80; see also Dyachkovskiy, 1962: 20). A stressed word-final /i/ is realized as the short /ɯ/, e.g., /nosˈk**i**/→/nɑsk**ɯ**/ 'socks' (Sleptsov, 1964: 81). In turn, an unstressed /i/ is also adapted as /ɯ/ in the presence of non-front vowels in the syllables before the stressed one, e.g., /kap**i**ˈtal/→/χɑpː**ɯ**tɑːl/ 'capital' (Sleptsov, 1964: 81). To attain rounding harmony, if an unstressed /i/ is preceded by (rounded) non-front vowels, it is realized as the rounded back vowel /u/, e.g., /ˈkort**i**k/→/kuɒrt**u**k/ 'dirk' (Sleptsov, 1964: 81).

A stressed back vowel /o/, influenced by the preceding front vowels /i, e/, tends to be adapted as the front diphthong /iɛ/, e.g., /vinˈt**o**vka/→/bint**iɛ**pkɛ/ 'rifle' (Sleptsov, 1964: 77). An unstressed /o/, however, is most frequently realized as the front rounded /œ/ affected by the adaptations of another stressed /o/, which is heavily rounded, and other front vowels /i, e/ within a word, e.g., **/**koriˈd**o**r/→/kœlyd**yœ**r/ 'corridor' (Sleptsov, 1964: 78).

Finally, an adaptation as the long /yː/ based on a stressed vowel /u/ occurs when it is preceded by front vowels and surrounded by two non-palatalized consonants e.g., /miˈn**u**ta/→/myn**y**ːtɛ/ 'minute' (Dyachkovskiy, 1962: 22; see also Sleptsov, 1964: 83). When a word's vowel characteristics are primarily front, an unstressed /u/ is adapted as the front rounded /y/, e.g., /g**u**ˈbʲerniʲa/→/k**y**byœrynɛ/ 'province' (Sleptsov, 1964: 83). Another frequent adaptation of an unstressed /u/ is the unrounded back /ɯ/, influenced by the harmony determining vowel /a/ in a word, e.g., /ˈparus/→/bɑːrɯs/ 'sail' (Sleptsov, 1964: 83). Note that Sleptsov's example indicates the first stressed vowel /a/ as the vowel that determines harmony.

Generally, based on Sleptsov's summaries I observe that the non-front vowels /a, o, u/ undergo fronting in adaptation when preceded by the front vowels /i, e/. On the other hand, the front vowels /e, i/ become back when preceded by non-front vowels. Thus, there is a clear tendency that the backness feature tends to spread rightward. Another tendency that is observed in Table 6.2, is that the unrounded vowels, like /a/ and /i/ become rounded, influenced by a preceding or a following rounded vowel to attain rounding harmony. An effect of rounding harmony rules on the vowel realizations specified by Sleptsov, enables me to arrive at a preliminary conclusion that rounded vowels tend to spread their roundedness feature either leftward or rightward in order to comply with the rounding harmony rules.

According to the literature, the most-frequent adaptations that are affected by other vowels in the word are *mainly* driven by the backness feature of preceding vowels, and the roundedness of preceding or following vowels. Additional factors influencing adaptations include word's vowel characteristics, stress, syllable position, adaptations of the other vowels, and the quality of adjacent vowels (palatalized versus non-palatalized).

6.5 Summary

In sum, the previous studies on the most-frequent adaptations of Russian vowels in Yakut show their dependence on such factors as stress, syllable position, allophonic variations due to surrounding consonants, and the vowels' backness feature of especially vowels in initial syllables in the source Russian words. I thus consider these factors as crucial input predictors of adaptations of the Russian vowels in loanwords in accordance with the Yakut phonology.

Chapter 7: Methodology

The data for this dissertation was collected in the summer of 2014 when I went to the Republic of Sakha (Yakutia) in the Russian Federation, to do field work. Materials of the data collection consisted of two tasks: production and rating. During the production task, Yakut-Russian bilingual speakers were asked to read Russian words silently and adapt them in Yakut spontaneously. The rating task contained audio files of nonce Yakut words and the participants rated the words for Yakut likeness. In addition, they filled out a short language background information questionnaire. I conducted the field work in the months of July-August 2014 in the capital city Yakutsk and in the villages Khampa and Tympy in the Vilyuysky District of the Republic of Sakha (Yakutia).

This study titled "Phonological study of Russian loanwords into Yakut" (ID: Pro00049053) received an ethics approval by the University of Alberta Research Ethics Board (REB) 1 on June 23rd, 2014.

7.1 Participants

The participants were 40 native Yakut speakers in the age-range from 20-81 years old (mean age 45.65). There were 32 female and eight male speakers in the study. The reason for excluding participants in their teens was that younger speakers had a probable tendency to resort to code-switching between Yakut and Russian more often than more mature speakers. Thus, the focus was on adult speakers over the age of 20. Fourteen of the participants were permanent residents of the city of Yakutsk, which can be characterized as a balanced bilingual city, one person lived in a rural place in the Gorny District visiting Yakutsk, and one speaker lived and worked in the predominantly Russian-speaking city of Neryungri, two speakers lived in the city of Vilyuysk, which is predominantly Yakut-speaking, and the rest of 22 participants were residents of the predominantly Yakut-speaking villages Khampa and Tympy in the Vilyuysky District. Thirty-seven speakers were Yakut-Russian bilinguals, and three speakers were monolingual Yakut speakers. Except for the three Yakut monolinguals, all the participants filled out a questionnaire written in Russian that was adapted based on Dr. Johanne Paradis's (2010) Alberta Language Environment Questionnaire (ALEQ) and Dr. Juhani Järvikivi's Language Background Information Self-Report (see an English translation of the document in Appendix A). There was no Yakut version of the language background information questionnaire since most of the questions in it were related to the Russian language competency, and thus were irrelevant to the monolingual speakers. Another reason for not including a separate questionnaire written in Yakut meant for Yakut monolingual speakers was that all official documentation in the Republic of Sakha (Yakutia) is written in Russian. Moreover, the monolingual speakers had a low level of literacy. Details of the bilingual participants' answers to the questionnaire are presented in Section 12.1.

7.2 Materials

7.2.1 Production task

The production task's materials consisted of three types of word lists: the first list consisted of 45 Russian words that have been adapted in Yakut (hereafter, borrowed words); the second list contained 50 Russian nonce words (hereafter, nonce words), and the third list had 49 Russian words that have not been adapted in Yakut (hereafter, un-borrowed words) as some of them have corresponding words in the Yakut lexicon. All the words in the word-lists were disyllabic. Below (20) I give examples of the words used in three different types of word-lists. Note that I transcribe the Russian words reflecting their orthographic forms, i.e. phonemic transcriptions are presented.

(20) Word examples from the word lists

a. Borrowed words

Russian	Loanword in Yakut	
ˈlagerʲ	lɑːʁɯr	'camp'
ˈmesto	miɛstɛ	'place'
fiˈtilʲ	bitiːl	'wick'
ˈzontik	suɒntʃuk	'umbrella'
ˈmore	muɒrɑ	'sea'

b. Nonce words

ˈlonik
goˈmulʲ
ˈmufik
tiˈtir
vaˈpar

c. Un-borrowed words

ˈgolod	‘hunger’
kaˈban	‘boar’
ˈdulo	‘muzzle’
mosˈkit	‘mosquito’
beˈgun	‘runner’

The aim of the list of borrowed words (20a) was to assess participants’ general knowledge of the borrowed words (with corresponding loanwords) on the lists to consequently test if the extents of knowledge of the Russian loanwords (the way the Russian words on the lists were borrowed in Yakut) affected the participants’ adaptations. The second reason for including the borrowed words was to engage participants in a warm-up activity prior to spontaneous adaptations of the Russian nonce and un-borrowed words. The intent was to give participants an idea of the nature of the production task overall. The next list (20b) contained nonce words that were created following Russian phonotactic rules. Finally, a list (20c) of un-borrowed words consisted of actual Russian words that have not been adapted in Yakut.

The target words were selected and organized in categories within each of the three word types (borrowed, nonce and un-borrowed words). Each of the stressed and unstressed five input Russian vowels in both syllable positions were combined with stressed and unstressed front and back vowels. As a result, four basic categories for the vowels’ combinations were organized: 1) the stressed [+back/+round][29] vowels followed and preceded by the unstressed [-back/-round] vowels: 2 stressed vowel phonemes /o, u/ X 2 syllable positions (initial/final) X 3 unstressed vowel phonemes /a, e, i/ = 12 combinations; 2) the stressed [-back/-round] vowels followed and preceded by the unstressed [+back/+round] vowels: 3 stressed vowel phonemes /a, e, i/ X 2 syllable positions (initial/final) X 2 unstressed vowel phonemes /o, u/ = 12 combinations; 3) the stressed [+back/+round] vowels followed and preceded by the unstressed [+back/+round] vowels: 2 stressed vowel phonemes /o, u/ X 2 syllable positions (initial/final) X 2 unstressed vowel phonemes = 8 combinations; 4) the stressed [-back/-round] vowels followed and preceded by the unstressed [-back/-round] vowels: 3 stressed vowel phonemes /a, e, i/ X 2 syllable positions (initial/final) X 3 unstressed vowel phonemes /a, e, i/ = 18. Thus, 50 possible phonemic combinations of the five Russian vowels were defined, in both stressed and unstressed syllables

[29] The Russian [+back] vowels are both [+round] too, and the [-back] vowels are [-round].

and both positions for each vowel. Note that each pair of the vowel combinations was supposed to have one example word per word type in each of the three groups of words (3 X 50 = 150). If a certain combination of vowels in disyllabic words had neither suitable borrowed words nor un-borrowed words, such slots were left blank. However, in case of absence of one of the example words per word type, the nonce words still represent each of the vowel combinations in the designated pair types.[30] As a result, five borrowed words and one un-borrowed word were missing as neither I nor my language consultants found suitable words. For the full list of the way the 144 words of the production task were organized into the four categories, see Appendix B.

During the arrangement of the word-lists for the production task, I checked each word with two language consultants, one female 55-year-old and one male 59-year-old native Yakut speaker. In addition, I used Afanasyev et al.'s (2008) *Yakut short explanatory dictionary* [my translation] for reference. The word list additionally contained words with allophonic variants of some vowel phonemes ([ɨ],[31] [ɛ], [ʲa], [ʲo] and [ʲu]); however, these words did not represent all possible vowel combinations and were excluded from the analysis. Thus, initially the total number of Russian input words in the production task word-lists was 181 words, including the 37 words with allophonic vowels that were subsequently not considered in the analyses. Ultimately, 144 target words that had only phonemic vowels in both syllables were analyzed.

7.2.2 Rating task

The purpose of the rating task was to examine whether the Yakut speakers were perceptually sensitive to violations of vowel harmony rules and whether they could recognize words with no vowel harmony violations.

I prepared 100 nonce Yakut words for the rating task, where all the words were disyllabic. The disyllabic words included in the rating task focused on backness (hereafter, BH) and rounding (RH) harmony. Below (21) gives examples of the way the target words in the rating task were created and grouped in the data organization. Each heading in the date below (21a and 21b) represents a category of words based on which the nonce words were created. Overall, there were

[30] The words *siˈfon* 'syphon' and *siˈrop* 'syrup' had the same vowel combination, including stress. An un-borrowed word was intended to have the unstressed /o/ in this combination; nevertheless, the nonce word *ˈmivo* and the borrowed word *ˈpivo* 'beer' compensate for the lack of an un-borrowed word with this vowel combination. Productions of the target word *siˈfon* were included in the analyses.

[31] In this study, I treat the Russian vowel [ɨ] as an allophone.

five different categories of words illustrated in the two tables. Note that I do not test all possible rounding harmony violations. For example, violations like the sequences **y-i, *u-ɯ, *ɒ-a, *œ-i*, where the the roundedness feature fails to spread from the first to the second vowel even though the spreading would be licensed, are not included. The reason I focus on specifically the two kinds of violations presented in (21b) is to assess the perception of the height violations in the two adjacent rounded vowels (Category 4) and the violation in the order of the roundedness feature between first and second syllables (Category 5).

(21) Organization of nonce Yakut words for the rating task

a. Backness harmony

Category 1: Nonce words following BH rule	Category 2: Nonce words violating BH rule. Vowels with different backness features within a word
tɒbus ɲibɛs mɯkɯːs biɛmir	*sɯmis *dʒymɑχ *tuɒsœχ *tɛːbɑ

b. Rounding harmony

Category 3: Nonce words following RH rule	Category 4: Nonce words violating RH rule. High rounded vowels *precede* low rounded vowels	Category 5: Nonce words violating RH rule. Unrounded vowels *precede* rounded vowels
bynys tɒbur subɑr syœbɛj	*bugɒ *kytœl *tuɒmɒj *syːʁœn	*sɯtɒn *inys *χɑlɒː *biɛbyk

There were 20 words for each of the five groups. I ensured that the nonce words in each group had different combinations of back and front vowels including diphthongs and long and short vowels (see a full list of the rating task's nonce words in Appendix C).

After the words were randomized, I recorded myself producing each word using Praat (Boersma & Weenink, 2014) at 44100 Hz sampling rate and 16 bit, with an A4TECH Desktop Microphone Model MI-10 plugged in to the laptop. The individual words were recorded separately in the format of wave sound files. The sound files were given numbers and were inserted on slides of a PowerPoint presentation, where each slide had an individual sound file with a designated number. In case participants preferred me playing the sound files for them instead, an additional folder containing all the numbered sound files was prepared. Note that all participants heard the sound files in the same fixed order.

7.3 Procedures

Procedures involved two tasks in one session. Each session lasted for about 30 minutes. The order of the production and rating tasks was varied from one participant to the other with the purpose to have half of the participants complete the rating task first followed by the production task and vice versa. As most of the participants were Yakut-Russian bilinguals, in an attempt to have the bilingual participants switch more to the Yakut language mode, I first read principal parts of the consent form in the Yakut translation (see an English translation of the full consent form in Appendix D). My reading of the consent form in Yakut was recorded, including participants' responses "I agree" at the end. During a session, I sat next or close to a participant. After the session, participants filled out a language background information questionnaire written in Russian. The three monolingual Yakut speakers consented in the oral form and completed only the rating task. As the final step of the session, the bilingual participants read and signed the written consent form in Russian.

7.3.1 Production task

In the production task, the word lists containing the Russian input words appeared in the following order: 1) borrowed words; 2) nonce words; and 3) un-borrowed words. The words in the three word-lists based on word type were randomized, and printed out on paper with one word per line and were inserted in file sheets of a binder for presentation to the participants, with each sheet in a plastic file to avoid an extra paper noise. All the words were written in Russian and each stressed vowel was indicated by the stress symbol, a conventional symbol used in Russian formal primary school education, [32] whereas stress in Yakut is never marked. I asked participants to read the Russian words on the three lists silently and produce them by making them sound like native

[32] This symbol looks like a high tone in the IPA convention.

Yakut words spontaneously (immediate on-line adaptations). I let them rehearse with few words. The participants were instructed to produce each word aloud in a carrier sentence ______ *di:bin* '_______ I say'. I encouraged them to say the first word on the list as *min saχalɯ:* _______ *di:bin* 'I say _________in Yakut'. They were asked to skip words in case they did not know how to adapt them to avoid lengthy disruptions and pauses. Prior to the session, while greeting each participant and settling down to start, I spoke Yakut only to them. I told participants to imagine they did not speak Russian, and if they heard the words on the word-lists, how they would produce them in Yakut (if they were monolingual speakers). There was a short pause between each word-list. If the participants wished to do the sessions by themselves, without me being present right there, I left the room until they finished the recording sessions. All the sessions were recorded on a laptop directly in Praat at 44100 Hz sampling rate and 16 bit. An A4TECH Desktop Microphone Model MI-10 was plugged in to the laptop and the distance between participants and the microphone was adjusted by placing it not too close or too far from each individual. I ensured that the quality of recordings was adequate by verifying sample sound files in wave file format for the quality of spectrograms and sound.

7.3.2 Rating task

In the rating task, participants were given a rating sheet with 100 numbered lines with the rating grades in a linear order from 1 to 5 per line. Each number on the rating sheet was correspondent to the order (and number) of a sound file. Participants were instructed that they were going to hear nonce Yakut words and that they needed to rate each word on how likely a Yakut word it could be. The 5-point rating scale is identical to the grading system used in formal education in the Russian Federation with a "1" being "failure", a "2" (unsatisfactory), a "3" (satisfactory), a "4" (good) and a "5" being "excellent". Participants were told to circle appropriate rating numbers on the rating sheet after having listened to each word once. A pair of an MB Quart QP 805 High Solid headphones from the Alberta Phonetics Laboratory (APhL) of the Department of Linguistics of the University of Alberta was provided, and few participants preferred to listen to the target words directly from the laptop, without wearing the headphones. Despite preparing a PowerPoint presentation with sound files in each of the slides; as a matter of fact, for most participants I played each sound file one at a time by myself using a computer mouse. After they had heard an individual sound file and circled a rating number of their choice, I played the next sound file for them. Two participants asked to play the sound files by themselves, and instead of using the sound files in the PowerPoint presentation, they used the folder with the numbered sound files.

7.4 Transcriptions of the production data

7.4.1 Initial transcriptions

Out of 5,328 target items (144 words X 37 participants), a total of 5,160 tokens were transcribed, of which 1584 were borrowed words (81 words skipped by the participants), 1811 nonce words (39 words skipped), and 1765 un-borrowed words (48 words skipped). Thus, the participants skipped 168 words in total, i.e. 3.15% of the data. These numbers include translated words or synonyms, which were regarded as skipped, too.

Each borrowed word had an expected output as shown in (20), and participants' productions were compared to the expected output. Since this list of borrowed words was solely to estimate participants' overall knowledge of the loanwords and to prepare them for spontaneous adaptations, the whole word was strictly judged for accuracy, including consonants. The only exception was the debuccalization phenomenon, when the word-initial or intervocalic consonant /s/ shifts to /h/ commonly in production (e.g., Pakendorf, 2008), therefore the /h/ alternation was accepted as free variation. The borrowed words were subsequently coded as "correct/incorrect"; they were not coded for the error type.

In the initial round of transcriptions, as a native speaker of Yakut (mother tongue) and bilingual in Russian, I listened to each token in Praat using Sennheiser HD 280 Professional studio headphones, which are circumaural and characterized as "high passive noise attenuation". Although I had spectrograms visible on the screen, the focus was on judging the vowels in each word mainly perceptually based on my native proficiency. During the transcribing process, I transcribed each token in IPA in a spreadsheet. Individual tokens and vowels that were unclear were either noted down in TextGrids by putting boundaries, or they were recorded in a notebook.

Afterward, selected words' vowel transcriptions of the initial round were compared with transcriptions of two external transcribers. Thus, a hired first external transcriber transcribed 250 words in the first round, and there was a 60.8% agreement in the transcriptions between me and the first external transcriber. Next, 156 words with differences between my initial transcriptions and the first transcriber's ones were re-transcribed by her in the second round. Furthermore, a second external transcriber transcribed 107 words that had consistent differences in the vowel transcriptions between my initial transcriptions and the two rounds of the first external transcriber's transcriptions. As the final step, I consulted with my former academic supervisor, Dr. Anne-Michelle Tessier, on the vowels in 12 words. Details of the procedures of the external transcribers' transcriptions are presented in Appendix E.

7.4.2 Final transcriptions

Once the feedback from the external transcribers, including the supervisor's feedback, was finalized, I started the second and final transcriptions of all 5,160 tokens. I played each participant's session individually and I compared the initial transcriptions with the sound files of each session; simultaneously, I marked each vowel that needed revisions or verifications in the spreadsheet as I was listening to the participants' productions. Finally, the words that were marked for checking were verified for the accuracy of initial transcriptions perceptually including a careful examination of spectrograms; when applicable, further revisions of the vowels and consonants were conducted. As far as the words that were transcribed by the external transcribers were concerned, the vowels that had two or more identical transcriptions were mainly accepted; however, after careful revisions some vowels' initial transcription in those words were kept unchanged or revised, when necessary. Final transcriptions that also considered the external transcribers' transcriptions resulted in the revisions of both vowels and consonants including such suprasegmental features like stress and vowel length, including palatalization for consonants and vowel and consonant insertions or deletions in a total of 539 words, which is 10.4% (out of the total of 5,160 words). Overall, 10,788 vowels were transcribed, including 468 inserted vowels. Below (22) summarizes the breakdowns of vowel revisions. Additionally, 46 consonants were revised from the initial transcriptions. Note that the consonants were not coded in the data frame, and were not considered in the analyses; furthermore, the external transcribers did not transcribe the consonants.

(22) Revisions of vowels

Transcribed only by me, revised	Transcribed only by me, unrevised	Transcribed by others, too, revised	Transcribed by others, too, unrevised
505 (4.7%)	10,217 (94.7%)	54 (0.5%)	12 (0.1%)

Chapter 8: Input-output correspondences for individual input vowels

This chapter discusses vowel adaptations in Yakut of the five Russian input vowels /a, e, i, o, u/ in first and second syllables, including their stressed and unstressed forms. There were variations of Yakut vowel adaptations for each of the input Russian vowels depending on their position in the first versus second syllable of the word. The purpose of these analyses, though, is to establish general patterns of the vowel adaptations, i.e. their input-output mappings. Results showing all occurring adaptations will be shown for all five input Russian vowels individually. First, the most-frequent adaptations of the input vowels and their general tendencies with respect to the influence of syllable position, stress and a neighbouring vowel will be discussed to give an overview.

Upon the completion of the final revisions of the transcriptions of all the produced words (adaptations), I built a data frame by coding different categories of the vowels and the produced words for subsequent statistical analyses. The 144 target words' transcriptions for each of the 37 bilingual participants were coded which yielded a total of 5,160 words, excluding skipped, synonymized, translated words. The final data frame of the production task consisted of 10,320 data points, where each word from the input Russian disyllabic words had two lines for both syllables (initial and final).

In this dissertation, using linear mixed-effects modeling (Bates, Maechler, Bolker, & Walker, 2015), I tested fixed effects (predictors) and random effects in the R statistical environment (R Development Core Team, 2013) to arrive at a most optimal (best) statistical model representing the best fit to the data. A significant improvement of the models' goodness of fit in the models' comparisons was assessed based on measurements of log likelihood using the ANOVA function (Baayen, Davidson, & Bates, 2008). Thus, there were two ways the models were determined: backward fitting, which involved first fitting a model including all tested predictors and elimination of those predictors that did not significantly improve the model; and forward fitting, when tested predictors were added one by one to assess if added predictors and their interactions between the significant predictors improved the model's fit to the data. I always started by trying a backward fitting process, in case a model with all tested predictors did not converge, I employed forward fitting by adding predictors one at a time and interactions between them. When the best model for a tested dependent variable with significant predictors (fixed effects) was determined, I tested by-participant and by-item random effects by adding random slopes for all significant predictors of the model. I report all significant random slopes, and when I do not report them it means that random slopes did not improve the model or did not converge, i.e. were not included in the model. Each ultimate model for a given variable was arrived at following the same procedure, and I report only best models for all the tested dependent variables in the dissertation. Results involving insignificant predictors are reported only selectively and are clearly marked as such.

In Section 8.1, I show the most-frequent adaptations for all Russian input vowels and present results of linear mixed-effects modeling analyses in R (R Core Team, 2013) that tested a variety of Russian input words' characteristics as predictors of whether or not adaptations conformed to the most-frequently used adaptation patterns. In Section 8.2, I discuss adaptations of all five input vowels in more detail, including less frequent adaptations. Section 8.3 provides a summary and discussion.

Based the previous literature (e.g., Dyachkovskiy, 1962; Sleptsov, 1964), I hypothesize that most-frequent adaptations occur more often in first syllables than in second syllables and stressed vowels are either diphthongized or lengthened whereas unstressed vowels are adapted as short. The role of stress is discussed in more detail in Chapter 10.

8.1 Most-frequent adaptation

This section discusses variability of vowel adaptations, and includes results of linear mixed-effects modeling of most-frequent adaptation to reveal the input predictors at play in the vowels being adapted as the most-frequent adaptations. Table 8.1 summarizes most-frequent adaptations of stressed and unstressed variations across comprising both syllable positions. A binary dependent variable based on data of most-frequent adaptations in Table 8.1 was created. Each of the most-frequent adaptations was coded as 'yes', and variations were categorized as 'no'. For example, if the stressed /a/ was realized as /ɑ, ɛː, ɒː, ɯː/ and so on, those other adaptations, distinct from the most-frequent adaptation of the stressed /a/ as /ɑː/, were categorized as 'no'. Percentages of each input vowel's most-frequent adaptations are provided in Table 8.2, as well as visualizations of most frequent adaptations in Figure 8.5 below.

Table 8.1 Most-frequent adaptations of the input vowels

Vowel input	Stress	Vowel output (Most-frequent adaptation)
/a/	stressed	/ɑː/
/a/	unstressed	/ɑ/
/e/	stressed	/iɛ/
/e/	unstressed	/ɛ/
/i/	stressed	/iː/
/i/	unstressed	/i/
/o/	stressed	/uɒ/
/o/	unstressed	/ɒ/
/u/	stressed	/uː/
/u/	unstressed	/u/

A set of six independent variables – 'vowel input' that signifies all five vowels /a, e, i, o, u/, 'vowel reduction', 'word type', 'input stress', 'syllable position', and 'harmony' were tested. The category 'vowel reduction' denotes whether a vowel is reduced or not reduced in the Russian phonetics, that is, phonetically, all unstressed vowels are reduced, except for the vowels /i, u/, that remain unreduced even in unstressed position. The 'vowel reduction' category has two levels: 'reduced' and 'unreduced'. The category 'word type' implies the types of words in the production task, that include 'borrowed', 'un-borrowed', and 'nonce' words, leading to three levels. Stress variations in the input vowels are coded by the 'input stress' category, and the category has two levels: 'stressed' and 'unstressed'. The category 'syllable position' has two levels: 'final' and 'initial', specifying the two syllables where vowels occur. Finally, the category 'harmony' codes whether the input words were harmonic in backness (i.e. have backness harmony). Note I do not specify rounding harmony in the input, as it is not as straightforward as categorizing the input words as 'harmonic' based on the backness feature. The 'harmony' category had two levels: 'disharmonic' and 'harmonic'. The random factors were 'participant' and 'Russian input word'.

The best model of most-frequent adaptation included vowel input, syllable position, harmony and vowel reduction as predictors. No interaction between the significant predictors was revealed. The best model was a simpler model compared to the model that had input stress instead of vowel reduction ($p = 1$, $\chi^2 = 0$).[33] That model was further tested for the optimal random effects.

[33] In this dissertation, when models do not show significant difference in model comparisons using the ANOVA function, a simpler, less complex model is chosen as the most optimal. When the complexity of models is not supported by data, Matuschek, Kliegl, Vasishth, Baayen, and Bates (2017) recommend to avoid such complex models.

In addition to the random intercept for Russian input word, a by-participant random slope for harmony was found.

As visible in Figure 8.1, the best model showed that when the vowels were initial, there were significantly more most-frequent adaptations than when the vowels were in the final syllable (estimate = 1.04951, SE = 0.05001, $z = 20.988$, $p = <2e-16$).

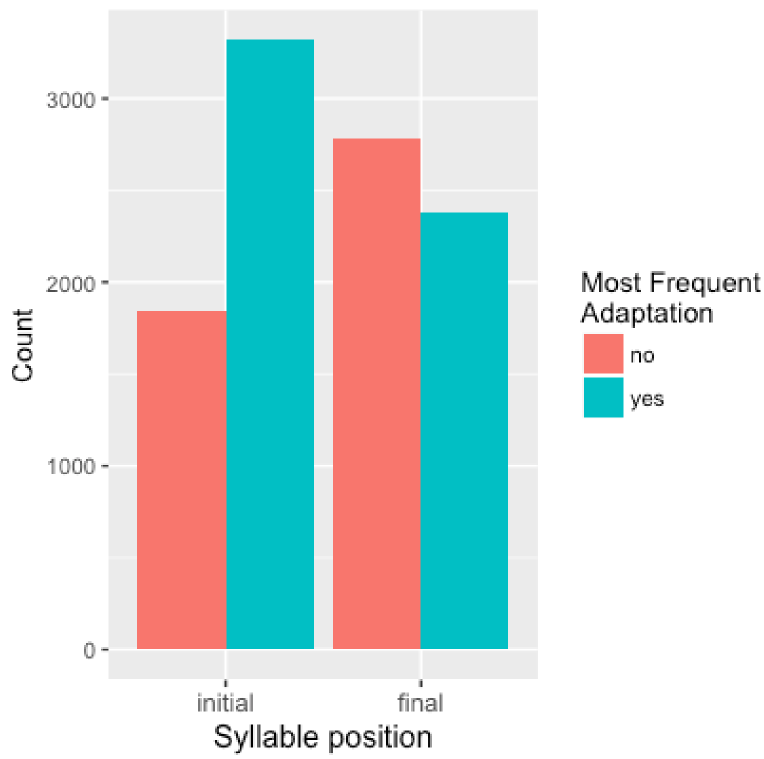

Figure 8.1 Effect of syllable position on the emergence of the most-frequent adaptations. The level 'no' means variation, and 'yes' means most-frequent adaptation

As illustrated in Figure 8.2, a significant effect of harmony showed that Russian input words harmonic in backness induced significantly more instances of most-frequent adaptations than words with vowels that were not harmonic in backness (estimate = 0.88328, SE = 0.23155, $z = 3.815$, $p = 0.000136$),

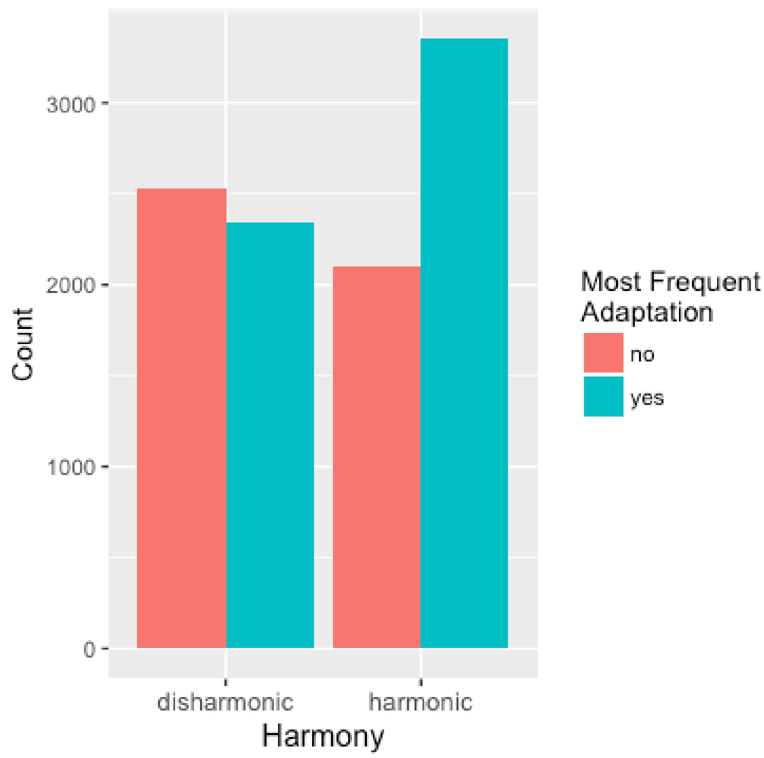

Figure 8.2 Effect of harmony on the emergence of the most-frequent adaptations

As seen in Figure 8.3, in addition, the by-participant random slope for harmony confirmed that the participants behaved differently when it came to harmony. Figure 8.3 shows different patterns of the ways the participants reacted to harmony in input words. Harmonic input words followed the most-frequent adaptation patterns in the majority of cases for all participants except participant 24. However, when given disharmonic input Russian words, the participants behaved in different ways. Eleven participants (numbers 2, 3, 5, 7, 9, 19, 25, 26, 33, 34, and 38) followed the most-frequent adaptation patterns in the majority of cases; five participants (numbers 12, 17, 18, 21, 35) had equal numbers of forms following and forms deviating from most-frequent adaptations or displayed a very slight difference between each other (participants 10, 13, 20, 22, 28, 19); and 14 participants (numbers 1, 4, 6, 8, 11, 14, 15, 16, 23, 30, 32, 36, 39, 40) had more words not following the most-frequent adaptation patterns to various degrees. Figure 8.3 suggests that whereas the participants had more unanimous reactions to harmonic words leading to more compliances with most-frequent adaptations, they had different reactions to disharmonic input words. The differences in adaptations of disharmonic and harmonic input words are discussed in Sections 9.2 and 9.3, respectively.

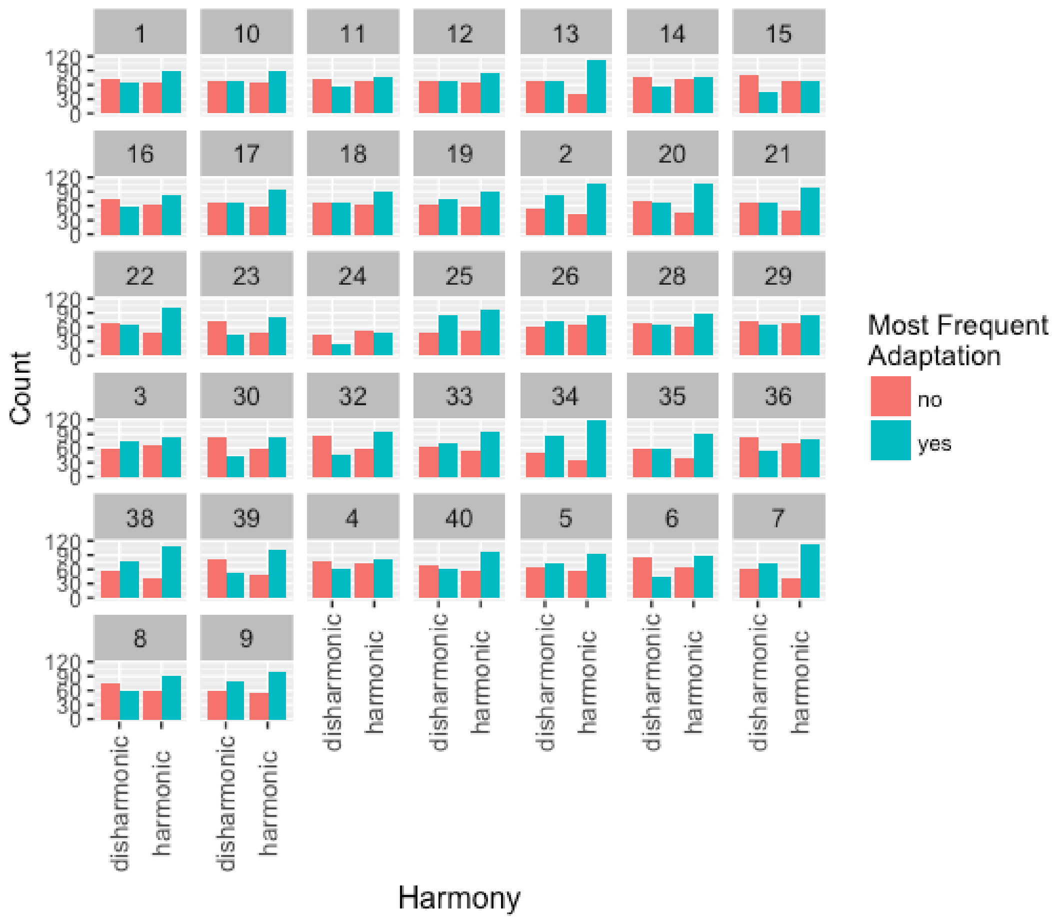

Figure 8.3 By-participant effect of harmony

In Figure 8.4, unreduced vowels had significantly more most-frequent vowel adaptations than reduced ones (estimate = 0.95522, SE = 0.06901, z = 13.842, p = <2e-16).

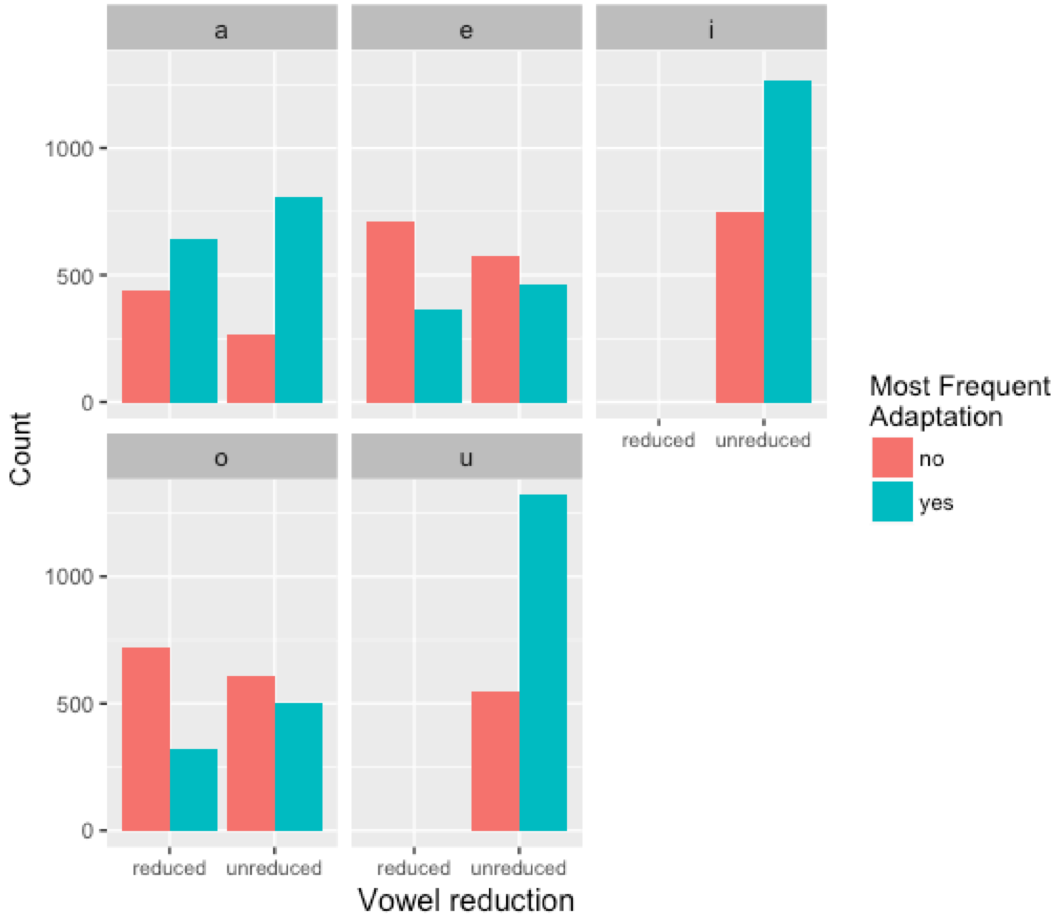

Figure 8.4 Effect of vowel reduction on the emergence of the most-frequent adaptations

That is, Figure 8.4 demonstrates adaptations of reduced and unreduced variations for the five input vowels. It shows that all reduced vowels, except for the reduced /a/, tended to have fewer most-frequent adaptations than their unreduced counterparts. It is also revealed that the high-mid vowels /e, o/ deviated frequently from the most-frequent adaptation patterns regardless of whether they were reduced or not. In turn, the unreduced forms of the input vowels /a, i, u/ exhibited more compliances with the most-frequent adaptation patterns.

As seen in Figure 8.5, I turn to the results of the effects of individual vowels on the adaptations following the most-frequent adaptations, based on the significant predictor 'vowel input'. Figure 8.5 shows a tendency for the input vowels /a, i, u/ to have more instances of most-frequent vowel adaptations, than the vowels /e, o/.

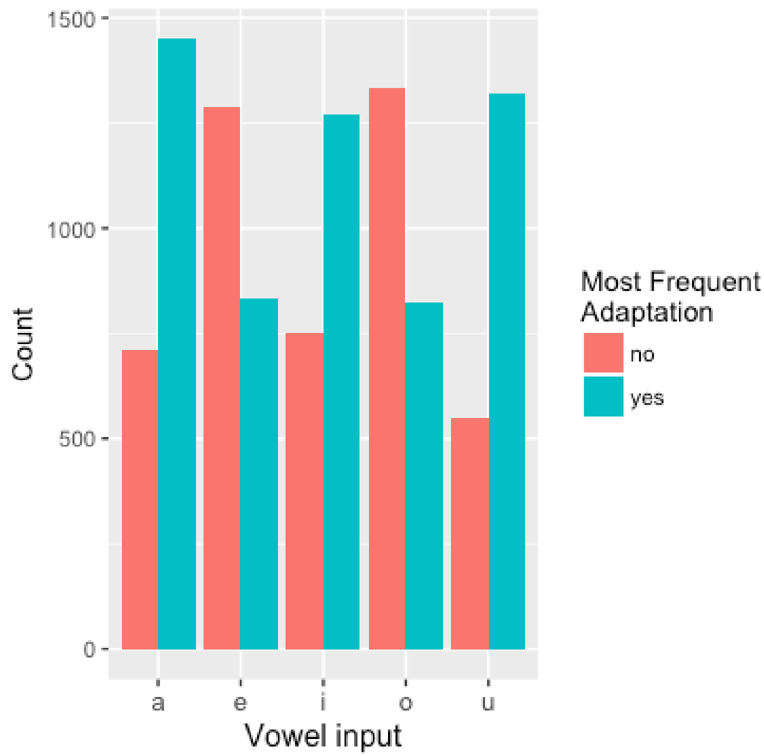

Figure 8.5 Effect of individual vowels

When the reference level was /a/, the vowels /e/ (estimate = -0.71588, SE = 0.09989, z = -7.167, p = 7.76e-13), /i/ (estimate = -0.24421, SE = 0.10514, z = -2.323, p = 0.020195), and /o/ (estimate = -1.11779, SE = 0.10184, z = -10.975, p = <2e-16) had significantly fewer most-frequent adaptations than /a/, as visible in Figure 8.5. In turn, the vowel /u/ had significantly more compliances of the patterns of most-frequent adaptations than the reference level /a/ (estimate = 0.69939, SE = 0.11526, z = 6.068, p = 1.30e-09).

Next, releveling of the predictor 'vowel input' was computed. Note that releveling for the input vowels /i, u/ did not converge; that could be explained by the significant predictor 'vowel reduction' in the model, since the vowels /i, u/ do not reduce in Russian, even when unstressed.[34]

Compared to the reference level vowel /e/, the vowels /i/ (estimate = 0.47008, SE = 0.10773, z = 4.364, p = 1.28e-05), and /u/ (estimate = 1.40877, SE = 0.11612, z = 12.132, p = <2e-16) were adapted significantly more consistently according to the patterns of most-frequent adaptations. However, the other input high-mid Russian vowel /o/ followed the most-frequent adaptation

[34] Note that releveling of the reference levels was done using a version of the best model that had no by-participant effect for harmony, as the best model reported here did not converge when the category 'vowel input' was relevelled.

patterns significantly less systematically than the vowel /e/ (estimate = -0.39916, SE = 0.10545, z = -3.785, p = 0.000154).

Releveling of the vowel input category's reference level into /o/ determined that all the other four vowels followed the most-frequent adaptation patterns significantly more often: /a/, /e/, /i/ (estimate = 0.86922, SE = 0.10866, z = 7.999, p = 1.25e-15), and /u/ (estimate = 1.80793, SE = 0.11872, z = 15.229, p = <2e-16).

To summarize, the results of the best model of most-frequent adaptation suggest that whether vowels follow the most-frequent adaptation patterns is contingent upon the factors the vowel quality of each input vowel, syllable position, vowel reduction and harmony in input words. The hypothesis that vowels in first syllables display more most-frequent adaptations was confirmed.

8.2 Adaptations of input vowels

This section presents adaptations of input vowels when they are followed and preceded by all five vowels, in both stressed and unstressed positions.

8.2.1 Input Russian vowel /a/

8.2.1.1 First syllable vowels

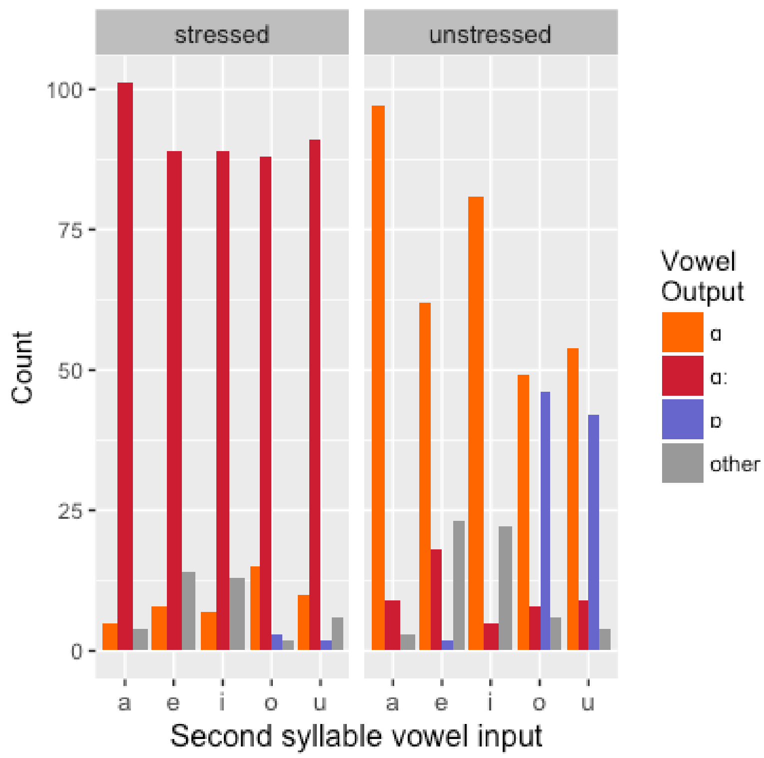

Figure 8.6 Input-output mappings of the first syllable stressed and unstressed /a/ followed by the five vowels

Figure 8.6 shows adaptations of the first syllable vowel /a/. Stressed and unstressed variations of the first syllable /a/ are plotted in different panels of the plot. All output adaptations (i.e. vowel output) presented in the plots (hereafter in the following sections) across the Russian input vowels are greater than the lower limit cut-off of 10% within each column. Other output adaptation variations of the subsets of vowels less than 10% were grouped as ‘other’. On the x-axis, I show the five following vowels for both stressed and unstressed /a/. On the y-axis, the plot presents the numbers of realizations of different output adaptations (i.e. vowel output). All output adaptations represented by a column of their own constituted more than 10% of realizations within each panel. Other output adaptation variations of the respective subsets of vowels comprising less than 10% were grouped as ‘other’. The figures of input-output mappings of the other four vowels (Figures 8.6-8.15) below are organized in a similar fashion. As illustrated in Figure 8.6, when the initial vowel /a/ was stressed, there was a dominant tendency for it to be adapted as the Yakut long /ɑː/ (83.73%) overall. By contrast, in unstressed positions the initial /a/ was realized as the short Yakut /ɑ/ in the majority of cases (63.52%). However, when the unstressed /a/ was followed by the back rounded vowels /o, u/, there was a strong tendency for it to be realized as the Yakut unrounded vowel /ɒ/ (after /o/ 42.20%, and after /u/ 38.53%), a weaker version of this tendency was observed for the stressed /a/, too (after /o/ 2.78%, and after /u/ 1.83%).

8.2.1.2 Second syllable vowels

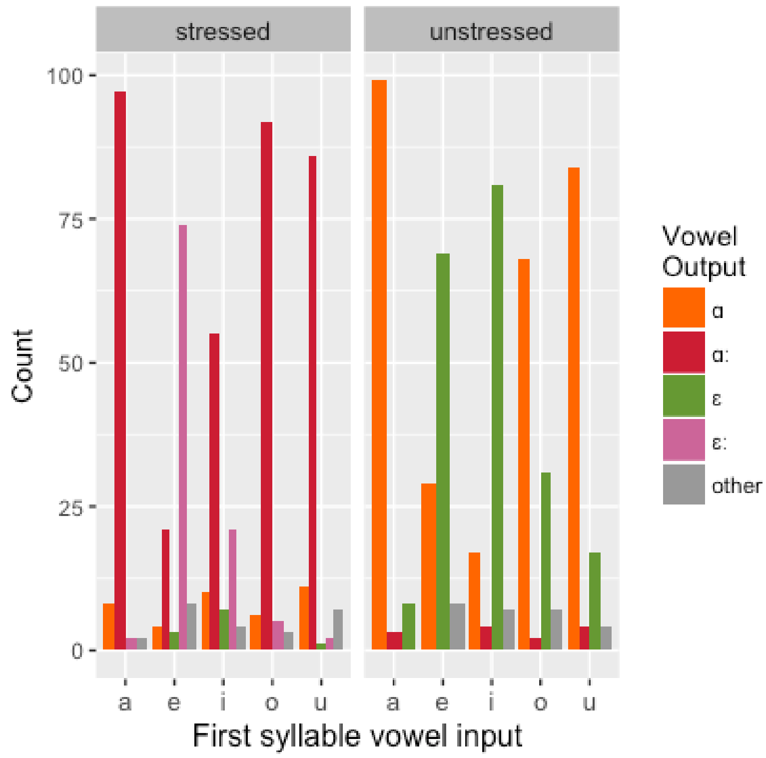

Figure 8.7 Input-output mappings of the second syllable stressed and unstressed /a/ preceded by the five vowels

Second syllable /a/ vowels had more varieties of adaptations, which is in line with the significant predictor ‘syllable position’ of the best model of most-frequent adaptation that indicated significantly more forms following most-frequent adaptations for initial syllables, rather than second ones. There was a prevalent tendency for second syllable stressed vowels /a/ to be adapted as the long /ɑː/ (66.35%). However, after the initial /e/, the stressed second syllable /a/ was primarily realized as the long /ɛː/ (67.27%), which might be triggered by vowel harmony. The unstressed input second syllable /a/ also had two different major variations, depending on the preceding vowels. After the initial stressed /a/, /o/ and /u/, the unstressed second syllable /a/ was prominently adapted as the Yakut short /ɑ/ (90%, 62.96% and 77.06%, respectively; across the five phonemes 54.80%). Another prominent variation of the unstressed second syllable vowel /a/

adaptation was /ɛ/, especially following the front vowels /e/ (65.09%) and /i/ (74.31%), with an overall occurrence of /ɛ/ 38.01% when the input vowel /a/ was unstressed.

8.2.2 Input Russian vowel /e/

8.2.2.1 First syllable vowels

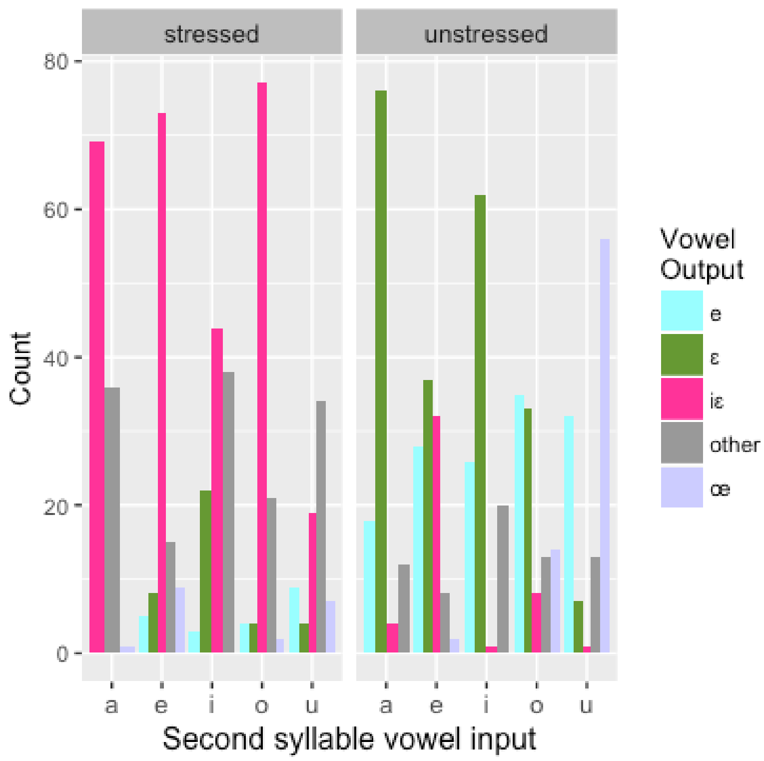

Figure 8.8 Input-output mappings of the first syllable stressed and unstressed /e/ followed by the five vowels

The first syllable stressed vowel /e/ overall had a high tendency to be adapted as the diphthong /iɛ/ (55.95%). Furthermore, when the stressed /e/ preceded /i/, there was a high proportion of its realization as /ɛ/ (20.56%). Moreover, the first syllable stressed /e/ showed preservation (non-adaptation) of the phoneme /e/, most frequently, when followed by /u/ (12.33%). Most importantly, when stressed, there were more different variations of the vowel adaptation that were less than 10% combined in the 'other' column (28.57% overall). I discuss the most-frequent 'other' adaptations of the first syllable stressed /e/ when the vowel was followed by the other five vowels. The most-frequent 'other' adaptation, i.e. non-adaptation, for the first syllable stressed /e/ was the stressed /ˈe/ (17.92%), when followed by /a/. When followed by /e/, the vowel was realized as /e/ and /ɛː/ both in 4.55% cases. There were adaptations as the long Russian /eː/ (6.54%) or /ˈe/

(4.67%) when the following vowel was /i/, thus displaying more inclinations to preserve the input Russian phoneme. Overall, the vowel had many variations when followed by /u/, including realizations as /œː/ (13.70%) and /uɒ/ (12.33%).

In unstressed positions, /e/ was adapted as the monophthong /ɛ/, mostly when followed by /a, e, i/, (overall in unstressed positions 39.96%). When followed by /a/, the unstressed /e/ had a high tendency to be realized as /ɛ/ (69.09%), along with the non-adapted original /e/ (16.36%). There were more variations of vowel adaptation when the unstressed /e/ was followed by another /e/. Particularly, there was a slight preference for /e/ to be produced as /ɛ/ (34.58%), and to a lesser extent as the diphthong /iɛ/ (29.91%), and it also remained as /e/ in 26.17% instances of the adaptations. When followed by the front vowel /i/, the unstressed first syllable /e/ was mostly adapted as /ɛ/ (56.88%) and /e/ (23.85%). However, the vowel /e/ was used, although it is not a Yakut vowel, especially when followed by the back rounded vowels /o/ (33.98%) and /u/ (29.36%). Comparably, /e/ was adapted as /ɛ/ when followed by /o/ (32.04%). It is noteworthy that in order not to violate rounding harmony, the unstressed /e/ turned into the rounded front vowel /œ/ (13.38% overall), and when it was followed by the rounded vowel /u/ (51.38%) alongside with /e/, which occurred 29.36% of the time before /u/.

8.2.2.2 Second syllable vowels

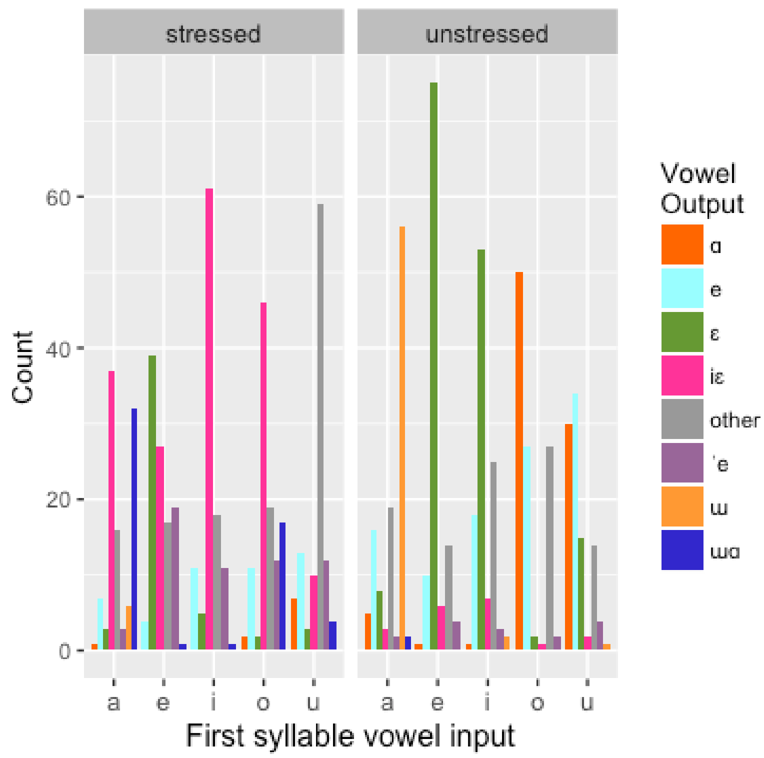

Figure 8.9 Input-output mappings of the second syllable stressed and unstressed /e/ preceded by the five vowels

Like other second vowels, the second syllable vowel /e/ displayed many variations of adaptations. The stressed second syllable /e/ was adapted as the diphthong /iɛ/ after the initial /a/ (35.24%) and to a lesser extent as another diphthong /ɯɑ/ (30.48%). When preceded by /e/, the stressed /e/ had many adaptation variations. Namely, the most prominent adaptation was the short Yakut vowel /ɛ/ (36.45%), along with /iɛ/ (25.23%) and the non-adapted stressed vowel /ˈe/ (17.76%). In addition, there were many other variations of vowel adaptation represented by the 'other' columns (24.07%). The most common 'other' adaptation in this context was the diphthong /uɒ/, when the preceding rounded /u/ triggered roundedness of the following stressed /e/ (37.96%), resulting in an output that complies with Yakut rounding harmony rules. Next, affected by /i/, second /e/ was also predominantly adapted as the diphthong /iɛ/ (57.01%), and there were minor occurrences of /e/ (10.28%) and the stressed Russian /ˈe/ (10.28%). Similar to the preceding vowel /i/, the vowel /o/ before the second stressed /e/ led to its adaptations as /iɛ/ (42.20%), /e/ (10.09%), the diphthong /ɯɑ/ (15.60%) and /ˈe/ (11.01%). There were many different variations when the vowel was preceded by the vowel /u/, with fewer occurrences of /e/ (12.04%) as compared /uɒ/ (37.96) in this context. Note that the stressed /e/ was primarily realized as either long vowels or diphthongs across all preceding phonemes. Once unstressed, the vowel /e/ had more short vowel adaptations. After the vowel /a/, the unstressed /e/ was most prominently adapted as the back vowel /ɯ/ (50.45%), and to a lesser extent it remained as /e/ (14.41%). In most cases, the preceding stressed /e/ instigated the realization of the second vowel /e/ as the lower Yakut mid counterpart /ɛ/ (68.18%). That tendency was observed when the vowel was preceded by /i/ (48.62%); in addition, /e/ also stayed the same in this environment (16.51%). Triggered by the preceding vowel /o/, the unstressed /e/ was also adapted as /ɑ/ (45.87%), and /e/ remained the same in this too (24.77%). After the first syllable stressed vowel /u/ the following realizations of unstressed /e/ occurred: the vowels /ɑ/ (30%), /e/ (34%) and /ɛ/ (15%).

8.2.3 Input Russian vowel /i/

8.2.3.1 First syllable vowels

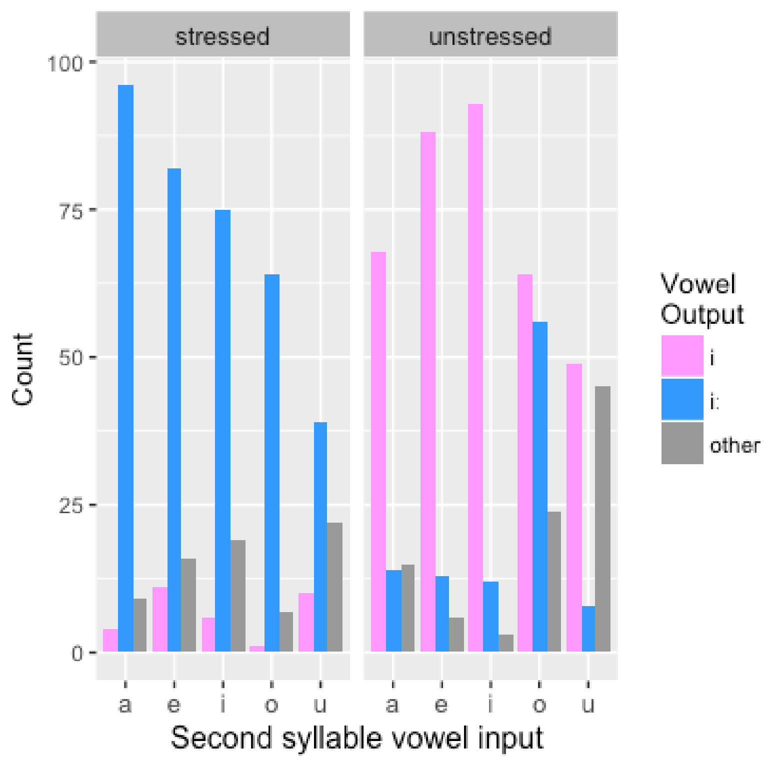

Figure 8.10 Input-output mappings of the first syllable stressed and unstressed /i/ followed by the five vowels

First syllable stressed vowels /i/ in most cases were adapted as the long /i:/ (77.22%); by contrast, when /i/ was unstressed, it was realized as the short /i/ in a majority of the cases (64.87%). Apart from this general tendency, there were more realizations of the initial unstressed /i/ to be adapted as /i:/ when it was followed by the rounded vowel /o/ (38.89%). If the unstressed /i/

occurred before the other rounded vowel /u/, then it predominantly stayed as /i/ (48.04%), and as /u/ (27.45%) where the roundedness of the following vowel led to rounding of /i/, and it was very rarely adapted as the long /iː/ (7.84%). This context also produced more variations, as displayed by the 'other' column (16.67%).

8.2.3.2 Second syllable vowels

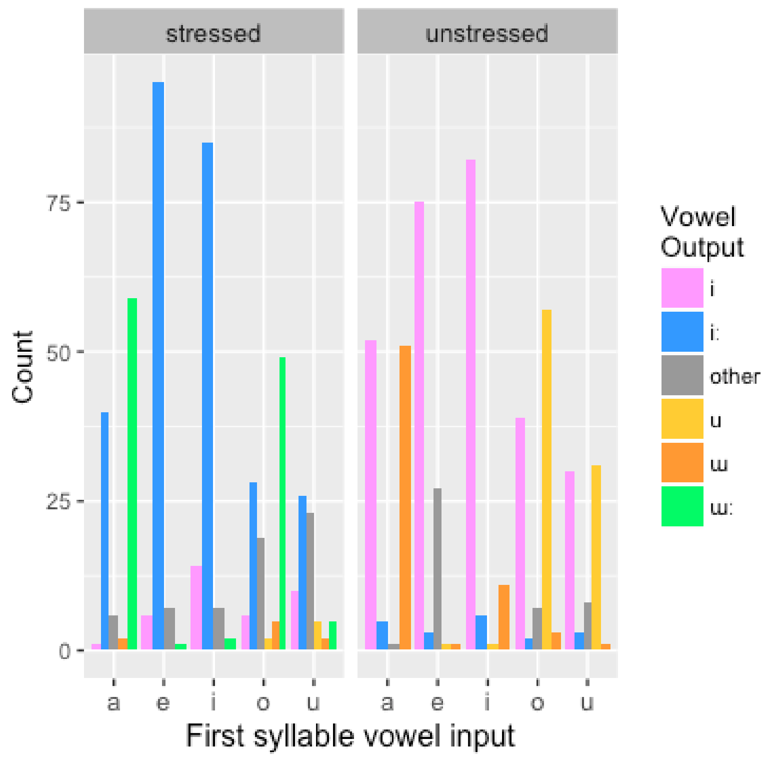

Figure 8.11 Input-output mappings of the second syllable stressed and unstressed /i/ preceded by the five vowels

There were more variations of the adaptation of the second syllable /i/, compared to the first syllable position. The most prominent adaptation of the input second syllable stressed /i/ was the long /iː/ (54.26% overall). Adaptation of the stressed /i/ as /iː/ occurred when following /a/ (37.04%), /e/ (87.06%) and /i/ (78.70%). The long /iː/ also appeared after /o/ to a lesser extent (25.69%) and after the other rounded vowel /u/ (36.62%).

When following /a/, the stressed /i/ was adapted as the long /ɯː/ most often (54.63%), thus changing its backness, as the Russian front vowel /a/ generally had a strong tendency to be adapted as the Yakut back vowel /ɑ/, which is acoustically very close to the Russian counterpart /a/. The adaptation of the second syllable stressed /i/ as the long /ɯː/ was also prominent after the initial /o/ (44.95%). The overall characteristics of the stressed vowel /i/ adaptation is that there was a tendency to be adapted as long vowels. In contrast, the unstressed vowel /i/ was predominantly realized as the short vowels /i, ɯ, u/.

The unstressed /i/ remained the same (47.71%) or was realized as /ɯ/ (46.79%) after /a/. After the front vowels, it remained as /i/: (70.09%) after /e/ and (82%) after /i/. The adaptation of the second syllable unstressed vowel /i/ was competing between the short /u/ and /i/ after the back rounded vowels /o/ and /u/. That is, after /o/, the vowel was most frequently adapted as /u/ (52.78%), thus following rounding harmony, whereas the occurrence of the unchanged non-adapted /i/ after /o/ was 36.11%. The two vowel adaptations appeared almost equally often once the unstressed second /i/ followed /u/: it remained as /i/ (41.10%) or, influenced by the preceding rounded vowel /u/, was realized as /u/ (42.47%) thus following vowel harmony.

8.2.4 Input Russian vowel /o/

8.2.4.1 First syllable vowels

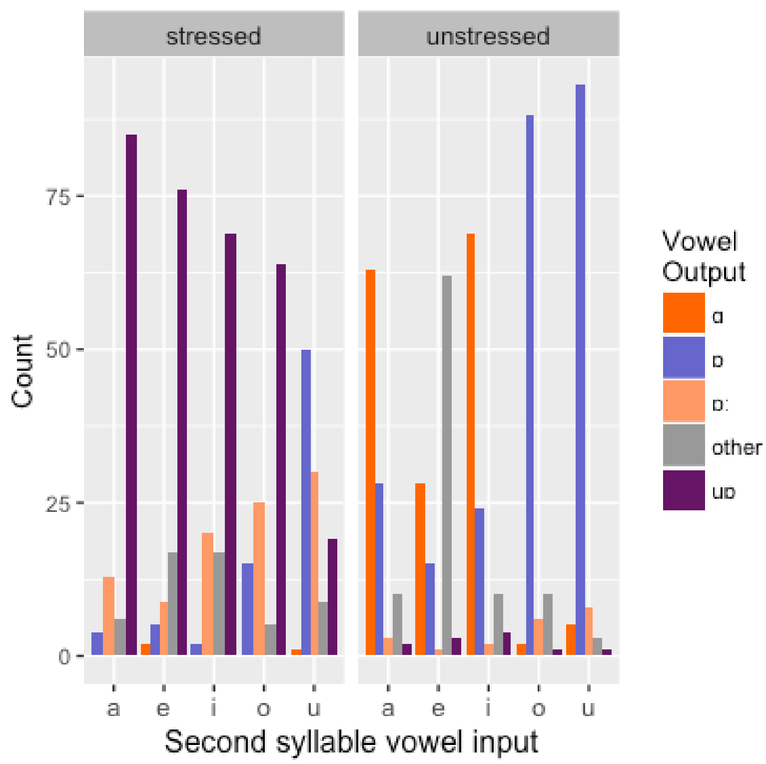

Figure 8.12 Input-output mappings of the first syllable stressed and unstressed /o/ followed by the five vowels

Noticeably, the first syllable stressed /o/ was primarily adapted as the diphthong /uɒ/ (57.64% across all the five phonemes). However, when followed by /u/, diphthongization of the first syllable stressed /o/ had fewer instances (17.43%) and was instead adapted as the Yakut /ɒ/ in most instances (45.87%). The long vowel /ɒː/ also occurred, when the initial stressed vowel /o/ was followed by /a/ (12.04%), /i/ (18.52%), and the rounded vowels /o/ (22.94%) and /u/ (27.52%).

The most prominent adaptation of first syllable unstressed /o/ was /ɒ/, most frequently when followed by the rounded back vowels /o/ (82.24%) and /u/ (84.55%). Unstressed /o/ was also adapted as /ɑ/, with general occurrences of 30.87%. This adaptation primarily emerged when /o/ was followed by the front vowels /a/ (59.43%), /e/ (25.69%), and /i/ (63.30%). The main difference of the adaptations of /o/ between stressed and unstressed positions was that in stressed positions the input /o/ tended to diphthongize; whereas in unstressed positions /o/ had more short vowel adaptations. It is also noteworthy that when followed by the front vowel /e/, the first syllable unstressed /o/ had a lot of variations represented by the prominent 'other' column (17.56%).

8.2.4.2 Second syllable vowels

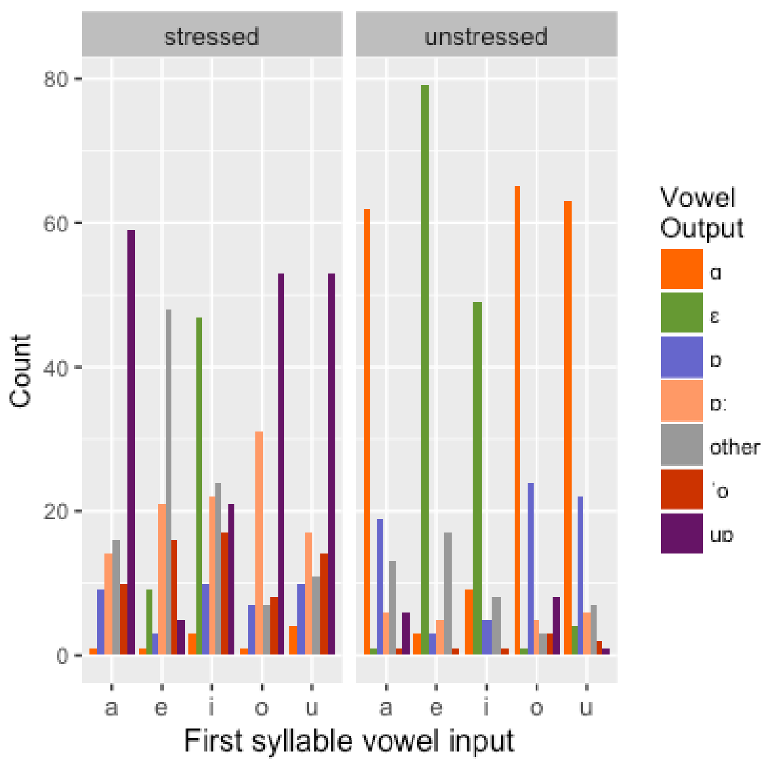

Figure 8.13 Input-output mappings of the second syllable stressed and unstressed /o/ preceded by the five vowels

The second syllable stressed vowel /o/, when preceded by /a/ had prominent instances of being adapted as the diphthong /uɒ/ (54.13%) as well as when it was after /o/ (49.53%). Along with fewer occurrences of the long /ɒː/ (12.84%) after /a/ and when preceded by /o/ (28.97%). Similar adaptations were observed for the preceding vowel /u/, when the stressed /o/ diphthongized (48.62%), lengthened (/ɒː/ 15.60%), and retained its Russian non-adapted form (/ˈo/ 12.84%). There were many variations of the vowel adaptation for the second syllable stressed /o/ when it was preceded by /e/, specifically the adaptation of /o/ as /ɒː/ (20.39%), along with the non-adapted stressed /ˈo/ (15.53%). After the unstressed /i/, the stressed /o/ often turned into /ɛ/ (32.64%), thus following the backness feature of the preceding front vowel. There were less frequent adaptations for the stressed second /o/ when following /i/, including /ɒː/ (15.28%), the stressed /ˈo/ (11.81%), and /uɒ/ (14.58%).

Unlike the stressed second syllable vowels /o/, the unstressed second syllable vowel /o/ had two major vowel adaptations: /ɑ/ and /ɛ/ (overall 40.24% and 26.69%, respectively). Most frequently, the unstressed /o/ was adapted as /ɑ/ after /a/ (57.41%), /o/ (59.63%), and /u/ (60%). Note that the two vowels /o, u/ are back, and the front Russian vowel /a/ had a strong tendency to be adapted as /ɑ/, as shown in the previous sections. Alternatively, the second syllable unstressed /o/ was realized as the front vowel /ɛ/, especially following the front vowels /e/ (73.15%), and /i/ (68.06%). This tendency suggests that the input back vowel was affected by the backness feature of the preceding vowels. It is noteworthy that there were several occurrences of adaptations as /ɒ/ (14.54% overall) for the second syllable unstressed /o/, especially after /a/ (17.59%), /o/ (22.02%), and /u/ (20.95%). The Russian vowel /o/ is similar articulatorily to the Yakut vowel /ɒ/, besides the vowel has the same orthographic representation in both languages.

8.2.5 Input Russian vowel /u/

8.2.5.1 First syllable vowels

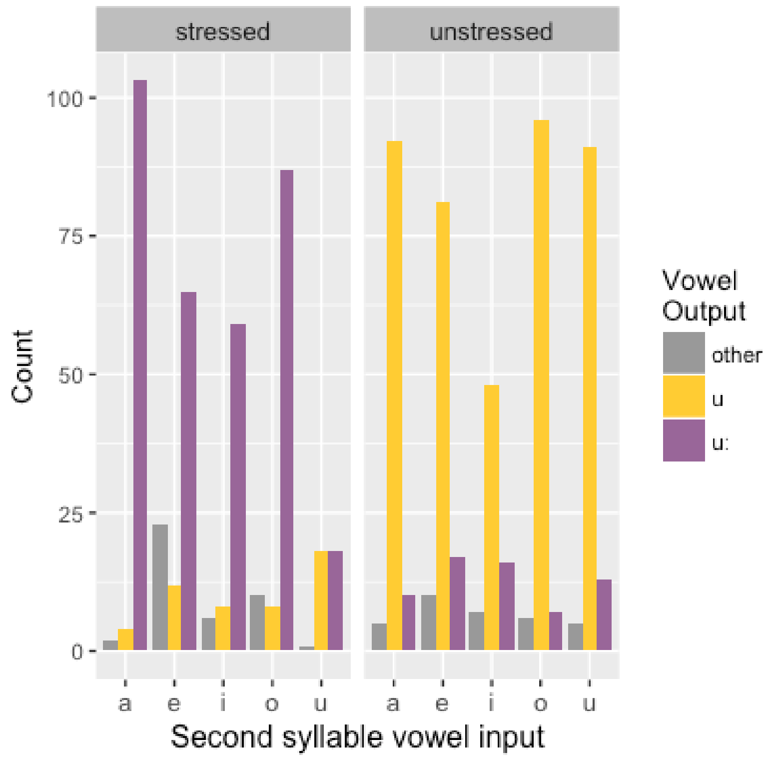

Figure 8.14 Input-output mappings of the first syllable stressed and unstressed /u/ followed by the five vowels

The first syllable stressed vowel /u/ was primarily adapted as the long /uː/ (78.30% overall), and the primary realization of the unstressed /u/ was the short /u/ (across all the following five phonemes 80.95%). Interestingly, when followed by another /u/, the stressed /u/ had roughly equal instances of realizations as both short /u/ and long /uː/ (48.65% each). Overall, the occurrence of the short /u/ from the stressed /u/ was 11.79% for all the following phonemes, and the unstressed /u/ was realized as the long /uː/ in 12.50% of instances.

8.2.5.2 Second syllable vowels

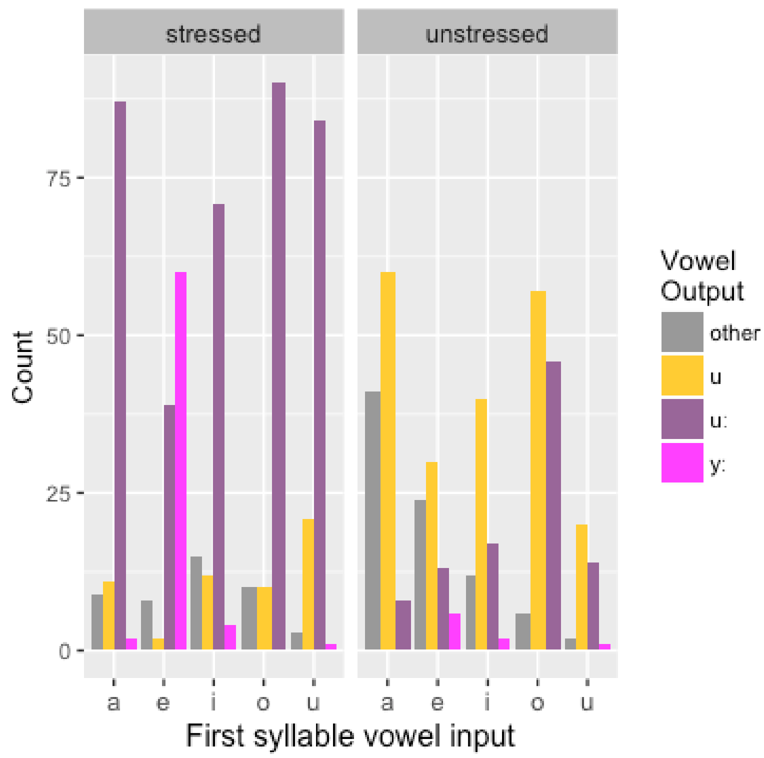

Figure 8.15 Input-output mappings of the second syllable stressed and unstressed /u/ preceded by the five vowels

Second syllable stressed vowels /u/ had a strong tendency to be adapted as the long /u:/ with all five preceding phonemes (68.83%). However, this tendency drastically changed when the stressed /u/ was preceded by the front vowel /e/, then the stressed /u/ was realized as the front long rounded vowel /y:/ (55.05%) most frequently. This example suggests an effect of the front vowel /e/ which led to the fronting of the following back vowel, the adaptation as /u:/ after /e/ occurred in 35.78% cases instead. Adaptations as the short vowel /u/ from the stressed /u/ were consistently present with all five preceding phonemes (10.39% overall). However, the occurrence of the short /u/ was most noticeable after /u/ (19.27%), /i/ (11.76%), and /a/ (10.09%).

Unlike the stressed vowel /u/, the unstressed vowel /u/ was more inclined to remain as the short /u/ overall (51.88%). There was more variety in the vowel adaptation after the vowel /a/, represented by the 'other' column in Figure 8.15. Most frequently, the unstressed /u/ was realized as the back vowel /ɯ/ (32.11%). The unstressed /u/ had also many variations of adaptations following /e/: it was realized more often as the short front vowel /y/ (26.03%). The 'other' column for unstressed /u/ is 21.30% overall. As for adaptations of the unstressed /u/ as /u/ versus /u:/, the vowel tended to remain as /u/ when preceded by the front vowels /e/ (41.10%) and /i/ (56.34%) and to a lesser extent was adapted as the long /u:/ following either of the vowels (after /e/ 17.81%

and after /i/ 23.94%). The unstressed /u/ when preceded by the back vowels /o/ and /u/ had competing adaptations as the short and long counterparts of /u/, with the short /u/ being slightly more frequent than the long one. After the vowel /o/, the unstressed vowel /u/ remained as the short /u/ 52.29% and lengthened in the output 42.20%. Similarly, the first syllable vowel /u/ led to adaptation of the unstressed /u/ as the counterpart /u/ (54.05%) in addition to the long one (37.84%).

8.3 Summary and discussion

This section presents a summary of the previous sections of the chapter and discusses the most-frequent adaptations of the input vowels in first and second syllable positions preceded and followed by stressed and unstressed syllables.

Table 8.2 shows percentages of realizations as most-frequent adaptations of the five input Russian vowels in the first and second syllable positions and in stressed and unstressed syllables.

Note that a significant effect of the 'vowel input' category in the best model of most-frequent vowel adaptation revealed that the back vowel /u/ had significantly more most-frequent adaptations than the front /a/, and /a/ had more most-frequent adaptations than /e, i, o/ (see Section 8.1). Overall, the percentages of realizations in Table 8.2 confirm that the high and low vowels had higher percentages of most-frequent adaptations, as compared to the high-mid vowels /e, o/, which showed more variability in adaptation. Moreover, the best model also showed that unreduced vowels had significantly more most-frequent adaptations than the reduced ones. In Russian, stressed vowels and the high vowels /i, u/ (both stressed and unstressed) are unreduced (see Padgett & Tabain, 2005). Table 8.2 demonstrates that each vowel in the stressed position had more most-frequent adaptations than in the unstressed one, and the high vowels /i, u/ had higher percentages of most-frequent adaptations overall, as noted above.

Table 8.2 Summary table of most-frequent adaptations based on the syllable position (Syl) and stress

Input vowel	**Stress**	**a**	**i**	**e**	**u**	**o**
Most-frequent adaptation in Syl 1	stressed	ɑː (83.73%)	iː (77.22%)	iɛ (55.95%)	uː (78.30%)	uɒ (57.64%)
Most-frequent adaptation in Syl 2	stressed	ɑː (66.35%)	iː (54.26%)	iɛ (33.77%)	uː (68.83%)	uɒ (33.39%)
Most-frequent adaptation in Syl 1	unstressed	ɑ (63.52%)	i (64.87%)	ɛ (39.96%)	u (80.95%)	ɒ (45.84%)
Most-frequent adaptation in Syl 2	unstressed	ɑ (54.80%)	i (55.94%)	ɛ (28.39%)	u (51.88%)	ɑ (40.24%)

There was more variation in the adaptation when the vowel phonemes were in the second syllable position than when they were in the first syllable. As far as stress was concerned, stressed vowels in general resulted in less variation than unstressed ones. Stressed vowels tended to lengthen or diphthongize, and unstressed vowels were realized as short. The highest percentage of consistent individual vowel adaptations is observed for the stressed first vowel /a/, which in 83.73% of the instances was adapted as the long Yakut /ɑː/. The first unstressed vowel /u/ was also consistently adapted as the short Yakut /u/ in 80.95% of the cases. Note that the mid vowels /e/ and /o/ were particularly unstable in their adaptation, displaying comparatively more variation than the vowels /a, i, u/. Also, the unstressed rounded input vowel /o/ was generally realized as the rounded /ɒ/ in the first syllable position and lost its roundedness feature in the second syllable position (is adapted as /ɑ/). This adaptation suggests an influence of the rounding harmony rules that ban unrounded vowels preceding rounded vowels. Table 8.3 shows adaptations of first syllable vowels when followed by each of the five input vowels.

Table 8.3 Most-frequent adaptations of first syllable input vowels and percentage of realization by stress and following vowel

Vowel in syllable 1	Following vowel				
	a	**i**	**e**	**u**	**o**
Stressed /a/	ɑː (91.82%)	ɑː (81.65%)	ɑː (80.18%)	ɑː (83.49%)	ɑː (81.48%)
Unstressed /a/	ɑ (88.99%)	ɑ (75%)	ɑ (59.05%)	ɑ (49.54%)	ɑ (44.95%)
Stressed /i/	iː (88.07%)	iː (75%)	iː (75.23%)	iː (54.93%)	iː (88.89%)
Unstressed /i/	i (70.10%)	i (86.11%)	i (82.24%)	i (48.04%)	i (44.44%)
Stressed /e/	iɛ (65.09%)	iɛ (41.12%)	iɛ (66.36%)	iɛ (26.03%)	iɛ (71.30%)
Unstressed /e/	ɛ (69.09%)	ɛ (56.88%)	ɛ (34.58%)	œ (51.38%)	e (33.98%)
Stressed /u/	uː (94.50%)	uː (80.82%)	uː (65%)	u & uː (48.65%)	uː (82.86%)
Unstressed /u/	u (85.98%)	u (67.61%)	u (75%)	u (83.49%)	u (88.07%)
Stressed /o/	uɒ (78.70%)	uɒ (63.89%)	uɒ (69.72%)	ɒ (45.87%)	uɒ (58.72%)
Unstressed /o/	ɑ (59.43%)	ɑ (63.30%)	ɛ (41.28%)	ɒ (84.55%)	ɒ (82.24%)

Table 8.3 illustrates the relatively small influence of second syllable vowels on the adaptations of vowels in first syllables. The stressed vowel /a/, regardless of the following vowels, was primarily adapted as the long Yakut /ɑː/. Similarly, unstressed first input vowels /a/ was predominantly realized as the short Yakut /ɑ/. The stressed first syllable stressed /i/ lengthened as /iː/ in most instances for all five following input vowels. In turn, the first syllable unstressed vowel /i/ remained as /i/ predominantly across all the following vowels. The first syllable stressed vowel /e/ had a high tendency to diphthongize into /iɛ/, and that tendency was prominent for all the following vowels. The unstressed vowel /e/, on the other hand, had more variations of vowel adaptation. It tended to be produced as the short front /ɛ/ when followed by the front vowels /a, i, e/. However, when followed by the rounded vowel /u/, it tended to retain its frontness and became the rounded vowel /œ/. Conversely, when the unstressed /e/ was followed by the other rounded vowel /o/, it had a noticeable tendency to stay as the Russian /e/, thus displaying non-adaptation. Note that the percentage of adaptations covered by the most frequent form of adaptation was

generally lower for /e/ than for the other input vowels. Consistent adaptations are observed for the first stressed vowel /u/ which was adapted as the long Yakut /uː/ in most cases for all the following vowels. Note that the stressed /u/ followed by another /u/ had exactly equal percentages of adaptation as the long or short variations in Yakut. The same consistent tendency of the vowel adaptation occurred for the first syllable unstressed vowel /u/, which usually remained as /u/ regardless of the quality of the following vowels. The stressed vowel /o/ was realized as the diphthong /uɒ/ except when it was followed by the vowel /u/. In this case, instead of diphthongization, the vowel /o/ was produced as the Yakut /ɒ/. Although the combination /uɒ-u/ is an acceptable vowel combination, the speakers preferred to realize the stressed /o/ as the short /ɒ/ in most cases. Furthermore, there was a pattern for the unstressed /o/ to lose its roundedness feature. That is, when followed by the front unrounded vowels /a, i/, the unstressed /o/ was primarily adapted as /ɑ/. Influenced by the following front vowel /e/, it tended to be adapted as the front vowel /ɛ/. However, when the unstressed /o/ was before the other back rounded vowels /u, o/, it was produced as the Yakut /ɒ/. These findings strongly suggest that the output from both harmonic and disharmonic input follows the rounding harmony rules in several occasions and creates a harmonic output.

Next, most-frequent adaptations of second syllable vowels are shown in Table 8.4.

Table 8.4 Most-frequent adaptations of second syllable input vowels and percentage of realization by stress and preceding vowel

Vowel in syllable 2	Preceding vowel				
	a	**i**	**e**	**u**	**o**
Stressed /a/	ɑː (88.99%)	ɑː (56.70%)	ɛː (67.27%)	ɑː (80.37%)	ɑː (86.79%)
Unstressed /a/	ɑ (90%)	ɛ (74.31%)	ɛ (65.09%)	ɑ (77.06%)	ɑ (62.96%)
Stressed /i/	iː (37.04%)	iː (78.70%)	iː (87.16%)	iː (36.62%)	iː (25.69%)
Unstressed /i/	i (47.71%)	i (82%)	i (70.09%)	u (42.47%)	u (52.78%)
Stressed /e/	iɛ (35.24%)	iɛ (57.01%)	ɛ (36.45%)	uɒ (37.96%)	iɛ (42.20%)
Unstressed /e/	ɯ (50.45%)	ɛ (48.62%)	ɛ (68.18%)	e (34%)	ɑ (45.87%)
Stressed /u/	uː (79.82%)	uː (69.61%)	uː (35.78%)	uː (77.06%)	uː (81.82%)
Unstressed /u/	u (55.05%)	u (56.34%)	u (41.10%)	u (54.05%)	u (52.29%)
Stressed /o/	uɒ (54.13%)	ɛ (32.64%)	iɛ (26.21%)	uɒ (48.62%)	uɒ (49.53%)
Unstressed /o/	ɑ (57.41%)	ɛ (68.06%)	ɛ (73.15%)	ɑ (60%)	ɑ (59.63%)

As presented in Table 8.4, adaptations of second vowel syllables showed more variability than those of first syllable vowels. However, there are consistent regularities for each vowel phoneme in the way they were adapted. The vowel /a/ in both stressed and unstressed positions had two frequent realizations - /ɑ/ and /ɛ/. Consistently, the stressed /a/ lengthened, and the unstressed counterpart was short in Yakut. In particular, when the second syllable stressed vowel /a/ was preceded by the front /e/, it was adapted as the front long /ɛː/; in all other cases the most-frequent adaptation of the second syllable stressed /a/ was the long /ɑː/. Similarly, the unstressed /a/ was realized as /ɛ/ after the front vowels /i, e/, and was produced as /ɑ/ when it followed /a, o, u/. The stressed /i/ was consistently adapted as the long /iː/, with more variation when it was preceded by the back rounded vowels /o, u/. However, the unstressed /i/ had a consistent tendency to remain as the short /i/ after the front vowels /a, i, e/. In turn, when it was preceded by the back rounded vowels /o, u/, it had more instances of being adapted as the back rounded vowel /u/. In these cases, the vowel /i/ was affected by the roundedness and backness of the preceding vowels to achieve rounding harmony. Although there were more variations for the stressed vowel /e/, it is observed that the vowel was frequently adapted as the diphthong /iɛ/ after /a, u, o/. It was most frequently realized as the short /ɛ/ when it was preceded by the unstressed /e/. This is an exception from the main pattern that stressed vowels generally either diphthongized or lengthened. After the rounded back /u/, the vowel /e/ was often adapted as the rounded diphthong /uɒ/. This result also shows the affectedness by the rounded vowels. Unstressed /e/ had many variations of the vowel adaptation. Most frequently, it was produced as /ɯ/ after /a/. It was consistently adapted as /ɛ/ after the front vowels /i, e/. The vowel had a tendency not to be adapted and it stayed as the non-adapted /e/ after the vowel /o/ in the majority 34% of the instances, and it was frequently realized as /ɑ/ after the rounded vowel /o/. The vowel /u/ had very consistent patterns of adaptations in both stressed and unstressed positions. Thus, the stressed /u/ primarily lengthened to /uː/ and the unstressed /u/ stayed as /u/ usually. The stressed /o/ had variations of the vowel adaptation depending on the preceding vowels. It most regularly diphthongized as /uɒ/ after /a, u, o/; however, it was adapted as another diphthong /iɛ/ after the front vowel /e/ 26.21% of the time. Unlike the relatively consistent lengthening and diphthongization of stressed vowels in most other contexts, the stressed /o/ was adapted as the short /ɛ/ after /i/ in comparatively most cases. The unstressed /o/ was mostly adapted as /ɑ/ after the vowels /a, u, o/, and after the front vowels /i, e/ it tended to be adapted as the front vowel /ɛ/, so that the output complies with the rounding harmony rules.

On-line adaptations of the vowels in the input words by the bilingual speakers in the production task are remarkably congruent with the way established loanwords were adapted, described previously by Dyachkovskiy (1962) and Sleptsov (1964). As far as stress is concerned, the percentages of most-frequent adaptations in all four tables vividly show a high tendency for stressed high-mid vowels to diphthongize, and for high and low vowels to lengthen; in contrast, unstressed vowels tended to be adapted as short, which is largely consistent with the previous literature (e.g., Dyachkovskiy, 1962; Sleptsov, 1964). The observed effect of stress is separately addressed in Chapter 10. In line with Dyachkovskiy's and Sleptsov's summaries, the first syllable stressed vowels /a, i, u/ in the production task lengthened and were realized as /ɑː, iː, uː/; and the first syllable stressed high-mid vowels /e, o/ diphthongized and were adapted as /iɛ, uɒ/, respectively. Tables 8.2-8.4 reveal the tendency that the high and low vowels, especially in first syllables, have more uniform predictable adaptation, as opposed to the high-mid vowels, which have lower percentages for their patterns of most-frequent adaptations.

On a whole, most-frequent adaptations of the input vowels revealed a great influence of neighbouring vowels, especially in regards to second syllable vowels which were noticeably affected by the first syllable vowels. Generally, Dyachkovskiy's and Sleptsov's studies describe the realization of the stressed vowels /a, o/ in non-initial syllables as /ɛː, iɛ/ respectively, affected by the preceding front vowels. Similarly, the unstressed /a/ was predominantly realized as /ɛ/ when following the front vowels /i, e/, which is consistent with Sleptsov's observations (p. 76). Table 8.4 suggests that this was a more general pattern of adaptation: the frontness of preceding vowels frequently influenced adaptation of following vowels. Krueger (1962/2012: 48) highlights the importance of initial vowels in attaining vowel harmony, "There are, consequently, restrictions on the vowels in non-first syllables, conditioned by the type of vowel in the first syllable". The best model of most-frequent vowel adaptation showed that vowels in initial syllables were more often realized as the most-frequent adaptations more (i.e. less variability in adaptation) than vowels in final syllables of the disyllabic input words, whose adaptation is suggested to be largely dependent on the quality of a first syllable vowel.

Furthermore, as visible in Table 8.4, especially initial rounded vowels /o, u/ tended to spread their roundedness and backness to the following front unstressed unrounded vowels /i/ and the stressed unrounded /e/, which shows the rightward spreading of backness and roundness features. Moreover, leftward directionality of roundedness spreading from the rounded /u/ was observed for the unstressed /e/, which is realized as /œ/, as shown in Table 8.3. This finding is consistent with Sleptsov's description of spreading of roundedness and backness of the back rounded vowels to the following unstressed /i/ and the stressed /e/. Overall, adaptations of disyllabic words in Yakut show effects first syllable vowels on second syllable vowels in achieving harmonization. In general, to attain more vowel harmony in adaptations, backness and roundness features of preceding and following vowels affected the ways first and second syllable vowels were realized.

In essence, Table 8.4 above demonstrates that in comparison with the vowels in the first syllable position, the vowels in second syllables exhibit more variations, as shown by the best model of most-frequent adaptation, which is especially noticeable for high-mid vowels. I suggest that second syllable vowels in general were more contingent on the backness and roundness features of the preceding vowels in the way they were adapted. That is, there was an observed inclination for participants to adapt second syllable vowels depending on the preceding vowels to enforce a harmonizing effect. Moreover, as shown by the best model of most-frequent adaptation, input words that were harmonic in backness led to more most-frequent adaptations, which suggests that harmony in input words affects vowel adaptation. Considering that vowels exhibited a noticeable affectedness by the surrounding vowels depending on the syllable position and the observed tendencies to change their backness, roundness, and height features, I speculate that participants generally adapted words with an attempt to conform to the native phonology, i.e. vowel harmony. To test specific input predictors of vowels that propagate better *and* worse harmonization, I model vowel harmony by analyzing sets of relevant input predictors of input vowels and words in the following chapter (Chapter 9). Specifically, closer attention is paid to the input predictors backness, roundness, and height of first and second syllable vowels.

Chapter 9: Phonological input features driving adaptations

Summaries of bilingual speaker's most-frequent on-line adaptations in the production task, presented in Chapter 8, suggest a noticeable affectedness of the input vowels by such input factors as syllable position, stress, backness, height, roundness, and the vowel quality overall. Most of the adaptations are in line with the previous descriptions of Russian vowel adaptations in Yakut, analyzed based on established loanwords (Dyachkovskiy, 1962; Sleptsov, 1964). Similar to earlier loanwords primarily adapted by monolinguals, presented in Dyachkovskiy's and Sleptsov's studies, on-line adaptations of the vowels in the production task point to an overall affectedness of vowels by surrounding vowels to achieve a better vowel harmony in adaptation.

Moreover, previous research on the application of vowel harmony in loanwords has shown several important vowel features at play that include height (e.g., Cohen, 2013; Kimper, 2011); backness (Harrison, 1999; Välimaa-Blum, 1999), roundedness (Harrison, 1999), length (Harrison, 1999; Sy, 2006), and stress (Cabré, 2009, among others). Thus, the previous studies highlight the importance of certain phonological features of input vowels that are crucial in whether harmony is attained or not. Considering that certain phonological predictors have been suggested to be active in instigating harmony, this chapter addresses the main research question: In Yakut, what phonological predictors of input vowels and words, including individual input vowels, drive application of vowel harmony in adaptation? To address the main research questions, this chapter discusses analyses of phonological input predictors of harmony in the complete dataset (Section 9.1), in the subset of input disharmonic words (Section 9.2) and input harmonic words (Section 9.3), as well as analyses of faithfulness to the input vowels' backness and roundness features (Section 9.4).

I hypothesize that in Yakut, input features of the Russian vowels like stress, height, backness/roundness, syllable position, vowel sharedness (shared and unshared vowel phonemes between the languages), and vowel reduction, affect application of vowel harmony. That is, I anticipate that in Russian input words, factors like harmony and word type play a crucial role in whether adapted words follow backness harmony, rounding harmony, and exhibit Yakut-like adaptation. Therefore, the effects of these (and other) factors were tested using linear mixed-effects modeling (Bates, et al., 2015) in R (R Core Team, 2013). Three dependent variables, backness harmony in the adaptation (BH), rounding harmony in the adaptation (RH), and overall Yakut-likeness of adaptation (YLA), were analyzed, in addition to the dependent variable of faithfulness to backness and roundness, which is discussed separately in Section 9.4.

The subsections of the chapter show results derived from the data frame of the production task. The production task data frame included 5,160 words, containing 10,320 individual vowels of each of the disyllabic input word's initial and final syllables. The following dependent variables were coded to assess the entire produced words, meaning that each word is one data point: backness harmony (BH), rounding harmony (RH), and Yakut-like adaptation (YLA).[35] In Table 9.1, I show the three dependent variables, assigned levels of coding, and Table 9.2 presents tested predictors with subsequent explanations of the coding, when necessary.

Table 9.1 Coding of the tested dependent variables

Dependent variable	Assigned level	Levels
backness harmony (BH)	whole word	no yes
rounding harmony (RH)	whole word	no yes
Yakut-like adaptation (YLA)	whole word	no yes

The dependent variable BH checks whether vowels in the word agree in backness; words harmonic in backness were coded as 'yes', and words disharmonic in backness were coded as 'no'.

In a similar fashion, the dependent variable RH coded whether produced words follow rounding harmony. That is, the dependent variable checks whether vowels in words have correct combinations of roundness, and height of rounded and unrounded vowels, according to the rounding harmony rules described in Chapter 4. Hence, harmonic words consistent with the rounding harmony rules were coded as 'yes', and disharmonic words violating the rounding harmony rules were coded as 'no'. Note that words were coded for the dependent variable RH when they had rounded vowels in the input and/or in the output, including the words that had rounded output forms from unrounded vowels, like *syryœɲ* from the input un-borrowed word with all unrounded vowels *siˈrenʲ* 'lilac'. If the Russian input word had a rounded vowel in it, like /o/ in *kiˈno* 'movie' and the output form was *kiːnɛ* (borrowed word) with no rounded vowels in the word, such words were still coded for the dependent variable RH. And since words like *kiːnɛ* do

[35] Hereafter, I use the acronyms BH, RH, and YLA, respectively, when I refer to backness harmony, rounding harmony and Yakut-like adaptations, respectively, as dependent variables of linear mixed-effects models.

not conflict with the rounding harmony or backness harmony rules, they were coded for the dependent variable RH as 'yes', and for 'BH' as 'yes', although they do not contain rounded vowels on the surface. The intention in this case was to estimate whether words with rounded input vowels ultimately led to production of vowel harmony words.

Coding of the dependent variable YLA involved assessing vowel harmony in general (which involves ensuring that sequences of vowels in words are according to the rules of vowel harmony), and checking whether a Russian vowel or stress was used. A word was coded as 'yes' for this dependent variable if it had no Russian vowel in it and followed backness harmony and rounding harmony, if the latter was applicable. Note that use of Russian consonants did not affect the coding of the dependent variable YLA. That is, only vowel sequences in the words were assessed, without considering the consonants.

Note that epenthetic vowels in the words were coded too, like /u/ inserted word-initially in the borrowed word *ustudʒuɒn* 'student' from the input word *stuˈdent*. Thus, in estimating words for the dependent variables shown in Table 9.1, where the output produced words in Yakut were assessed as whole words, all inserted vowels, when applicable, were considered to assess overall application of vowel harmony within the word. However, the inserted vowels and their quality were not analyzed and were not included in the data frame, since I specifically focus on the input-output vowel correspondents of the initial and final syllables of the disyllabic input words.

Out of 5,160 produced words, participants adapted 4,183 words (81.1%) following backness harmony, and 977 words (18.9%) violated backness harmony. Furthermore, participants adapted 2,167 words (66.4%) following rounding harmony, and 1,098 words (33.6%) violated rounding harmony out of 3,265 words in which the category rounding harmony was applicable. Most importantly, the majority of words – 3,554 (68.9%) – were Yakut-like adaptations, and 1,606 words (31.1%) had violations of vowel harmony or contained Russian vowels or stress (out of a total of 5,160 words).

To create the predictor variables, the vowels in the transcribed words (both input and output) were coded separately for vowel quality features in both syllables. I present tested input predictors coded for the Russian vowels and input Russian words in Table 9.2.

Table 9.2 Coding of the tested input predictors of the Russian vowels and words

Predictor	Assigned level	# of levels	Levels
input backness	individual vowel	2	back; front.
input height	individual vowel	3	close; high mid; open.
input roundness	individual vowel	2	rounded; unrounded.
input stress	individual vowel	2	stressed; unstressed.
vowel input	individual vowel	5	/a/; /e/; /i/; /o/; /u/.
vowel reduction	individual vowel	2	reduced; unreduced.
vowel sharedness	individual vowel	2	shared; unshared.
word type	whole word	3	borrowed; nonce; un-borrowed.

As the Russian vowels /o, u/ are both rounded and back at the same time, the categories input backness and input roundness code the same features of the vowels, i.e. when the vowel is coded as 'back' it is also 'rounded'. I distinguished between backness and roundness of the input Russian vowels to use input backness in testing backness harmony, and input roundness as a predictor for the dependent variable RH. Vowel sharedness concerned the vowels /i/ and /u/, these vowels have similar phonetic characteristics between Russian and Yakut (Samsonova, 1959). Thus, /i, u/ were coded as 'shared' in this category, and the other vowels were categorized as 'unshared'. The category word type signifies the three types of the target words: borrowed, nonce, and un-borrowed.

In addition, all models included the random factors 'participant' and 'Russian input word',[36] which has 144 levels that correspond to the target words that each participant adapted in the production task.

[36] As an exception, a random effect 'input vowel' was added to the two random effects 'participant' and 'Russian input word' in models of faithfulness to roundness, reported in Section 9.4.

Depending on the analysis in each subsection, specific phonological predictors from the above listed categories were selected for analyses. After arriving at a best phonological model (the model testing phonological input features, but not including the predictor 'vowel input') by following the modelling process detailed in Chapter 8, a separate best model involving first and second vowel input only as factors was completed. The distinction of models as 'phonological' is used here in terms of distinguishing input predictors that specify input features of vowels like height, backness, etc. And the category 'vowel input' contains all those phonological features at once. As the final step, if both best models – the phonological model and the one with vowel input - yielded significant results, both models were compared with each other using the ANOVA function. The category 'vowel input' represents the five individual vowels, the intention of including the two separate analyses was to estimate if certain dependent variables were determined by phonological factors of the input vowels and words, or rather by the quality of individual vowels.

9.1 Phonological predictors in overall best models

This section presents results of exploratory data analyses that included all the variables listed above as predictors. Overall best models show input Russian phonological features that trigger backness harmony, rounding harmony, and Yakut-like adaptation, respectively. Results presented in this section addressed the following research question: What phonological predictors of the Russian input words and vowels - first and second vowel input roundness, first and second vowel input height, first and second vowel input backness, first syllable input stress, first and second vowel's vowel sharedness, first and second vowel's vowel reduction, and word type - drive application of backness harmony, rounding harmony, and Yakut-like adaptation, respectively? A sub-question concerns the quality of the individual input vowels: Are there specific vowels that instigate backness harmony, rounding harmony, and Yakut-like adaptation?

9.1.1 Backness harmony

Ten input predictors were tested for the dependent variable 'BH': first and second vowel input height; first and second vowel sharedness; first and second vowel input backness; first and second vowel reduction; first syllable input stress; and word type. Note that most produced words (81.06%) applied backness harmony in the production task.

Linear mixed-effects modeling showed that the best model of BH had a significant interaction between first vowel input backness and second vowel input backness. Another significant predictor at play in driving backness harmony was word type. Moreover, a by-participant effect of first vowel input backness was revealed, in addition to the random intercept factor ‘Russian input word’.

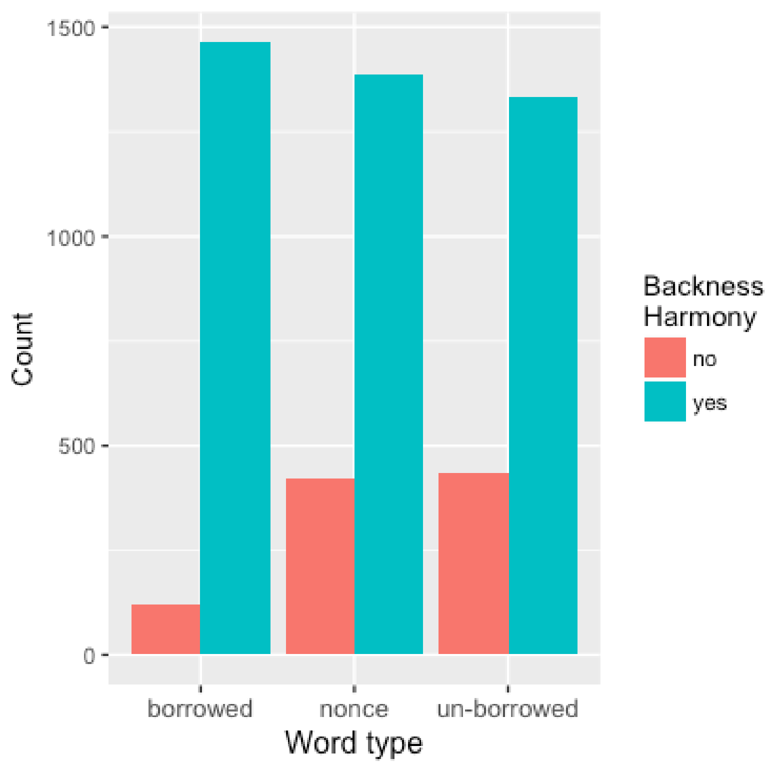

Figure 9.1 Output backness harmony by word type

As is demonstrated in Figure 9.1, one of the significant predictors was word type, showing that nonce (estimate = -2.1634, SE = 0.5203, z = -4.158, p = 3.21e-05) and un-borrowed (estimate = -2.0778, SE = 0.5206, z = -3.991, p = 6.58e-05) words led to significantly fewer backness harmony words, compared to borrowed words. Next, releveling of the reference level of the category ‘word type’ within the model was conducted. When the reference level was ‘un-borrowed’, it was confirmed that borrowed words had significantly more backness harmony adaptations than the un-borrowed ones).[37]

[37] Releveling of the reference level of the category ‘word type’ to ‘nonce’ did not converge.

The significant interaction between first and second vowel input backness showed that when first and second vowels were both front, i.e. harmonic in backness, they resulted in productions of significantly more backness harmony words than when only one of the vowels was front (estimate = 6.1969, SE = 0.9316, z = 6.652, p = 2.89e-11), as seen in Figure 9.2:

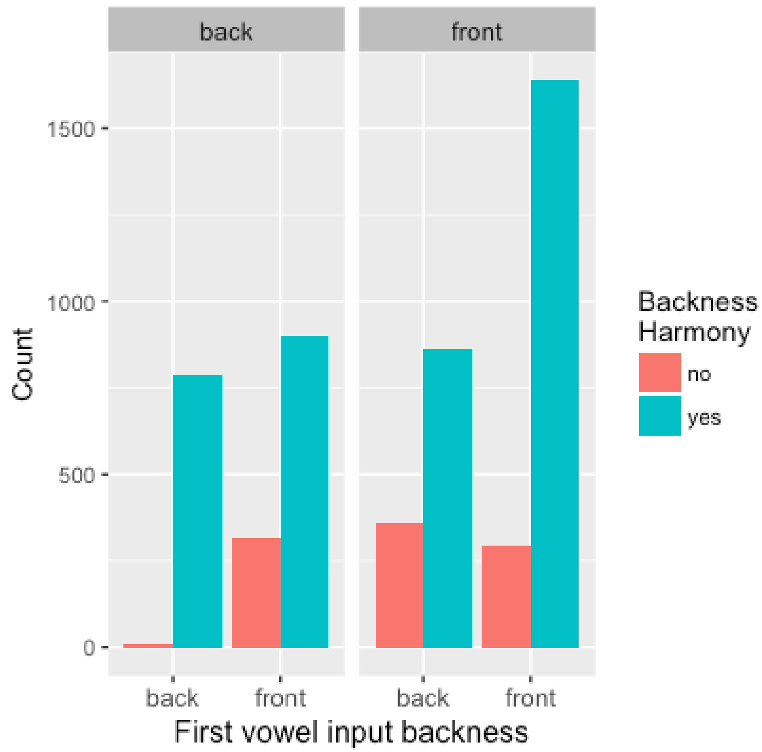

Figure 9.2 Output backness harmony by first and second vowel input backness. Groups of bars show first vowel backness, panels show second vowel backness

Additionally, significant main effects suggested that first front vowels (estimate = -4.0508, SE = 0.7970, z = -5.083, p = 3.72e-07) and second front ones (estimate = -4.8144, SE = 0.6833, z = -7.046, p = 1.84e-12) both led to productions of significantly fewer backness harmony words than back vowels. Figure 9.2 shows the tendency of first and second front vowels to lead to significantly fewer productions of backness harmony words. Note that even when both input vowels agreed in backness, there were proportionally fewer backness harmony output words when they were both front than when they were both back (85% vs. 99%). Next, a by-participant effect on first vowel input backness is demonstrated in Figure 9.3, showing that the participants had various reactions to the backness feature of first vowels in driving backness harmony.

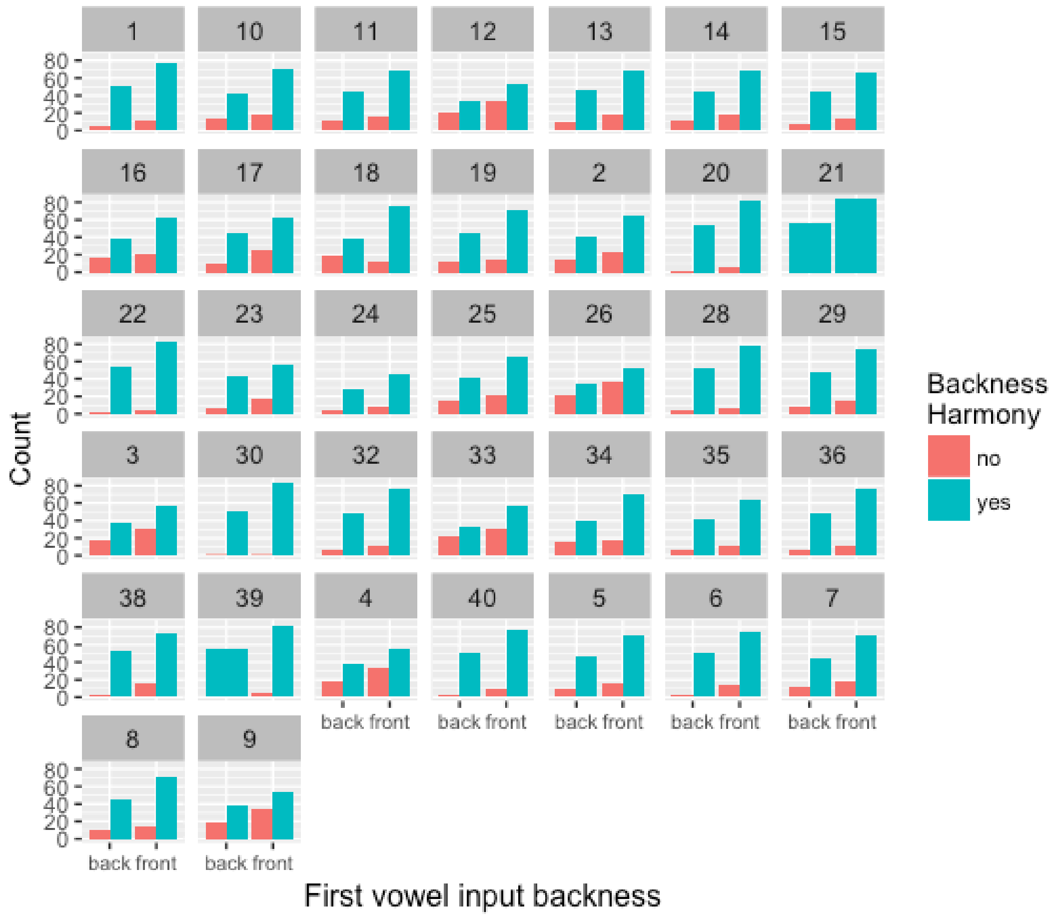

Figure 9.3 By-participant effect of first vowel input backness in the application of backness harmony

Among the first vowels, there were 2,012 (39%) back and 3,148 (61%) front vowels out of the 5,160 words. The general tendency observed from Figure 9.3 is that there were comparatively more violations of backness harmony for first front vowels rather than for first back vowels among a majority of 20 participants (numbers 1, 2, 5, 6, 7, 8, 10, 11, 13, 15, 17, 20, 22, 23, 24, 28, 29, 32, 38, 40). The following participants had equal or close to equal number of backness harmony violations for first back and front vowels: 19, 28, 34, 35, 36. Only one participant (number 18), had more violations of backness harmony when first vowels were back, as compared to the front ones. Participant number 30 had very few backness harmony violations for both first back and front vowels. Moreover, participant number 21 had no violations of backness harmony in their productions, and number 39 had also complete compliance with backness harmony when first vowels were back, and very few backness harmony violations for front vowels. Thus, generally the participants tended to apply backness harmony more often in productions when first vowels were back, as compared to front. For those participants who made most backness harmony violations in productions, the backness of first vowels did not make any crucial difference (participants 3, 4, 9, 12, 16, 25, 26, 33).

Finally, individual vowels, i.e., the category vowel input, did not produce significant results, when the null model was compared to the model with first vowel input as a predictor (p = 0.5739, χ^2 = 2.9047).[38] This result shows that backness harmony in Yakut is driven by phonological factors, rather than by the quality of individual vowel input.

It is shown that as far as features of Russian input words are concerned, word type is significant in backness harmony: borrowed words had better adaptations of backness harmony as compared to the nonce and un-borrowed ones. A significant interaction between first and second vowel input backness showed that input words with two vowels agreeing in frontness yielded significantly more backness harmony. The results also suggest that overall front vowels present in either of the syllables of input words led to significantly fewer productions of backness harmony, as opposed to first and second back vowels.

9.1.2 Rounding harmony

Rounding harmony was overall followed less consistently than backness harmony (66.4% vs. 81.06% of relevant output words). This tendency shows that participants prioritized application of backness harmony slightly more than application of rounding harmony. Similar to the analyses of backness harmony above, I tested the same set of the ten input predictors for the dependent variable RH. The best model of RH contained the following significant predictors: word type and first and second vowel input roundness, including a by-participant effect of first vowel roundness and the random factor Russian input word. No interaction between the significant predictors was found.

[38] A model with only second vowel input as a predictor and a model with first and second vowel input as predictors did not converge.

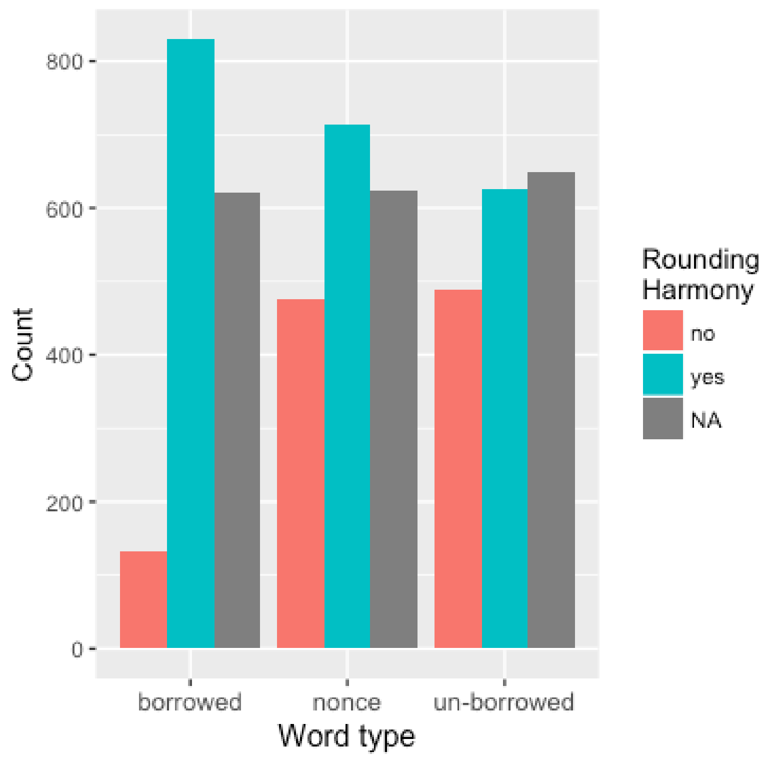

Figure 9.4 Output rounding harmony by word type

As seen in Figure 9.4, the significant effect of word type shows that when the words were nonce (estimate = -2.1403, SE = 0.4072, z = -5.256, p = 1.47e-07) and un-borrowed (estimate = -2.4072, SE = 0.4144, z = -5.808, p = 6.31e-09), participants produced significantly fewer rounding harmony words, as opposed to borrowed words. Confirming that borrowed words were superior in producing most rounding harmony words, releveling of the reference level to 'nonce' showed that borrowed words indeed produced significantly more rounding harmony words than the nonce ones, as well as showing a significant difference compared to the reference level 'un-borrowed'.

Another significant predictor of RH was first vowel input roundness, indicating that when first vowels were unrounded, they led to significantly fewer rounding harmony words than when they were rounded (estimate = -1.7859, SE = 0.3748, z = -4.764, p = 1.89e-06). Similarly, a significant effect of second vowel input roundness confirms that second unrounded vowels also led to productions of fewer rounding harmony words than second rounded vowels (estimate = -1.1302, SE = 0.3627, z = -3.116, p = 0.00183). Figures 9.5 and 9.6 present the tendency for first and second unrounded vowels to have more violations of rounding harmony.

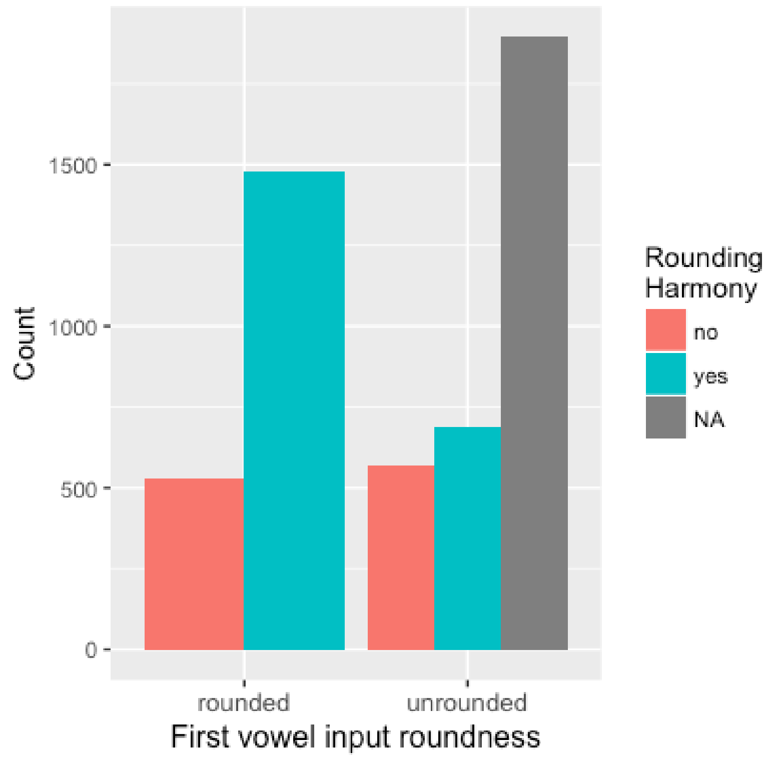

Figure 9.5 Output rounding harmony by first vowel input roundness

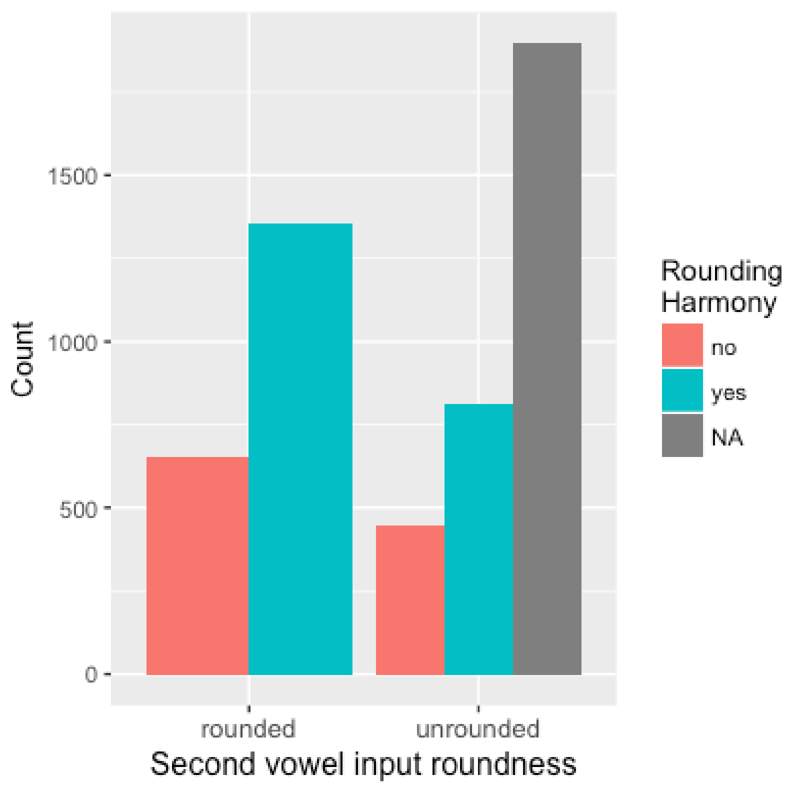

Figure 9.6 Output rounding harmony by second vowel input roundness

A by-participant effect of first vowel input roundness is presented in Figure 9.7, displaying different reactions among the participants to the roundness feature of first vowels:

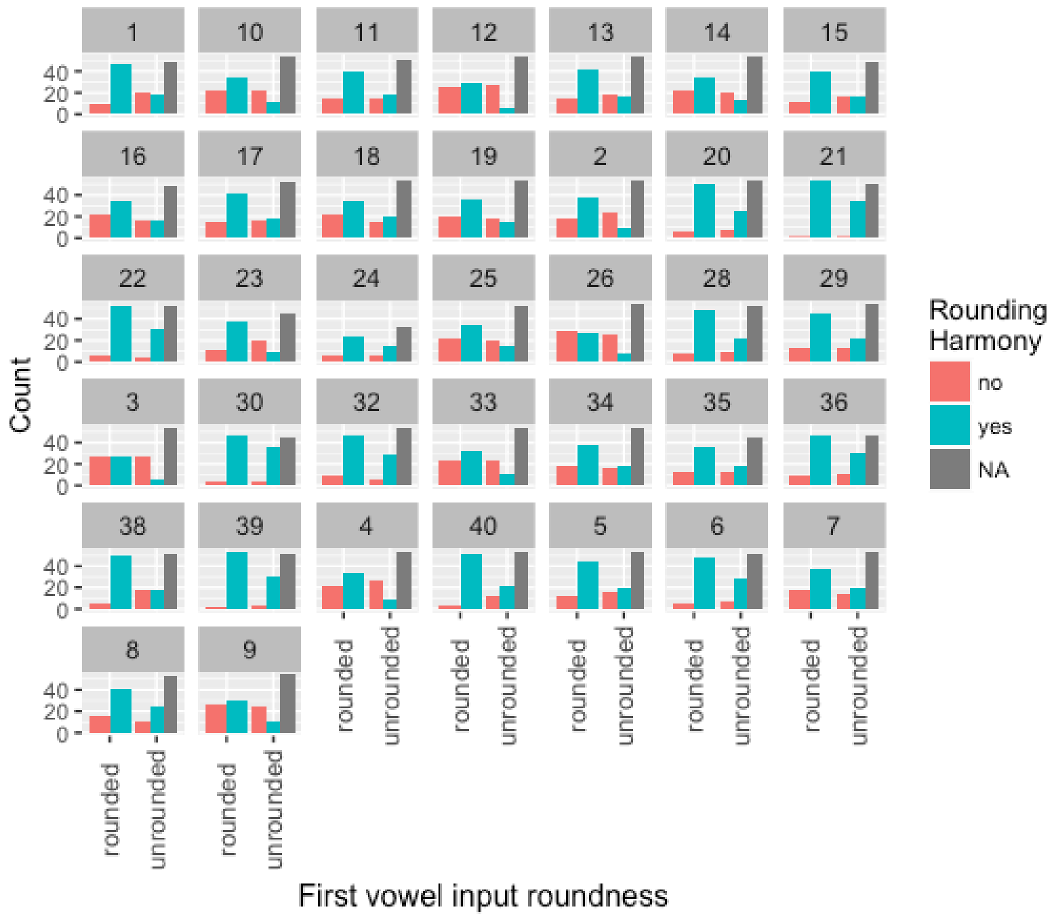

Figure 9.7 By-participant effect of first vowel input roundness in the application of rounding harmony

Figure 9.7 shows that all participants were in line with the general tendency of producing more rounding harmony when the first input vowel was rounded than when it was unrounded, though the size of this difference varied between participants. For example, participants 21, 22, 30, and 39 followed rounding harmony exceptionally well regardless of the roundness features of first vowels. In contrast, participants 3, 9, 12, and 26 produced equal or close to equal numbers of rounding harmony violations and compliances with rounding harmony when first vowels were rounded, but first unrounded vowels triggered comparatively fewer compliances.

In addition to the phonological model, the predictor first vowel input appeared to be significant in triggering rounding harmony (the best model included both random factors). Figure 9.8 illustrates that out of the five vowels, the vowels /o, u/ had most rounding harmony in productions. When the reference level was /a/, the rounded back vowel /o/ resulted in productions of significantly more rounding harmony words (estimate = 1.9703, SE = 0.6150, z = 3.204, p = 0.00136) than /a/. The other rounded back vowel /u/, however, only marginally contributed to productions of more rounding harmony words (estimate = 1.1396, SE = 0.6260, z = 1.820, p = 0.06870) as opposed to /a/. Below, Figure 9.8 shows the effect of first vowel input for the dependent variable RH.

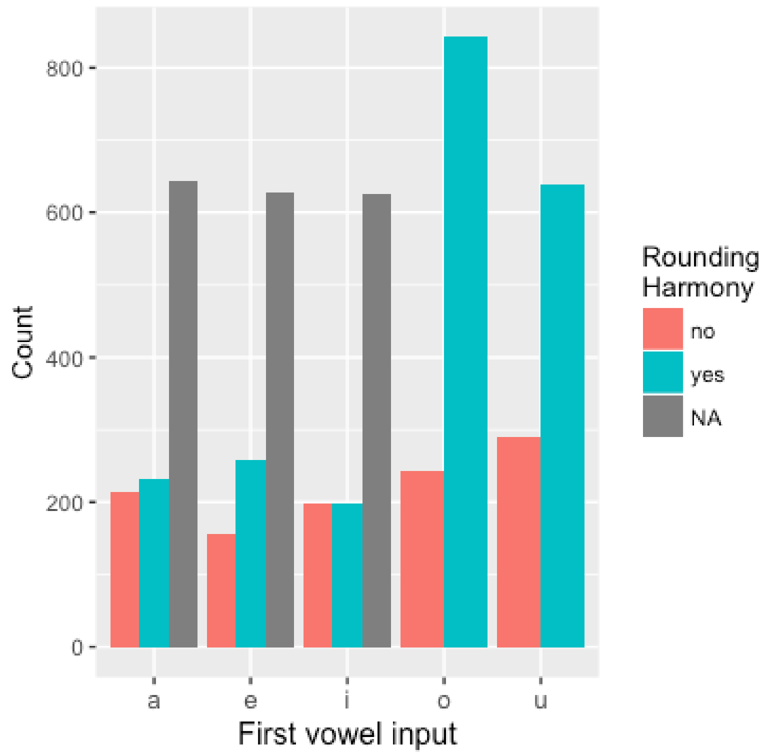

Figure 9.8 Output rounding harmony by first vowel input

Since the category vowel input had five levels, relevelling of the factor was completed. When the reference level was /e/, the vowel /o/ was significant in producing more rounding harmony words (estimate = 1.3526, SE = 0.5996, z = 2.256, p = 0.0241), confirming that the vowel /o/ is a strong trigger of RH. A relevelled reference level /i/ showed that both rounded vowels /o/ (estimate = 2.1465, SE = 0.6467, z = 3.319, p = 0.000903) and /u/ (estimate = 1.3158, SE = 0.6570, z = 2.003, p = 0.045217) were significant in producing more rounding harmony words. In turn, when the vowel /o/ itself was the reference level, it was confirmed that all three unrounded vowels /a/, /e/ (estimate = -1.3526, SE = 0.5997, z = -2.256, p = 0.024094), and /i/ (estimate = -2.1465, SE = 0.6465, z = -3.320, p = 0.000899), produced significantly fewer rounding harmony words, as compared to /o/. Finally, a relevelled reference level of the rounded vowel /u/ revealed the vowels that led to significantly fewer rounding harmony words: the vowel /a/ produced marginally fewer rounding harmony words and the vowel /i/ led to significantly fewer productions of rounding harmony (estimate = -1.3158, SE = 0.6568, z = -2.003, p = 0.045160).

Furthermore, both best models for the dependent variable RH were compared with each other. The best model appeared to be the phonological model which was significantly better than the model involving vowel input (p = 2.407e-12, χ^2 = 57.133).

Analyses of the dependent variable RH confirmed that word type of Russian input words was significant in driving rounding harmony: borrowed words followed rounding harmony significantly more often than nonce and un-borrowed ones. Roundedness of vowels is suggested to be important in application of rounding harmony: rounded vowels in first and second syllables significantly increased productions of rounding harmony words compared to unrounded vowels. A significant effect of the category vowel input revealed that the first vowel /o/ contributed to productions of more rounding harmony words compared to the unrounded vowels /a, e, i/.

9.1.3 Yakut-like adaptation

Yakut-like adaptation was observed in 68.9% of the words overall. Like in analyses of the dependent variables RH and BH reported above in Sections 9.1.1 and 9.1.2, linear mixed-effects modeling for the dependent variable YLA included the same set of the ten phonological input predictors. The best model had the same structure as the one of BH reported in Section 9.1.1, revealing that there was a significant effect of word type and a significant interaction between first and second vowel backness. As for the random effects, a by-participant effect of first vowel backness was confirmed, along with the random factor Russian input word.

The significant effect of word type showed that when words were nonce, there were significantly fewer Yakut-like adaptation words (estimate = -2.0622, SE = 0.3160, z = -6.527, p = 6.71e-11) than for the borrowed ones; similarly, un-borrowed words also produced significantly fewer Yakut-like adaptation words (estimate = -1.9188, SE = 0.3178, z = -6.039, p = 1.56e-09), as opposed to borrowed words. To assess whether borrowed words were adapted best, releveling of the reference level to ‘nonce’ was completed, showing that borrowed words had significantly more Yakut-like adaptation.[39] Figure 9.9 illustrates the tendency for borrowed words to produce most Yakut-like adaptation words.

[39] Releveling of the reference level of the category ‘word type’ to ‘un-borrowed’ did not converge.

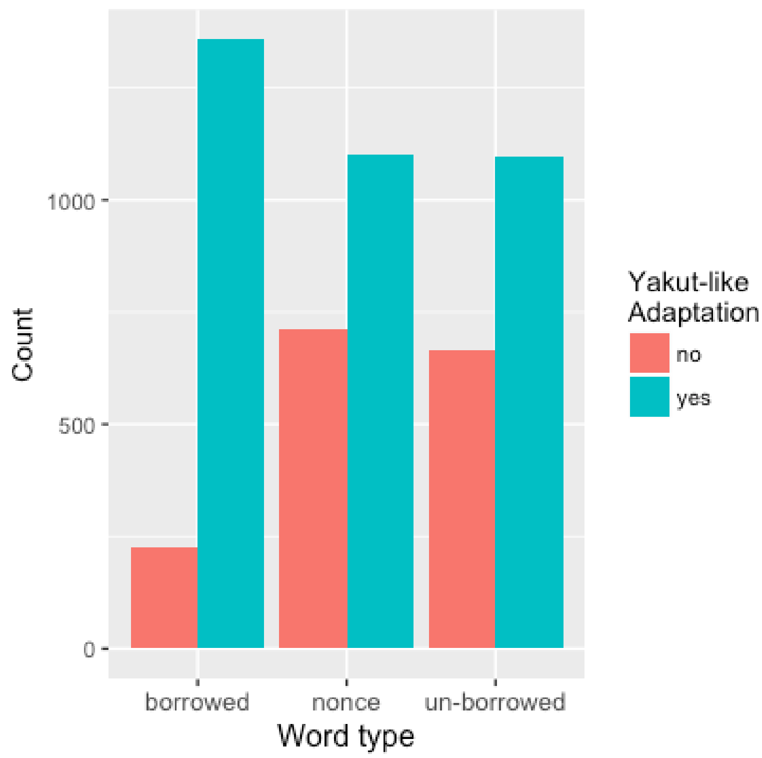

Figure 9.9 Output Yakut-like adaptation by word type

Next, the significant interaction between first and second vowel input backness showed that when first and second vowels were both front, there were significantly more Yakut-like adaptation words (estimate = 3.1238, SE = 0.5318, z = 5.874, p = 4.25e-09), as illustrated in Figure 9.10. In addition, significant main effects of first vowel input backness (estimate = -2.1759, SE = 0.4227, z = -5.148, p = 2.63e-07) and second input vowel backness (estimate = -1.5476, SE = 0.4168, z = -3.713, p = 0.000205) appeared in the model, suggesting that front vowels resulted in significantly fewer Yakut-like adaptation words than back ones.

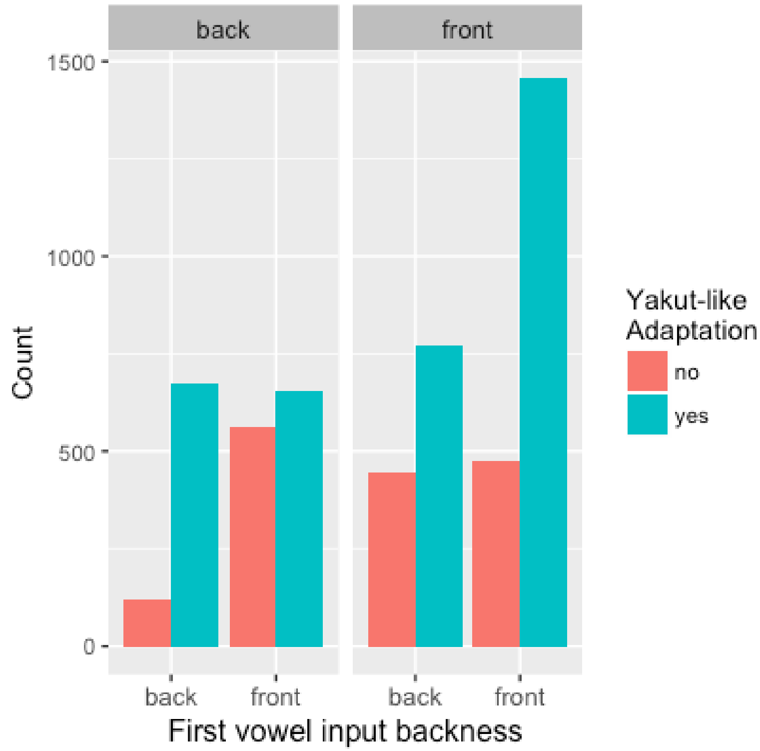

Figure 9.10 Output Yakut-like adaptation by first and second vowel input backness. Groups of bars show first vowel backness, panels show second vowel backness

As far as the random factors are concerned, similar to the best model of BH, reported above, a by-participant effect of first vowel input backness was significant in driving Yakut-like adaptation words. Various ways the participants behaved depending on the backness features of first vowels are shown in Figure 9.11.

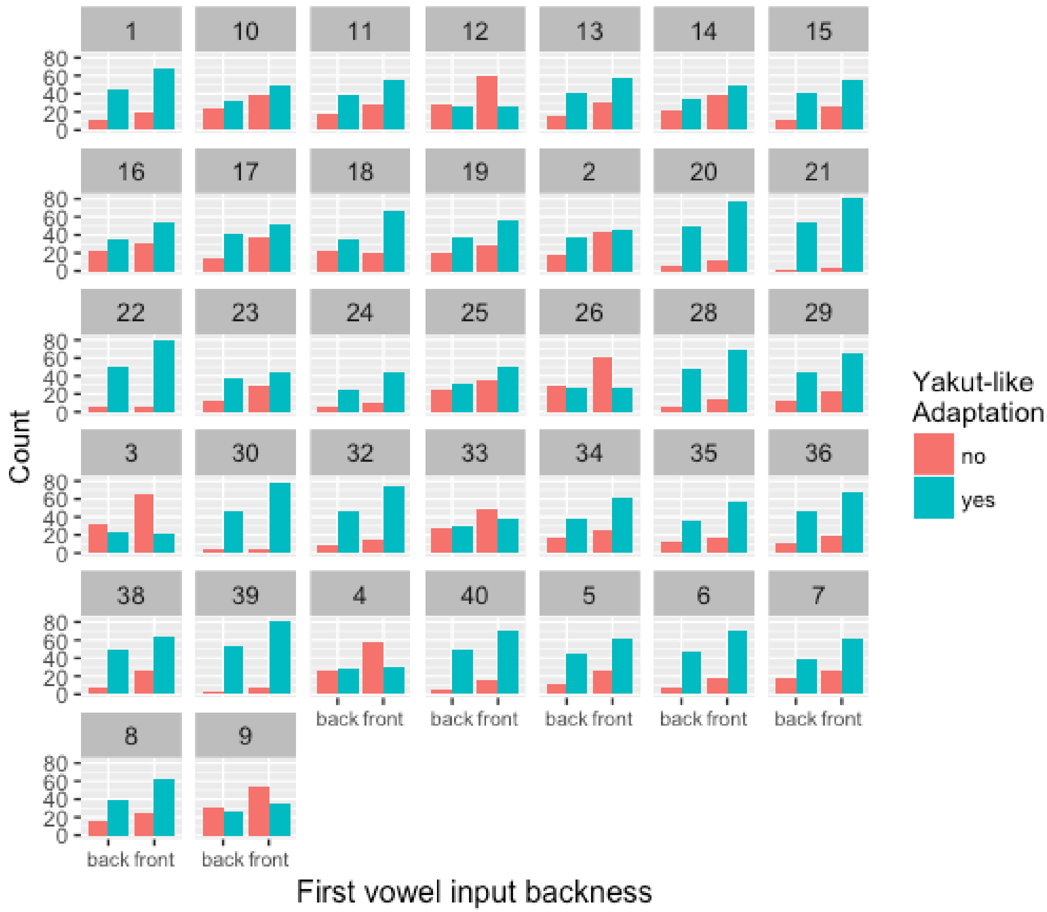

Figure 9.11 By-participant effect of first vowel input backness in driving Yakut-like adaptations

As visible in Figure 9.11, despite an overall tendency among the participants to produce more Yakut-like adaptation words, the majority of the participants had more Yakut-like adaptation words when first vowels were back as opposed to front. However, those participants (numbers 4, 9, 12, 26, 33), who had equal and close to equal numbers of both correct and incorrect Yakut-like adaptation words for first back vowels, had more violations for first front vowels, which shows that first back vowels generally facilitate more Yakut-like adaptation. None of the participants produced only Yakut-like adaptation words, however, participants 20, 21, 22, 28, 30, 39, 40 performed most efficiently in terms of producing most Yakut-like adaptations.

Finally, when compared to the null model, no significant effect of first (p = 0.7815, χ^2 = 1.7509) and second (p = 0.1099, χ^2 = 7.5415) vowel input individually in the models was revealed, including a model that had both predictors (p = 0.3108, χ^2 = 9.3855) indicating that Yakut-like adaptation in general was based on the phonological factors.

Yakut-like adaptation is shown to be driven by a similar set of significant input features as for the dependent variables BH and RH. Namely, just like the best model of BH, a significant interaction between first and second vowel input backness showed that front vowels per se in either of the syllables produced fewer Yakut-like adaptations than back vowels, however, two front vowels led to significantly more Yakut-like adaptations. Parallel to the best models of BH and RH words, revealing a significant effect of word type, borrowed words in the best model of YLA also led to productions of significantly more Yakut-like adaptation words than the un-borrowed and nonce word counterparts.

9.2 Driving input features of vowel harmony in disharmonic input words

This section concerns disharmonic input words in terms of backness harmony only, and it sheds light on the way participants adapted words that were disharmonic in backness in general, given the fact that Yakut has vowel harmony and Russian does not. The reason to focus on the subset of backness harmony disharmonic words in the input, rather than rounding harmony disharmonic ones, is that it is more directly possible to distinguish harmonic and disharmonic words with respect to backness, rather than roundness, which is harder to evaluate for Russian vowel categories. In other words, the vowel inventories of Russian and Yakut are different from each other, and mapping of rounded and unrounded vowels from Russian into Yakut is not straightforward for constructing Russian rounding harmony harmonic and disharmonic words in the input, unlike backness harmony. Thus, the research question addressed in this section is: What phonological input predictors drive vowel harmony (backness and rounding harmony) in adaptations of backness disharmonic words? Two dependent variables – BH and RH – were analyzed. I hypothesize that back, high and low, and shared vowels will induce more vowel harmony than front, high-mid and unshared vowels, respectively. There were six tested predictors included in the analyses involving phonological input predictors: first and second vowel input backness/roundness; first and second vowel input height; first and second vowel sharedness. These predictors describe important characteristics of vowel quality. Note that the categories first and second vowel input backness and first and second vowel input roundness are redundant, as the Russian input back vowels are all rounded, and the front vowels are all unrounded. In addition, separate models involving first and second vowel input were tested, similar to the models in the previous sections, and were compared to the best models involving phonological input predictors.

Overall best models presented in Section 9.1 showed no effect of stress or vowel reduction, therefore, these factors were excluded from consideration in models of vowel harmony presented here. The category first and second vowel sharedness, although not significant in the models of vowel harmony, was included to ensure that the sharedness of vowels between languages in disharmonic and harmonic words does *not* affect harmony. In addition, the category word type is not relevant in analyses of the tested research question, as the research question posed in this section focuses on the characteristics of vowels predicting vowel harmony, rather than the characteristics of whole words. All models included the two random effects participant and Russian input word. Sections 9.2.1 and 9.2.2 discuss results of the best models of BH and RH in disharmonic input words, respectively. Productions of 2,434 disharmonic words were analyzed, showing that 1,759 produced words (72.3%) followed backness harmony, and 1,442 words (59.2%) followed rounding harmony, respectively.

9.2.1 Backness harmony

The best model of BH revealed that there were two significant predictors in driving backness harmony: first and second vowel input height. No interaction between the predictors was found. As shown in Figure 9.12, low first vowels resulted in significantly more backness harmony words compared to the reference level 'high' (estimate = 4.6868, SE = 0.6875, z = 6.818, p = 9.26e-12).

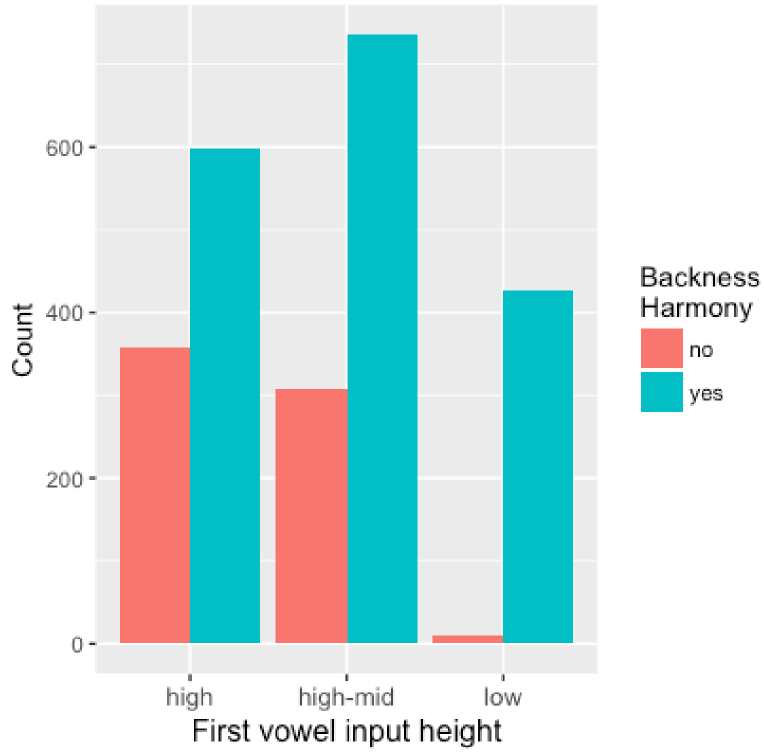

Figure 9.12 Output backness harmony of disharmonic words by first vowel input height

Similarly, second low vowels also led to significantly more productions of backness harmony words than second high vowels (estimate = 2.6673, SE = 0.6027, z = 4.426, p = 9.61e-06), see Figure 9.13.

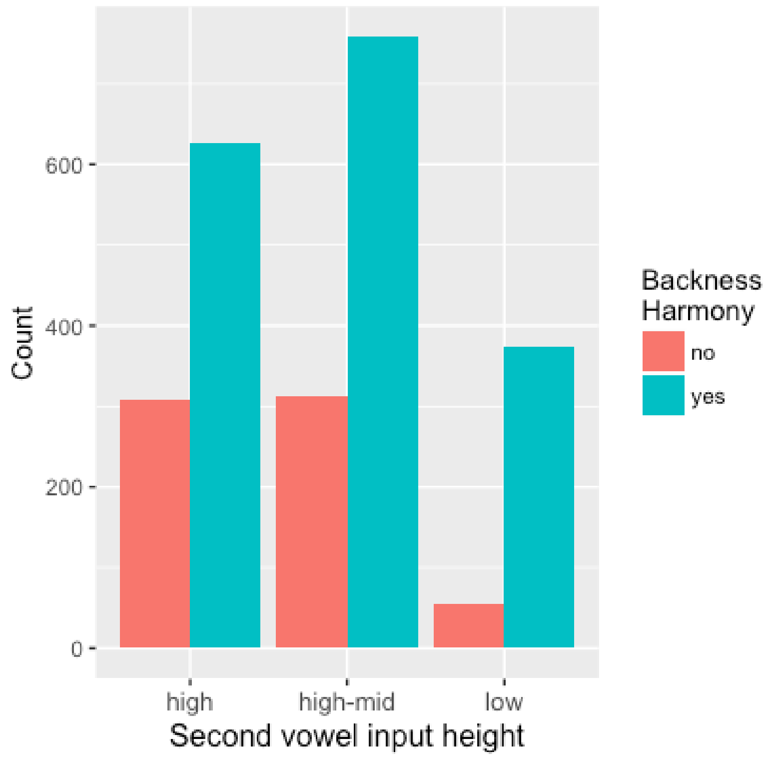

Figure 9.13 Output backness harmony of disharmonic words by second vowel input height

As input height has three levels, relevelling of the predictors' levels was computed. Checking of the levels exhibited a vivid picture about the dominant role of low vowels in facilitating more backness harmony words in production. When the reference level was 'low', there were significantly fewer BH words when first and second vowels were high respectively. Next, relevelling of the reference level to 'high-mid' showed that first (estimate = 4.0906, SE = 0.6797, $z = 6.018$, $p = 1.76\text{e-}09$) and second (estimate = 2.2435, SE = 0.5891, $z = 3.808$, $p = 0.00014$) low vowels produced significantly more backness harmony words. These results suggest that the low vowel differed significantly from high and high-mid vowels in driving backness harmony, in turn, high and high-mid vowels did not differ from each other significantly.

Finally, there was a significant effect of the category vowel input. As was shown by the significant predictors first vowel input height in the phonological model, as well, the first low vowel /a/ led to productions of significantly more backness harmony words than all other vowels, as shown in Figure 9.14.

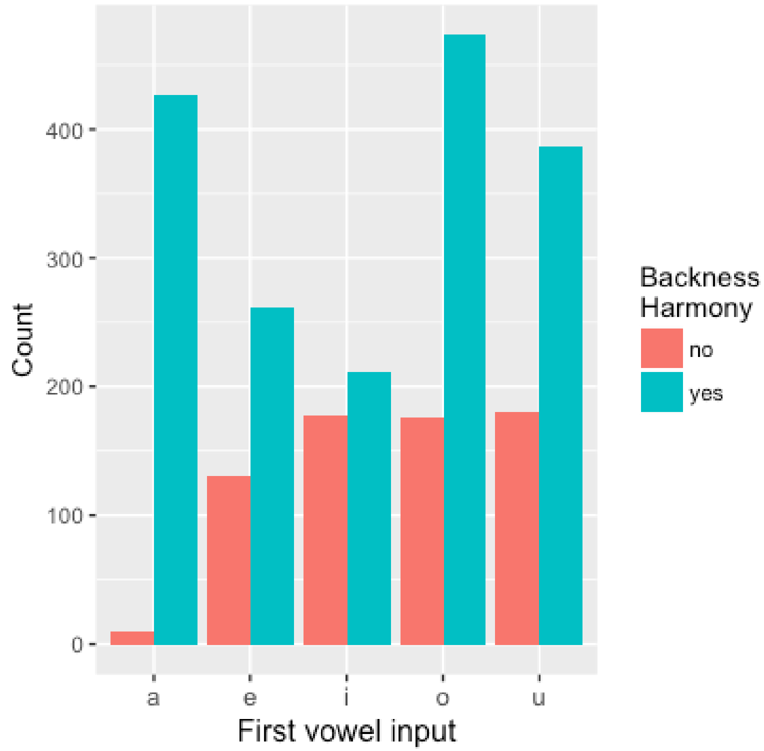

Figure 9.14 Output backness harmony of disharmonic words by first vowel input

The best model reports results based on the reference level /a/, showing that there were significantly fewer productions of backness harmony words when the first vowel was vowel /e/ (estimate = -4.0583, SE = 0.8603, z = -4.717, p = 2.39e-06); /i/ (estimate = -4.8943, SE = 0.8608, z = -5.686, p = 1.30e-08); /o/ (estimate = -3.5058, SE = 0.7924, z = -4.425, p = 9.66e-06); and /u/ (estimate = -3.8700, SE = 0.8061, z = -4.801, p = 1.58e-06), respectively. Next, releveling the category to /e/ showed that only the vowel /a/ produced significantly more backness harmony words. The reference level /i/ also revealed that the vowel /a/ led to significantly more backness harmony words, as well as the vowel /o/ that contributed to productions of significantly more backness harmony adaptations (estimate = 1.3885, SE = 0.6881, z = 2.018, p = 0.0436). Similarly, the significant effect of the vowel /a/ was confirmed when the reference level was /o/, showing that /a/ produced significantly more backness harmony words and the vowel /i/ led to significantly fewer backness harmony words. Finally, the reference level /u/ established a superior status of the vowel /a/ in driving productions of significantly more backness harmony words.

The best models – phonological and individual vowel input – were an equally good fit for the dependent variable BH in disharmonic words ($p = 1, \chi^2 = 0$).

To summarize, backness harmony in disharmonic words was driven by first and second vowel input height: first and second low vowels contributed to significantly more adaptations following backness harmony. Next, a significant effect of first vowel input confirmed that the only low Russian vowel /a/ significantly increased backness harmony adaptations in disharmonic words.

9.2.2 Rounding harmony

The best model of RH revealed only one significant predictor, which is second vowel input height. Figure 9.15 shows the effect of second vowel input height in driving rounding harmony.

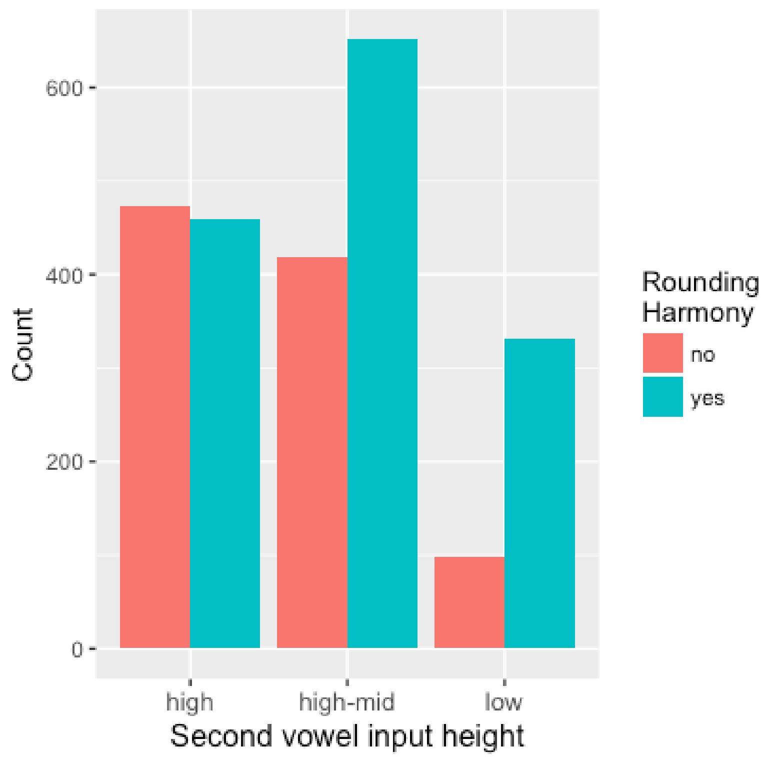

Figure 9.15 Output rounding harmony of disharmonic words by second vowel input height

As compared to high vowels, second low vowels lead to significantly more rounding harmony words (estimate = 2.18218, SE = 0.60089, $z = 3.632$, $p = 0.000282$). In turn, second high-mid vowels also produced significantly more rounding harmony words compared to high vowels (estimate = 0.90322, SE = 0.45184, $z = 1.999$, $p = 0.045608$).

Next, due to the presence of the three levels of the significant predictor second vowel height of the best model of RH, releveling of the reference level was completed. When the reference level was switched to 'high-mid', there were significantly fewer rounding harmony words for second high vowels than high-mid vowels, and second low vowels had significantly more rounding harmony words (estimate = 1.2790, SE = 0.5887, z = 2.172, p = 0.0298). In turn, when the reference level was 'low', second high, and high-mid vowels appeared to result in significantly fewer rounding harmony words, which is visible in Figure 9.15. These results show that second low vowels contributed to production of significantly more rounding harmony words in general.

In a next step, an effect of individual vowels was tested. Analyses of first and second vowel input showed that individual vowels differed in their contribution to rounding harmony. The best model of RH included second vowel input. When the reference level was /a/, it was revealed that three other vowels resulted in productions of significantly fewer rounding harmony words: /e/ (estimate = -1.4595, SE = 0.6904, z = -2.114, p = 0.034513); /i/ (estimate = -1.7216, SE = 0.7207, z = -2.389, p = 0.016910); and /u/ (estimate = -2.4637, SE = 0.6479, z = -3.803, p = 0.000143). Note that the second rounded vowel /o/ led to marginally fewer rounding harmony words compared to /a/ (estimate = -1.1526, SE = 0.6335, z = -1.819, p = 0.068876). These results are similar to the best model of backness harmony in terms of the predictors where primarily the second vowel /a/ significantly contributed to better harmonization.

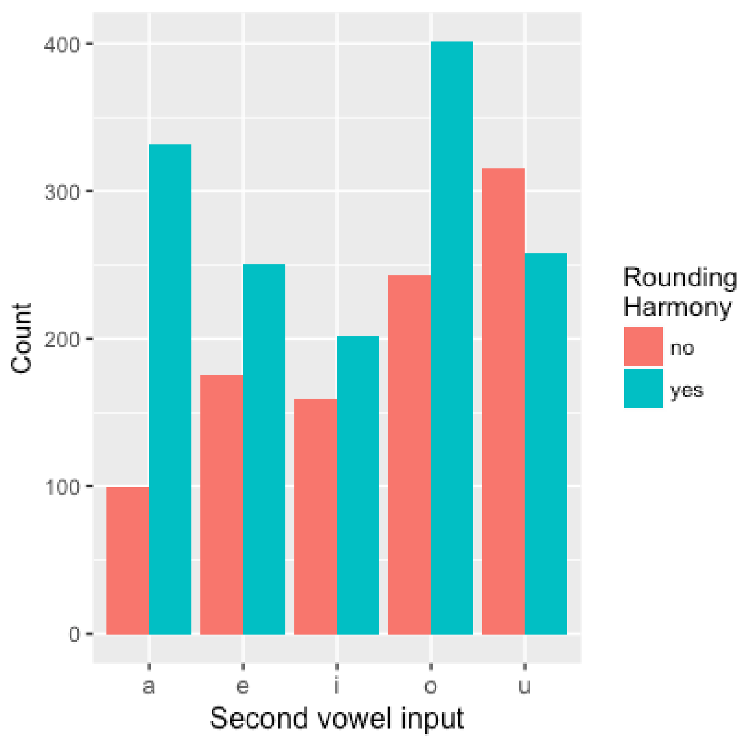

Figure 9.16 Output rounding harmony of disharmonic words by second vowel input

As visible in Figure 9.16, the second vowels /a/ and /o/ have most compliances with rounding harmony, as compared to /e, i, o/. In a next step, re-leveling of the category 'second vowel input' was computed to confirm the status of /a/ as a significant trigger of RH. The relevelled reference level /e/ showed that the second /a/ produced significantly more rounding harmony words. The reference level /i/ also confirmed that /a/ resulted in productions of significantly more rounding harmony words. However, the reference level /o/ only showed a marginal effect of the vowel /a/ contributing to more rounding harmony words, and instead showed a significant effect of /u/ in driving fewer rounding harmony productions than /o/ (estimate = -1.3111, SE = 0.5739, $z = -2.285$, $p = 0.0223$). Finally, the reference level /u/ confirmed a significant effect of the second /a/ in resulting better rounding harmony productions, along with the vowel /o/ that also led to significantly more rounding harmony words.

A final comparison of the best phonological model with the best model with vowel input showed that the model involving vowel input was not significantly better than the phonological model ($p = 0.4817$, $\chi^2 = 1.461$).

Similar results of both models suggest that the second vowel /a/ (the low vowel) was a significant predictor in driving rounding harmony in disharmonic words.

9.3 Driving input features of vowel harmony in harmonic input words

The research question posed in this section concerns input harmonic words, i.e. words that had only back or front vowels in them: What are the driving features of vowel harmony of input vowels in words already agreeing in backness? In the same fashion as the best models of backness harmony and RH in disharmonic words, the two dependent variables BH and RH were tested in harmonic words. Because front vowels (which are unrounded) were worse triggers of vowel harmony in the overall best models of BH and RH (and the best model of YLA) above, I hypothesize that front vowels in either of the syllables will result in fewer vowel harmony words in input harmonic words compared to back vowels. Sections 9.3.1 and 9.3.2 present the best models of the two dependent variables in harmonic input words. Considering that I am specifically interested in the features of vowels, three predictors were tested: first vowel input backness,[40] and

[40] Second vowel backness was not tested, as it is a redundant feature and is predictable from first vowel input backness of harmonic words. Moreover, the predictor 'vowel sharedness' was not included, since the shared vowels /i/ and /u/ both have two different backness features (front and back).

first and second vowel input height. Both random effects were included. Note that the backness and roundness features of Russian vowels are equivalent, as all the input back vowels are rounded, and all the input front vowels are unrounded.

9.3.1 Backness harmony

The results of adaptations of harmonic input words showed that the majority 2,424 words (88.9%) were produced following backness harmony, and 302 words (11.07%) did not, out of a total of 2,726 words harmonic in backness. The best model of BH in harmonic words had a significant predictor first vowel input backness and included both random factors. It was found that first front vowels led to significantly fewer backness harmony words than first back vowels (estimate = -3. 5839, SE = 0.9472, z = -3.783, p = 0.000155), as shown in Figure 9.17.

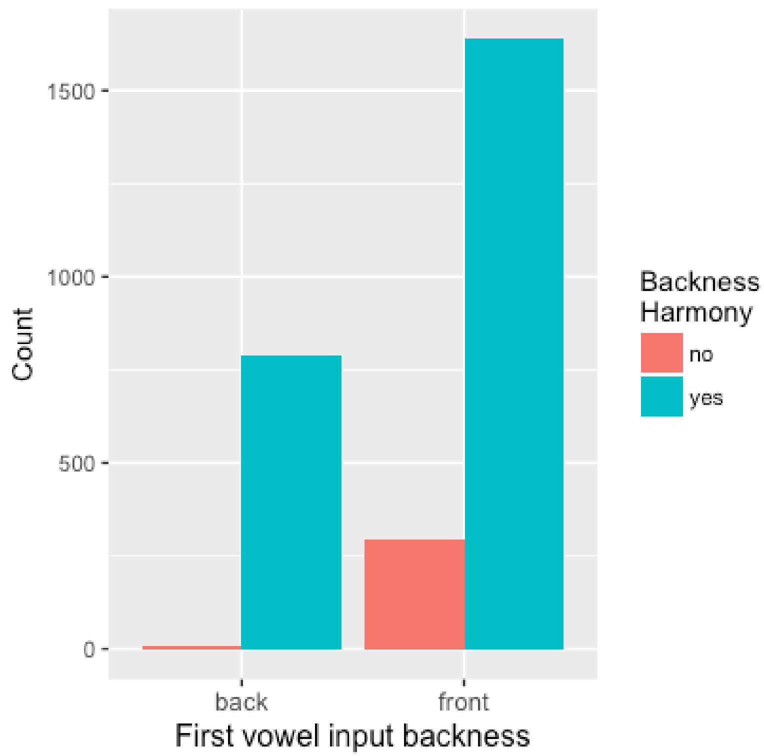

Figure 9.17 Output backness harmony of harmonic words by first vowel input backness

Next, an effect of individual vowels was found. The best model of BH containing vowel input revealed that first vowel input was a significant predictor of BH and the model included both random effects. When the reference level was /a/, the back vowels /o/ (estimate = 4.6475, SE = 1.3108, z = 3.545, p = 0.000392) and /u/ (estimate = 4.7707, SE = 1.4178, z = 3.365, p = 0.00076) led to significantly more backness harmony words than /a/. The front vowel /e/ also occurred to contribute to significantly more occurrences of backness harmony words compared opposed to /a/ (estimate = 2.3572, SE = 1.1039, $z = 2.135$, $p = 0.032731$), as seen in Figure 9.18.

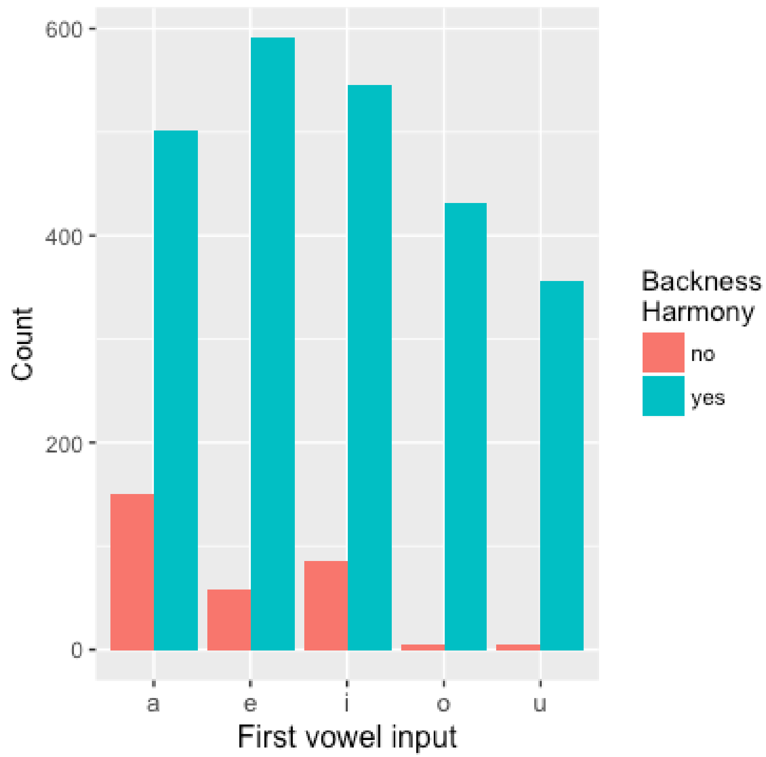

Figure 9.18 Output backness harmony of disharmonic words by first vowel input

Figure 9.18 shows that the vowels /o, u/ had the least instances of non-harmonic backness harmony words. Releveling of the category first vowel input was conducted. The releveled reference level /e/ showed that the vowel /a/ led to significantly fewer backness harmony words. The back vowels /o/ (estimate = 2.2904, SE = 1.3370, $z = 1.713$, $p = 0.0867$) and /u/ (estimate = 2.4135, SE = 1.4361, $z = 1.681$, $p = 0.0928$) had only marginal effects in contributing to more backness harmony words than /e/. When the reference level was /i/, both back rounded vowels /o/ (estimate = 3.2818, SE = 1.3204, $z = 2.485$, $p = 0.0129$) and /u/ (estimate = 3.4048, SE = 1.4244, $z = 2.390$, $p = 0.0168$) were significant in productions of more backness harmony words. The reference level /o/ revealed the vowels which led to productions of significantly fewer backness harmony words than /o/ – the two front vowels /a/ and /i/. Finally, relative to the reference level /u/, the front vowels /a/ and /i/ had fewer backness harmony words. In addition, the other front vowel /e/ triggered only marginally fewer backness harmony words than /u/. In sum, releveling of the reference levels confirms a ranking of the vowels in respect to the dependent variable backness harmony: /u/, /o/, /e/ > /a/, /i/, showing that both first back vowels and the high-mid /e/ were better in triggering backness harmony than the first front vowels /a/ and /i/ in harmonic words.

Final comparisons of the best phonological model with the model testing vowel input showed that the model with vowel input was not significantly better than the phonological one ($p = 0.1902$, $\chi^2 = 4.7607$).

An important role of first vowels in general was revealed in applying backness harmony in harmonic vowels. A significant effect of input backness showed that first front vowels led to fewer backness harmony adaptations, i.e. first back vowels contributed to more backness harmony words. In line with these findings, the first back vowels /o, u/ significantly increased instances of backness harmony words, as shown by the significant category first vowel input.

9.3.2 Rounding harmony

Analyses of the dependent variable RH in harmonic words included predictors first and second vowel input roundness, and first and second input height. Initial analyses of RH in harmonic words with all the vowels showed that due to the insufficient number of low vowels, releveling analyses were impossible to conduct. Therefore, final analyses contained high and high-mid vowels for the categories first and second input height, thus leaving it with two levels. Thus, the final data frame without low vowels in them contained 1,652 words including 836 words where rounding harmony was non-applicable, and 714 words (87.5%) that followed rounding harmony and 102 words (12.5%) that did not (from a total of 816 applicable words). Non-applicable to rounding harmony words are words that do not have rounded vowels in the input neither rounded vowels in the output (even from input unrounded vowels). The best model of RH contained the predictor first vowel input roundness, and an interaction between first and second input height, as well as including both random factors. The model showed that first unrounded vowels led to significantly fewer rounding harmony words than first rounded vowels (estimate = -2.2266, SE = 0.6917, $z = -3.219$, $p = 0.00129$). Figure 9.19 illustrates this tendency.

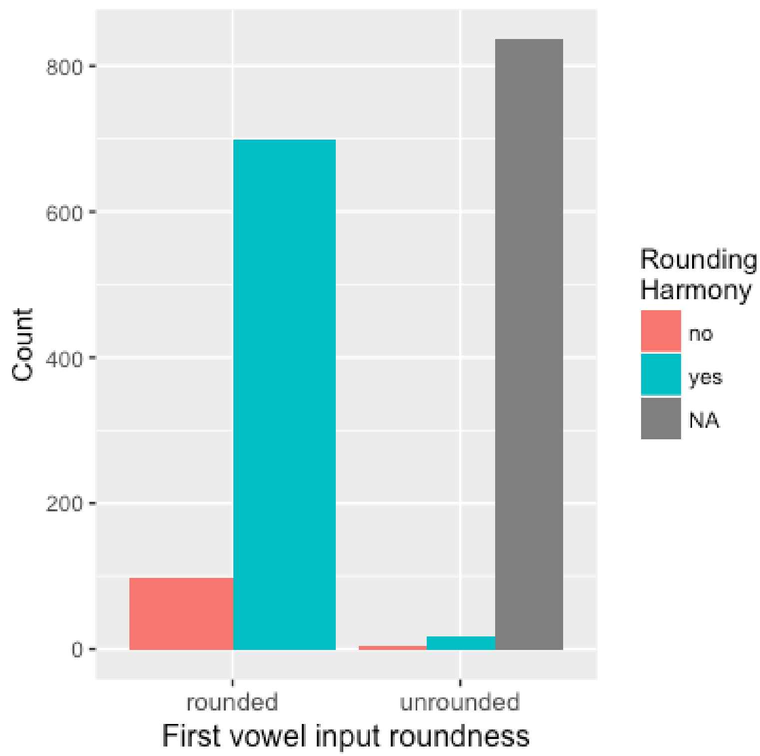

Figure 9.19 Output rounding harmony of harmonic words by first vowel input roundness

Figure 9.20 illustrates the significant interaction between first and second vowel input height that showed that when both vowels were high-mid, there were significantly more rounding harmony words than when only the first one was (estimate = 3.9635, SE = 0.8726, z = 4.542, p = 5.57e-06). Note that no significant main effect of first vowel input height was found within the best model (estimate = -0.8759, SE = 0.7337, z = -1.194, p = 0.23255). However, a main effect of second input vowel height suggested that second high-mid vowels generally resulted in productions of significantly fewer rounding harmony words than the high ones (estimate = -3.6049, SE = 0.6851, z = -5.262, p = 1.43e-07), as visible in Figure 9.20. Moreover, Figure 9.20 suggests a new interpretation of the main effect of second vowel input height that this effect is derived exclusively from second high-mid vowels combined with first high vowels.

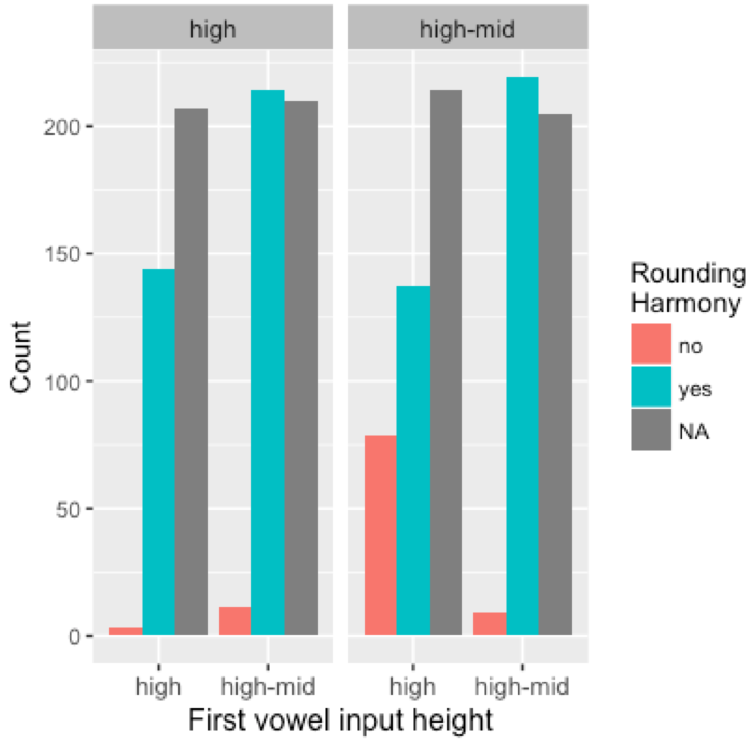

Figure 9.20 Output rounding harmony of harmonic words by first and second vowel input height. Groups of bars show first vowel height, panels show second vowel height

In a next step, analyses of vowel input were conducted revealing that there was an effect of individual vowels. The best model of RH in harmonic words showed that the significant predictor was first vowel input along with both random effects. The model suggested that the first vowel /o/ led to significantly more rounding harmony words compared to the reference level /a/ (estimate = 2.6723, SE = 1.1932, $z = 2.240$, $p = 0.0251$), as shown in Figure 9.21.

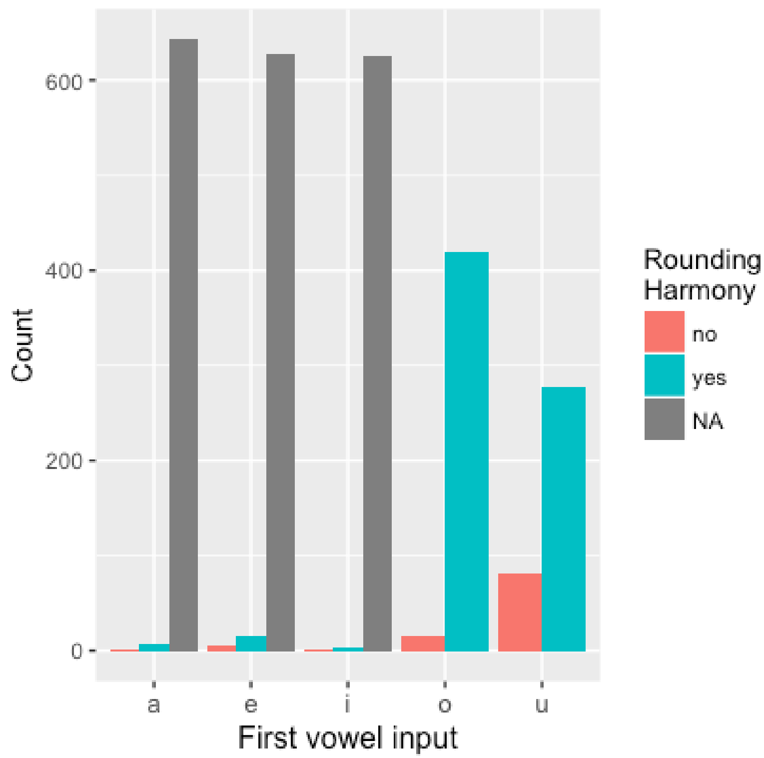

Figure 9.21 Output backness harmony by first vowel input of harmonic words

Figure 9.21 demonstrates that among all the vowels, the vowel /o/ had most instances of rounding harmony words, even compared to the other rounded vowel /u/. The unrounded vowels /a, e, i/ had very minimal occurrences of rounding harmony words. Releveling of the reference levels was carried out. The reference level /e/ confirmed a significant effect of the vowel /o/ in contributing to more rounding harmony words than /e/ (estimate = 2.9815, SE = 0.8956, $z = 3.329$, $p = 0.000871$). Furthermore, when /i/ was the reference level, any of the four vowels produced significant results: /a/ (estimate = -0.2301, SE = 1.7616, $z = -0.131$, $p = 0.896$); /e/ (estimate = -0.5394, SE = 1.5838, $z = -0.341$, $p = 0.733$); /o/ (estimate = 2.4422, SE = 1.4939, $z = 1.635$, $p = 0.102$); /u/ (estimate = 0.2879, SE = 1.4768, $z = 0.195$, $p = 0.845$). Next, with the reference level /o/, the vowels /a/, /e/, and /u/ (estimate = -2.1544, SE = 0.6294, $z = -3.423$, $p = 0.000620$) were inferior when compared to /o/ in regards to triggering words following rounding harmony, whereas /i/ did not significantly differ from /o/. The vowel /u/ as the reference level ultimately established an effect of first vowels /o/ in contributing to productions of significantly more rounding harmony words.

Finally, comparisons of the best phonological model with the model containing the category vowel input were not carried out due to the incongruent sizes of the datasets. As noted above, the best phonological model of RH in harmonic words was based on the dataset that eliminated low vowels, since the number of low vowels was low in the dataset of harmonic words, thus releveling of the category would not be achieved. The dataset of the best model of RH involving first vowel input as a factor was based on the larger dataset of harmonic words with low vowels included.

This section has shown that a significant driving feature of rounding harmony in harmonic words is first vowel input roundness, confirming that first rounded vowels significantly facilitated productions of rounding harmony words, as opposed to first unrounded vowels. A significant effect of second vowel input height suggests that high vowels produced significantly more rounding harmony words than high-mid vowels. In addition, interacted first and second vowel input height revealed that when first and second vowels were both high-mid, there were significantly more rounding harmony adaptations. Moreover, the significant predictor first vowel input revealed the vowels that were significant in productions of rounding harmony words: the first back rounded vowels /o/ and /u/ played a key role in productions of significantly more rounding harmony words.

9.4 Faithfulness to backness and roundness features of input vowels

This section presents analyses of faithfulness of output vowels to the input vowels' backness and roundness features. For these analyses, each vowel is regarded as a data point, as I reshaped the wide-format data frame of the production task into long-format data (Wickham, 2007). The data on which the models of faithfulness to backness and roundness were based on were input disharmonic words. Those words are particularly interesting for an analysis of faithfulness, since harmony in the output is also achieved from input disharmonic words, when one of the features wins (e.g. [+back] versus [-back]), as reported in Section 9.2. The subset of the data frame for testing faithfulness to backness was based on the 2,434 backness disharmonic words that yielded a total of 4,868 data points (two vowels per word). Analyses of faithfulness to roundness were based on 2,224 words (with a total of 4,448 data points) where the input did not follow rules of rounding harmony in Yakut.

The research question posed in this section is: What input predictors of vowels contribute to faithfulness to a) backness; and b) roundness? Based on the overall best models of vowel harmony, where input back/rounded vowels were significantly better at triggering harmony, I hypothesize that there will be more faithfulness to input back/rounded vowels than to the front/unrounded, respectively.

9.4.1 Faithfulness to backness

In the analyses of faithfulness to backness, four predictor categories were tested in modeling, presented in Table 9.3. The dependent variable faithfulness to backness has two levels: ‘yes’ means faithful to the input backness feature of the evaluated vowel, and ‘no’ implies unfaithfulness to the input backness feature.

Table 9.3 Predictors of faithfulness to backness and their levels

Predictor	Assigned level	# of levels	Levels
syllable	individual vowel	2	first vowel; second vowel.
stress	individual vowel	2	no; yes.
backness	individual vowel	2	back; front.
word type	whole word	3	borrowed; nonce; un-borrowed.

The best model of faithfulness to backness had three significant interaction pairs: syllable and backness, backness and stress, and syllable and word type, and the random effects participant and Russian input word. A significant main effect of syllable revealed that second vowels were significantly less faithful to backness, as opposed to first vowels (estimate = -2.25751, SE = 0.20141, z = -11.208, p = <2e-16). A significant main effect of backness showed that front vowels also tended to be significantly less faithful to backness than back vowels (estimate = -1.82770, SE = 0.21272, z = -8.592, p = <2e-16). However, the negative effect (i.e. less faithfulness to backness) for both predictors was weaker, when front vowels were in second syllables than in first syllables, and second syllables contained front vowels than back ones, based on the significant interaction (estimate = 0.81887, SE = 0.28469, z = 2.876, p = 0.004023), see Figure 9.22. The interpretation of the interaction is that the difference between back and front vowels with respect to faithfulness to backness became smaller in second syllables than in first syllables. Specifically, out of a total of 4,868 vowels, 1,106 back vowels (91%) in first syllables were faithful to their backness feature, and 826 back vowels (68%) faithfully preserved their backness feature in second syllables. In turn, faithfulness to the backness feature was observed among 693 front vowels (57%) in first syllables, and among 468 front vowels (38%) in second syllables.

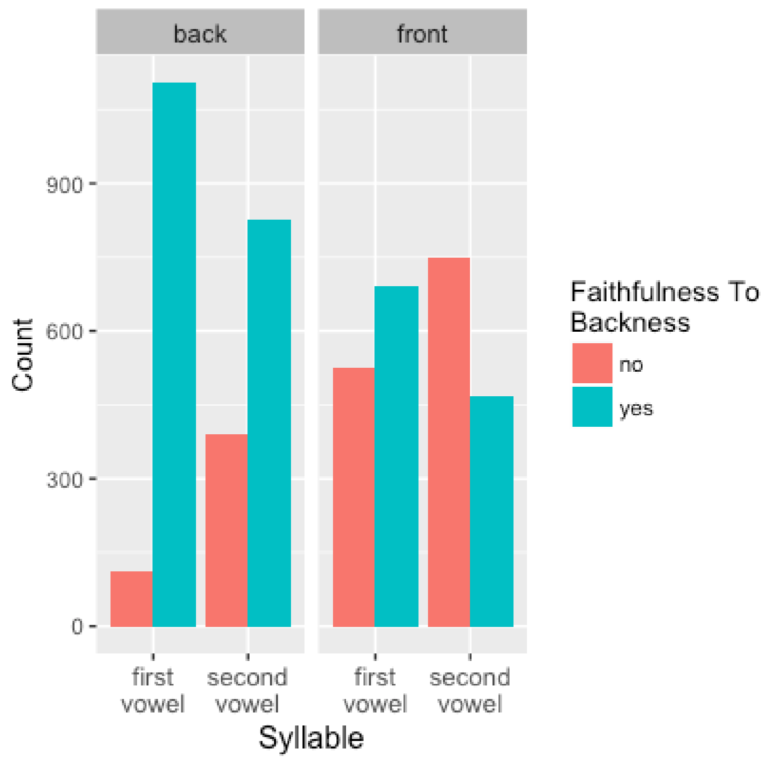

Figure 9.22 Faithfulness to backness by syllable and backness

Furthermore, a significant main effect of stress showed that compared to unstressed vowels, stressed vowels were significantly more faithful to backness (estimate = 0.50802, SE = 0.16699, z = 3.042, p = 0.002348). As shown above, front vowels had a negative effect in predicting faithfulness to backness. In contrast, stressed vowels as predictors had a positive effect. A significant interaction of backness and stress determined that when front vowels were stressed, they were significantly less faithful to backness (estimate = -0.73602, SE = 0.28199, z = -2.610, p = 0.009051), as seen in Figure 9.23. The significant interaction shows that the effect of stressed vowels in contributing to more faithfulness to backness weakens when front vowels are stressed as opposed to back vowels. In turn, a negative effect of front vowels in leading to significantly less faithfulness to backness is stronger when they are stressed than unstressed.

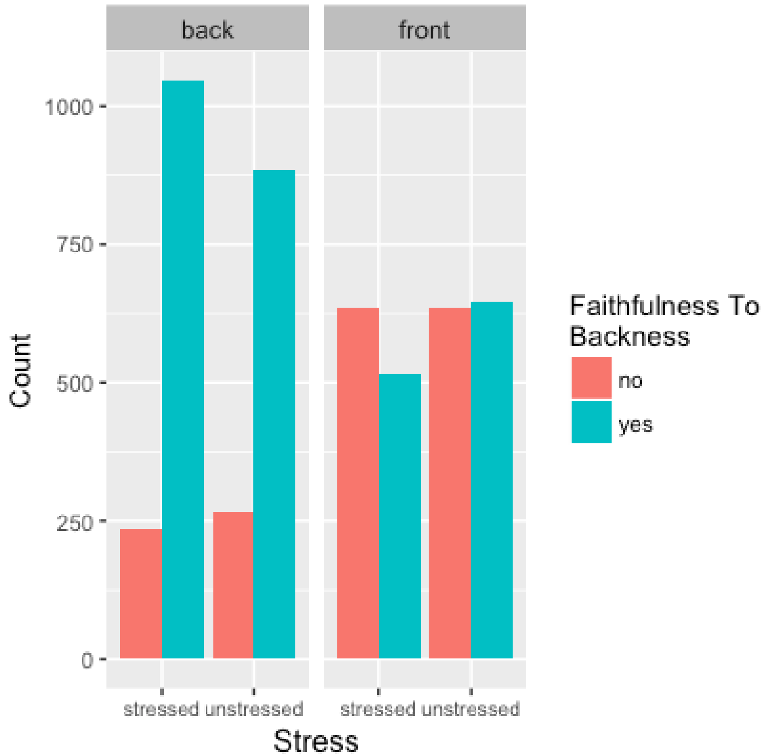

Figure 9.23 Faithfulness to backness by stress and backness

Finally, vowels in un-borrowed words were marginally more faithful to backness compared to vowels in borrowed words (estimate = 0.36523, SE = 0.20345, z = 1.795, p = 0.072615), as seen in Figure 9.24. Furthermore, releveling of word type to 'nonce'[41] showed that vowels in un-borrowed words displayed marginally less faithfulness to backness (estimate = 0.32669, SE = 0.19466, z = 1.678, p = 0.09330). That is, there an insignificant positive effect for un-borrowed and nonce words in contributing to faithfulness to backness. Recall that second vowels have a negative effect, as they lead to less faithfulness to backness. However, the negative effect of second syllable vowels weakens for nonce and un-borrowed words. Specifically, a significant interaction between syllable and word type shows that vowels in nonce (estimate = 0.98225, SE = 0.17499, z = 5.613, p = 1.99e-08) and un-borrowed (estimate = 0.68161, SE = 0.17945, z = 3.798, p = 0.000146) words in second syllables led to significantly more faithfulness to backness than vowels in borrowed words in second syllables. Releveling of the category[42] to 'nonce' confirmed that borrowed words' vowels in second syllables were significantly less faithful to backness and vowels

[41] Releveling of the reference level of the category 'word type' to 'un-borrowed' did not converge.
[42] See footnote 41 above.

in un-borrowed words were only marginally less faithful to the backness feature (estimate = -0.30064, SE = 0.17265, z = -1.741, p = 0.08163) than second vowels in nonce words. It shows that the marginal positive effect in contributing to more faithfulness among nonce and un-borrowed words, as compared to borrowed words, strengthens in second syllables than in first syllables.

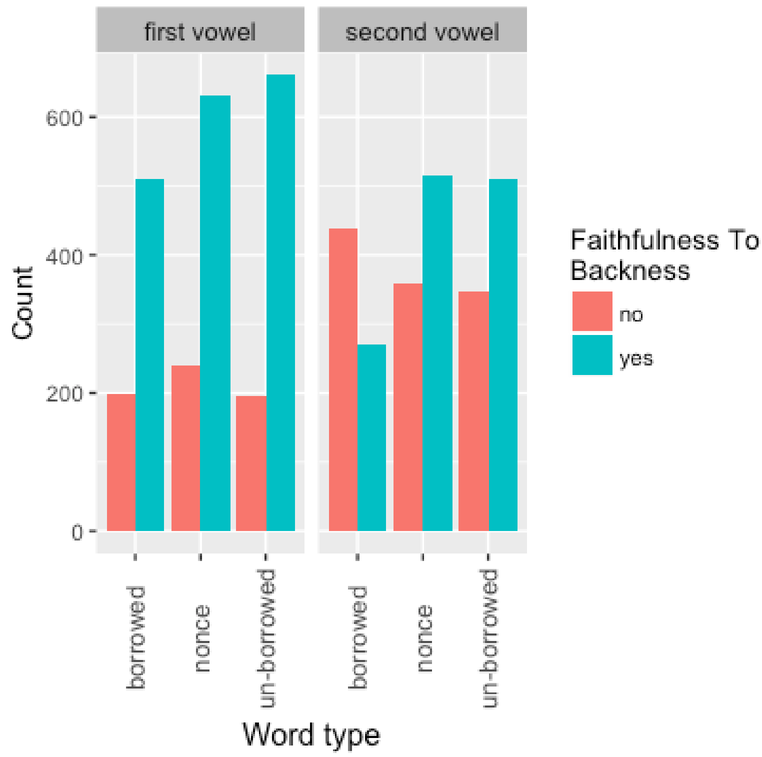

Figure 9.24 Faithfulness to backness by word type and syllable

To sum up, results of the best model of faithfulness to backness suggest that syllable, stress, and word type play a significant role in facilitating faithfulness of output vowels to the backness feature of input vowels. Namely, front vowels overall were less faithful to backness compared to back vowels, however, their faithfulness to backness increased in second syllables. Moreover, the negative effect of front vowels in leading to less faithfulness to backness strengthened when front vowels were stressed, and a positive effect in leading to more faithfulness among stressed vowels weakened with front vowels. Finally, a significant interaction between word type and syllable showed that vowels in second syllables in un-borrowed and nonce words were more faithful to backness than vowels in borrowed words in second syllables. This finding indicates that faithfulness to backness among vowels in borrowed words decreased specifically in second syllables.

9.4.2 Faithfulness to roundness

Models of faithfulness to roundness tested five independent predictors. That is, in addition to the three predictors syllable, stress, and word type presented in Table 9.4, two predictors were included, shown in Table 9.4:

Table 9.4 Predictors of faithfulness to roundness and their levels

Predictor	Assigned level	# of levels	Levels
roundness	individual vowel	2	rounded; unrounded.
height	individual vowel	2	high; non-high.

The category height distinguishes the vowel height in two broad categories: high and non-high. The level high codes the high vowels /i, u/, and the level non-high comprises the high-mid vowels /e, o/ and the low /a/, respectively. Note that unlike models of faithfulness to backness, the ones testing the dependent variable faithfulness to roundness had three random factors: participant, Russian input word, and input vowel, as including an additional random factor improved modeling analyses of faithfulness to roundness. That is, the latter random effect is an item random factor of the five input vowels.

The best model of faithfulness to roundness had three significant interactions: syllable and height, stress and roundness, and stress and height. A significant main effect of syllable suggested that vowels in second syllables were more faithful to roundness than in first syllables (estimate = 1.0114, SE = 0.3110, z = 3.253, p = 0.001144). Note that there was no significant main effect of height, suggesting that non-high vowels insignificantly contributed to more faithfulness to roundness than high ones (estimate = 0.6136, SE = 1.7693, z = 0.347, p = 0.728737). Thus, both predictors had a positive effect, and height was not a significant predictor. A significant interaction of syllable and height showed that when non-high vowels were in second syllables, they were significantly less faithful to roundness (estimate = -1.8037, SE = 0.4358, z = -4.139, p = 3.50e-05), as shown in Figure 9.25. That is, the insignificant positive effect of non-high vowels in contributing to more faithfulness to roundness than high ones weakens in second syllables, as opposed to first syllables.

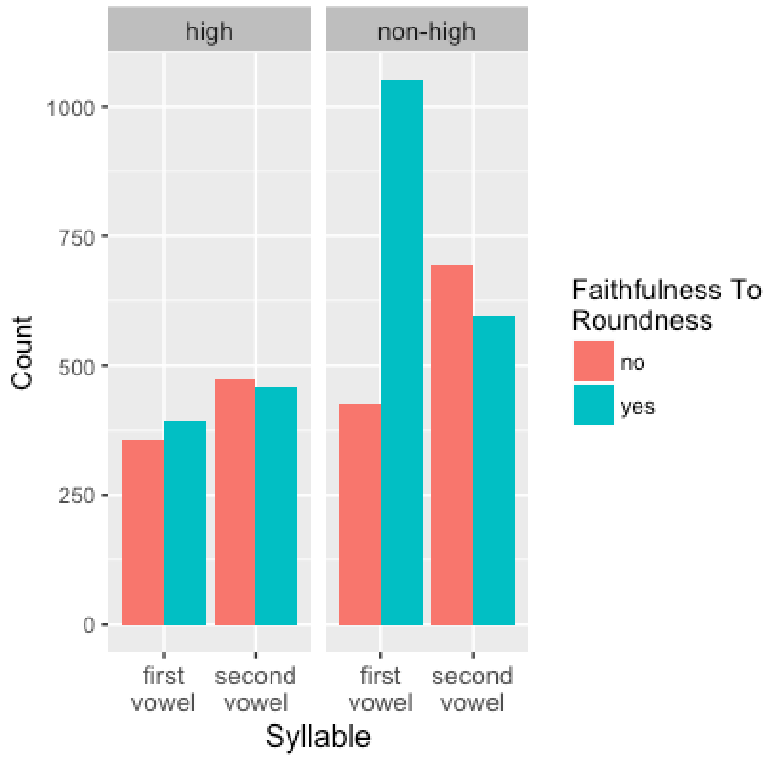

Figure 9.25 Faithfulness to roundness by syllable and height. Groups of bars show first vowel backness, panels show second vowel backness

Furthermore, significant main effects of stress and roundness show that stressed (estimate = 1.6646, SE = 0.4308, z = 3.864, p = 0.000112) and unrounded (estimate = 9.0834, SE = 1.7961, z = 5.057, p = 4.25e-07) vowels were significantly more faithful to roundness than unstressed and rounded ones, respectively, as visible in Figure 9.26. Hence, the significant interaction between stress and roundness revealed that both effects were weakened when combined (estimate = -4.2689, SE = 0.7401, z = -5.768, p = 8.01e-09), this tendency is presented in Figure 9.26. As shown in Figure 9.26, unrounded vowels in general were more faithful to the roundness feature than rounded vowels, but when stressed, unrounded vowels became significantly less faithful. To be precise, out of a total of 2,010 unrounded vowels, 903 unrounded stressed vowels (96%) were faithful to roundness, as opposed to 1050 unrounded unstressed vowels (98%); and the minority of 24 unstressed (2%) and 33 stressed (4%) unrounded vowels did not faithfully preserve the roundness feature. Therefore, the positive effect of unrounded vowels weakened in stressed positions compared to unstressed ones. And weakening of the stressed vowels' positive effect occurred with unrounded vowels that with rounded ones: Notice that the difference between stressed and unstressed rounded vowels is much larger than the difference between stressed and unstressed unrounded vowels.

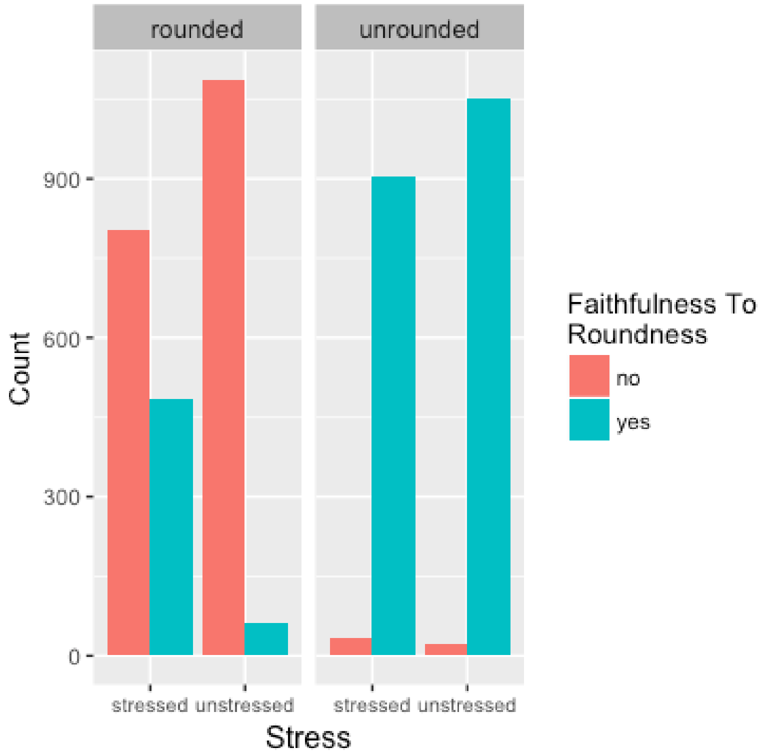

Figure 9.26 Faithfulness to roundness by stress and roundness

Finally, as visible in Figure 9.27, a significant interaction of stress and height showed that the positive effects of both predictors (although the main effect of height was insignificant) became stronger when combined (estimate = 2.1122, SE = 0.4269, z = 4.948, p = 7.50e-07). These results suggest that stressed non-high vowels were more faithful to roundness than unstressed non-high vowels, and stressed vowels were more faithful when they were non-high vowels as opposed to high ones.

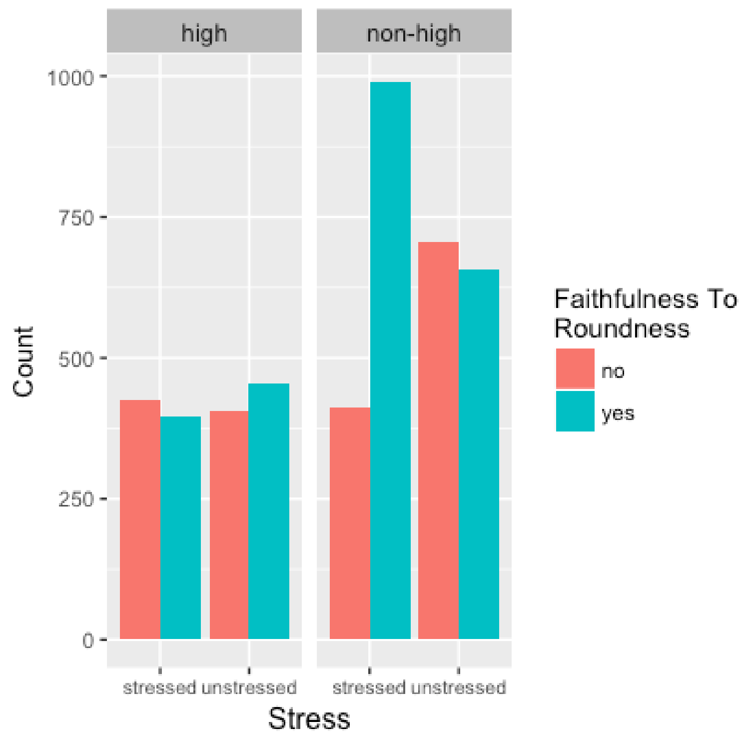

Figure 9.27 Faithfulness to roundness by stress and vowel height

In summary, the vowel categories that predict faithfulness of vowels to the roundness feature are: height, syllable, roundness, and stress, as shown by the significant interactions between the categories. Unlike the best model of faithfulness to backness, in models of faithfulness to roundness word type was not significant. Overall, vowels in second syllables, stressed, and unrounded vowels, respectively, tended to be faithful to the roundness feature. However, a significant interaction between syllable and height showed that non-high vowels in second syllables were less faithful to roundness than in first syllables. Significant interactions between stress and height and roundness, respectively, revealed that stress facilitated faithfulness to roundness for non-high vowels, and had a stronger positive effect of inducing faithfulness for rounded than for generally faithful unrounded vowels.

9.5 Summary and discussion

Results of the analyses of the ten tested phonological predictors of the dependent variables BH, RH, and YLA established that the categories vowel sharedness, vowel reduction and input stress were not significant in adaptations of Russian input words. Significant main effects of the predictor word type showed that nonce and un-borrowed words adapted and followed backness harmony, rounding harmony, and Yakut-like adaptation less than borrowed words (i.e. established loanwords).

As for the phonological predictors of vowel quality, the general tendency is that first and second front vowels led to worse adaptations of backness harmony, rounding harmony and Yakut-like adaptation than back vowels. Russian input front vowels are all unrounded, and all the input back vowels are rounded, meaning that particularly rounding harmony was triggered by the rounded vowels in the input. These results indicate that of all the phonological input predictors associated with vowel features, especially input backness (and roundness) played a key role in harmonization. As front vowels were worse triggers of harmony compared to back vowels, I summarize that the presence of back vowels in input words induced more application of vowel harmony in adaptation. Regarding the quality of individual vowels, it is shown that the first syllable back rounded vowels /o,u/ were particularly strong in triggering rounding harmony in the overall best model and BH in backness harmonic words, and the first rounded back vowel /o/ was superior in triggering most productions of rounding harmony words in the input harmonic words.

In disharmonic Russian input words, input height was significant in adaptations of backness harmony and rounding harmony. Specifically, the only Russian low vowel /a/ generally increased productions of harmonic adaptations of backness harmony in first and second syllables and for rounding harmony in second syllables.

Adaptations of backness harmony and rounding harmony within backness harmonic words, however, was contingent on input backness/roundness. Generally, both backness harmony and rounding harmony were adapted worse when harmonic input words had first front/unrounded vowels than when they contained back/rounded vowels in initial syllables. However, better adaptations of rounding harmony occurred when both vowels were high-mid. Moreover, the first vowels /o, u/ significantly increased adaptations of backness harmony and /o/ increased adaptations of rounding harmony in harmonic words.

The results of the overall best models show the overarching tendencies with respect to predictors of BH, RH, and YLA More harmony was applied in borrowed words (i.e. established loanwords), as opposed to nonce and un-borrowed words. Moreover, front unrounded vowels in either of the syllables triggered less harmony than back rounded vowels, however, when both vowels in the input were front, this led to more vowel harmony words. This finding suggests that feature sharedness between segments in the input word is generally a better trigger of vowel harmony application, which is also shown by better application of rounding harmony in harmonic words with two high-mid vowels. An overall tendency for application of vowel harmony in disharmonic words is shown to be contingent on input height: specifically, non-high vowels trigger better BH and rounding harmony application. In contrast, in input harmonic words, high vowels were better at triggering rounding harmony.

Furthermore, analyses of faithfulness of vowels to backness and roundness showed that front, second, and unstressed vowels were generally less faithful to the backness features than back, first, and stressed vowels, respectively. Moreover, stress (which is a salient feature) did not facilitate better faithfulness among front vowels. A significant interaction between word type and syllable showed an interesting tendency for vowels in nonce and un-borrowed words to be faithful to the backness feature in second syllables as opposed to vowels in borrowed words. This finding points out an overall unfaithfulness to input vowels' backness features in second syllables as opposed to first syllables among borrowed words, whereas on-line adaptations of vowels in nonce and un-borrowed words tended to faithfully preserve the backness feature even in second syllables. More faithfulness of vowels to the roundness feature was observed among second, stressed, and unrounded vowels than among first, unstressed, and rounded ones, respectively. Second syllable non-high vowels were unfaithful to roundness in the majority of realizations, showing that second syllable position negatively affected generally faithful non-high vowels. In addition, stressed non-high vowels were more faithful to the roundness feature. In sum, the preservation of the input backness and roundness features among input stressed vowels interacted with several factors shows that stress frequently, but not always, led to greater faithfulness.

Finally, model comparisons between phonological models and the ones including vowel input confirmed that vowel harmony in general in Yakut is driven by phonological factors, rather than by the quality of the individual input vowels. Analyses revealed that several times there were effect of individual vowels, however, their results were the same as the models' results with more abstract features as predictors. Precisely, the phonological input features backness (roundness) and height were crucial in the application of vowel harmony in Russian loanwords into Yakut.

Chapter 10: Adaptation of input stressed vowels

Analyses of vowel adaptations in Section 8.2 showed that stressed Russian vowels were predominantly adapted as either long vowels or diphthongs in Yakut. In line with previous research (see Dyachkovskiy, 1962; Sleptsov, 1964), the general pattern in participants' adaptations of stressed vowels was that Russian stressed high-mid vowels /e, o/ tended to be adapted as diphthongs and high /i, u/ and low /a/ vowels tended to adapt as long vowels in Yakut. In this dissertation, I will frequently refer to the adaptation and mapping of stressed input vowels as diphthongs as 'diphthongization' and as long vowels as 'lengthening'. The research question posed in this chapter is: How are stressed vowels adapted in Yakut? I hypothesize, based on the previous studies by Dyachkovskiy (1962) and Sleptsov (1964), that the following tendencies in stressed vowel adaptations are significant: stressed high-mid vowels become diphthongs and high and low vowels are realized as long vowels in adaptations.

To test this hypothesis, the category 'stressed vowel adaptation' was created in the data frame where adaptations of stressed vowels were categorized by types. Thus, four types of the ways stressed vowel adaptations were established and coded, for a total of 5,160 words: lengthening (56.7%), diphthongization (23.5%), short vowels (15.3%), and retention of Russian stress (4.5%). These categories were used to form four sets of dependent variables to reveal input predictors that affected the ways stressed vowels were adapted: whether they were lengthened or not, diphthongized, retained Russian stress or not, and were realized as short vowels or not, respectively. That is, the coding for each dependent variable was binary that included coding of the 'other' levels that contained all the other three types of adaptations different from the type of stressed vowel adaptation indicated by the dependent variable (e.g., 'lengthening' and 'other'). Two sets of analyses using binomial linear mixed-effects modeling were carried out for each of the dependent variables: models involving the phonological vowel input predictors 'input backness'[43] (levels: 'back'; 'front') and 'input height' (levels: 'high'; 'high-mid'; 'low') (hereafter, 'phonological models') and models containing the category 'vowel input' (levels: /a/, /e/, /i/, /o/, /u/), instead of having the two separate phonological categories. Note that just like in Chapter 9, the models are called 'phonological' to refer to the distinction of vowel quality by features (e.g.,

[43] Since the category 'input roundness' codes the same information as the category 'input backness' (because all Russian back vowels are rounded, and all Russian vowels are unrounded), I do not test the 'input roundness' category here.

input height/backness), whereas the models involving vowel input comprise phonological (and phonetic) features all at once. Three other input predictors were included in both types of modeling: word type (levels: 'borrowed', 'nonce', 'un-borrowed'), harmony (levels: 'disharmonic'; 'harmonic'), and syllable position (levels: 'final'; 'initial') including the random factors 'participant' and 'Russian input word'. Note that the category 'harmony' concerns exclusively backness harmony in the Russian input words. This category was included to test whether there was a harmony effect in the input words that affected adaptations of stressed vowels. For each dependent variable, both types of best models (based on phonological predictors vs. individual vowels) were compared with each other using the ANOVA function to arrive at the best or the most optimal simpler model.

Since height of Russian vowels was shown to be crucial in the way stressed vowels are realized in Yakut (e.g., as seen in Dyachkovskiy, 1962; Sleptsov, 1964), I determined four types of stressed vowel adaptations by vowel input height, as displayed in Figure 10.1.

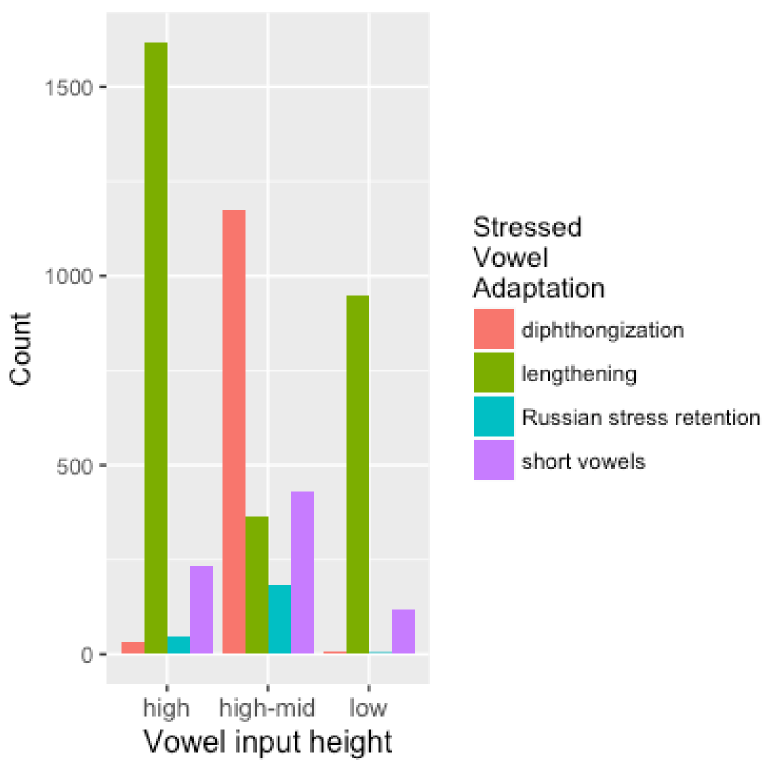

Figure 10.1 Adaptation of stressed vowels by vowel input height

A general pattern is that high and low vowels tended to lengthen, whereas high-mid vowels diphthongized in most adaptations. By contrast, high-mid vowels displayed more variation in their adaptation. Sections 10.1 to 10.4 below discuss if these differences illustrated in Figure 10.1 are statistically significant and I present specific vowel input predictors at play in adaptions of stressed vowels.

10.1 Lengthening

Lengthening was the most common way of stress adaptation, i.e., stress in a total of 2,927 words was realized as long vowels in Yakut (56.7%). The best model was the phonological model which was significantly better than the model with vowel input as a significant predictor (p = <2e-16, χ^2 = 5.3063). The best phonological model included input height and word type as significant predictors. No interaction was found. The model included both random factors participant and Russian input word. A significant effect of input height with the reference level 'high' revealed that high-mid vowels lengthened significantly less frequently (estimate = -4.0681, SE = 0.2368, z = -17.182, p = <2e-16), and low vowels lengthened only marginally more often than high vowels (estimate = 0.5262, SE = 0.2918, z = 1.803, p = 0.0714). To test differences between vowel heights, releveling of the category was done to establish a specific vowel height that contributed to more lengthening. Thus, when the reference level was 'low', the model indicated that high-mid vowels lengthened significantly less often than low vowels (estimate = -4.5943, SE = 0.2946, z = -15.594, p = <2e-16), and high vowels lengthened only marginally less often than low vowels. The reference level 'high-mid' determined that both high and low vowels lengthened significantly more often as opposed to high-mid vowels. Figure 10.2 demonstrates that high-mid vowels were least often adapted with lengthening in comparison to high and low vowels.

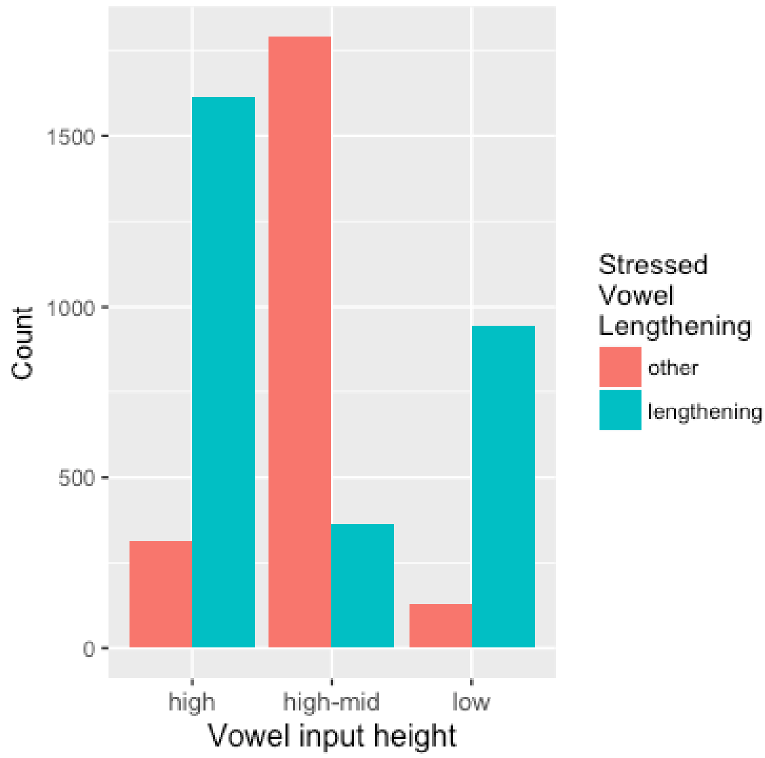

Figure 10.2 Output lengthening of stressed vowels by vowel input height

The category 'word type' with the reference level 'borrowed' showed only marginal effects, as vowels in nonce words had a weaker tendency to be lengthened compared to vowels in borrowed words (estimate = -0.5093, SE = 0.2601, z = -1.958, p = 0.0502). Releveling of the reference level to 'nonce', however, showed significant results: un-borrowed words' vowels lengthened significantly more often than vowels in nonce words (estimate = 0.8227, SE = 0.2441, z = 3.370, p = 0.000751), and vowels in borrowed words only marginally lengthened more frequently as opposed to nonce words' vowels. Switching to the reference level 'un-borrowed' showed that as opposed to vowels in un-borrowed words, vowels in nonce words lengthened significantly less frequently. Figure 10.3 demonstrates that vowels in un-borrowed words underwent most lengthening in adaptation.

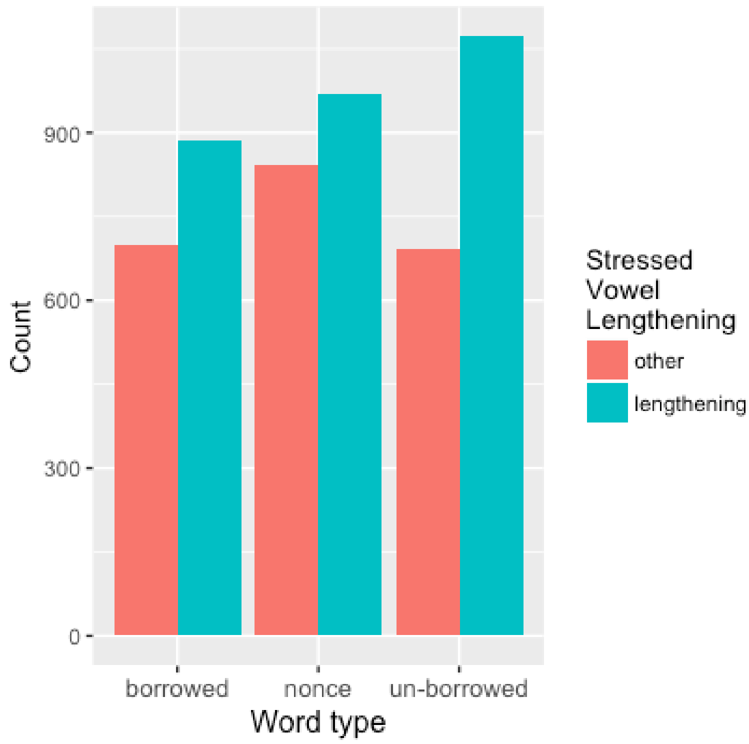

Figure 10.3 Output lengthening of stressed vowels by word type

Results of the dependent variable lengthening suggest that stressed high-mid vowels had the lowest instances of being lengthened in productions, unlike stressed high and low counterparts. In addition, word type also affected lengthening of stressed vowels, showing that stressed vowels in un-borrowed words tended to lengthen most frequently.

10.2 Diphthongization

Diphthongization of stressed vowels occurred in 1,214 words (23.5%), and it was the second most common way of stress adaptations after lengthening. The best model of the dependent variable 'diphthongization' was a simpler phonological model as compared to the model that had vowel input as a significant predictor ($p = 0.4157$, $\chi^2 = 1.7555$). Thus, the best phonological model of diphthongization had only input height as a significant predictor, and included the random factors participant and Russian input word. With the reference level 'high' the model showed that high-mid vowels diphthongized significantly more often as compared to high vowels (estimate = 5.8783, SE = 0.4399, z = 13.362, p = <2e-16) and low vowels only marginally diphthongized less often than high vowels (estimate = -1.2416, SE = 0.6867, z = -1.808, p = 0.0706), as illustrated in Figure 10.4.

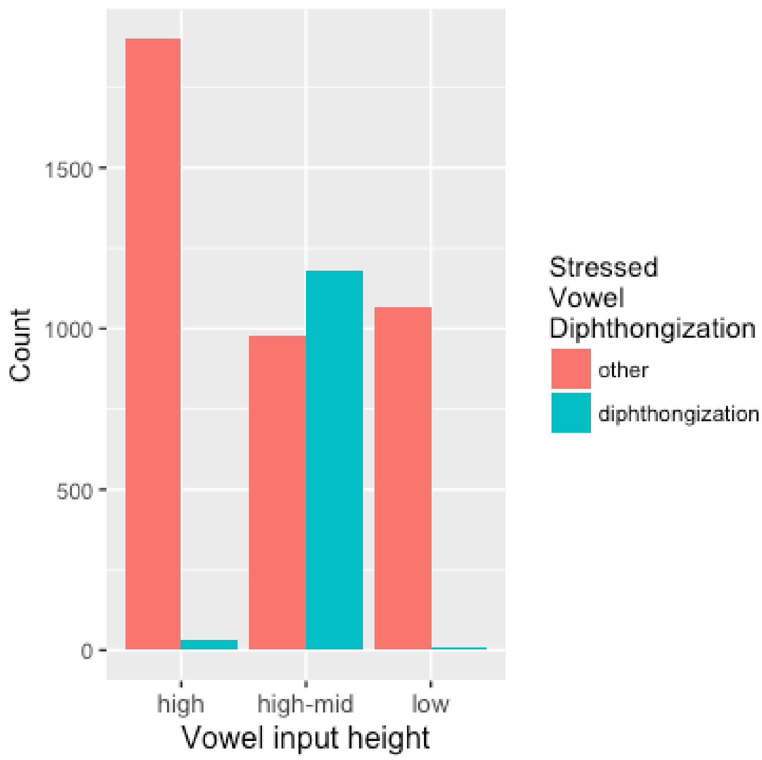

Figure 10.4 Output diphthongization of stressed vowels by vowel input height

Releveling of the significant category's reference level to 'low' confirmed that high-mid vowels diphthongized significantly more frequently than low vowels (estimate = 7.1199, SE = 0.6767, z = 10.521, p = <2e-16) and high vowels only marginally turned into diphthongs more often than low vowels. Next, a releveled reference level 'high-mid' showed that both high and low vowels diphthongized significantly less frequently compared to high-mid vowels.

Results of analyses of the dependent variable diphthongization confirm that of all three levels of input height, only stressed high-mid vowels significantly underwent diphthongization most.

10.3 Adaptation of stress as short vowels

A less common adaptation of stressed vowels was their realization as short (787 words in total, i.e. 15.3%). A model with the added category 'vowel input' as a predictor did not improve the zero model without predictors (p = 0.1096, χ^2 = 7.5491). Therefore, only phonological models were tested for the dependent variable 'short vowels'. The best model of short vowels had three significant predictors: word type, syllable position, and input height. No interaction was found between them. The model included the random factors participant and Russian input word.

A significant effect of the predictor 'word type' with the reference level 'borrowed' revealed that nonce words significantly contributed to adaptations of stressed vowels as short as opposed to vowels in borrowed words (estimate = 2.2074, SE = 0.3475, z = 6.352, p = 2.13e-10). Next, releveling of the reference level to 'nonce' determined that vowels in borrowed and un-borrowed (estimate = -1.6872, SE = 0.3115, z = -5.417, p = 6.06e-08) words adapted stressed vowels as short significantly less often than vowels in nonce words. Next, the reference level 'un-borrowed' showed that vowels in nonce words led to significantly more adaptations of stressed vowels as short vowels as opposed to vowels in un-borrowed words. Figure 10.5 shows the tendency for stressed vowels in nonce words to be adapted as short.

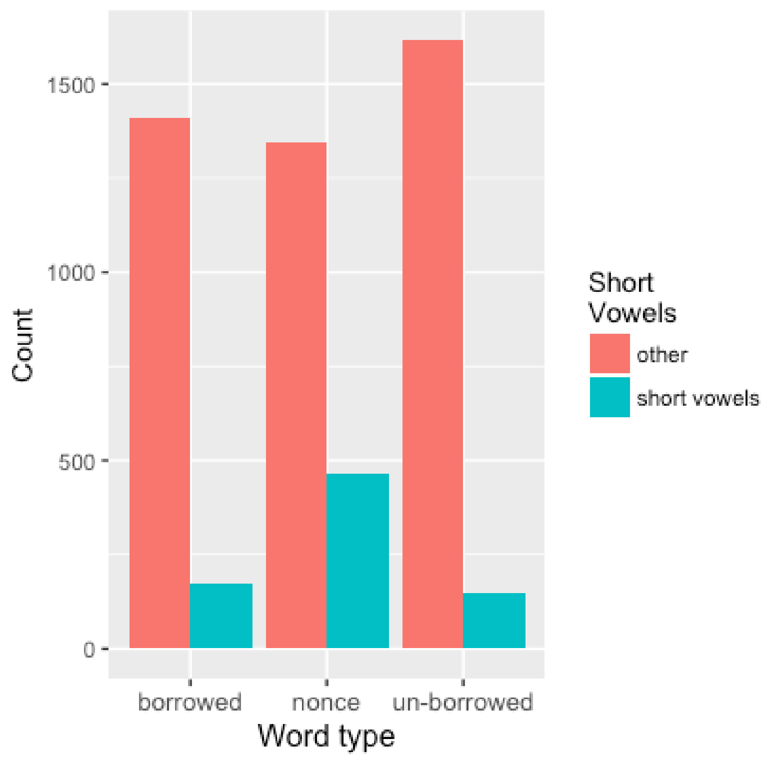

Figure 10.5 Output short vowels from stressed vowels by word type

A significant effect of syllable position confirmed that vowels in initial syllables had significantly fewer instances of adapted short vowels from stressed vowels than vowels in final syllables (estimate = -0.5530, SE = 0.2692, z = -2.054, p = 0.03996), as shown in Figure 10.6.

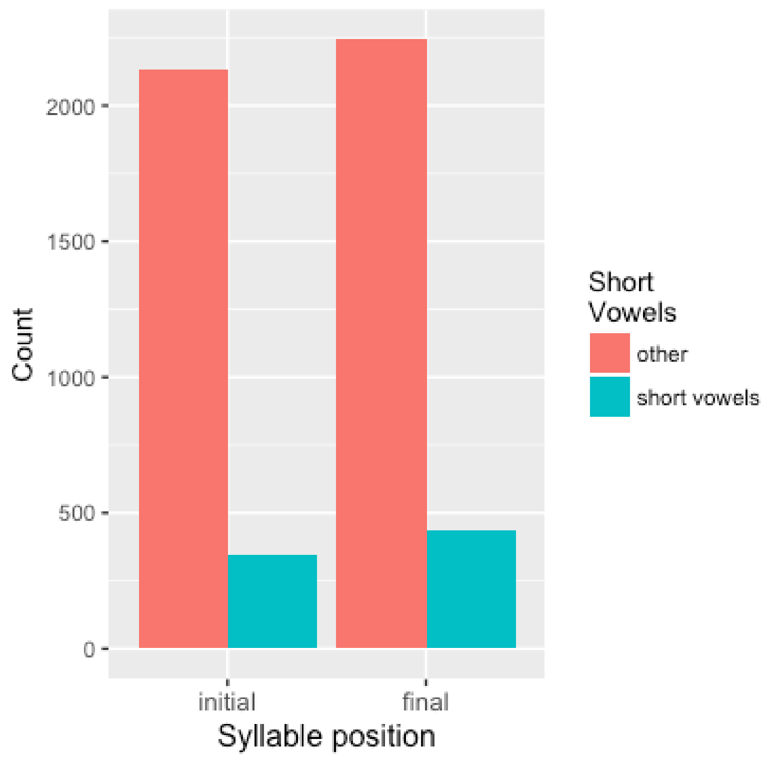

Figure 10.6 Output short vowels from stressed vowels by syllable position

Finally, a significant effect of vowel input height appeared to be significant in adaptations of stressed vowels as short. The category with the reference level 'high' showed that stressed high-mid vowels tended to be adapted as short more often unlike high vowels (estimate = 0.7878, SE = 0.2979, z = 2.644, p = 0.00819). Releveling of the reference level to 'low' yielded the same results suggesting that high-mid vowels were adapted as short vowels significantly more often than low vowels (estimate = 1.0071, SE = 0.3675, z = 2.740, p = 0.00614). In turn, the reference level 'high-mid' confirmed that both high and low vowels were adapted as short vowels significantly less often as compared to high-mid vowels. Figure 10.7 shows the tendency for high-mid vowels to have most instances when stressed vowels were adapted as short vowels.

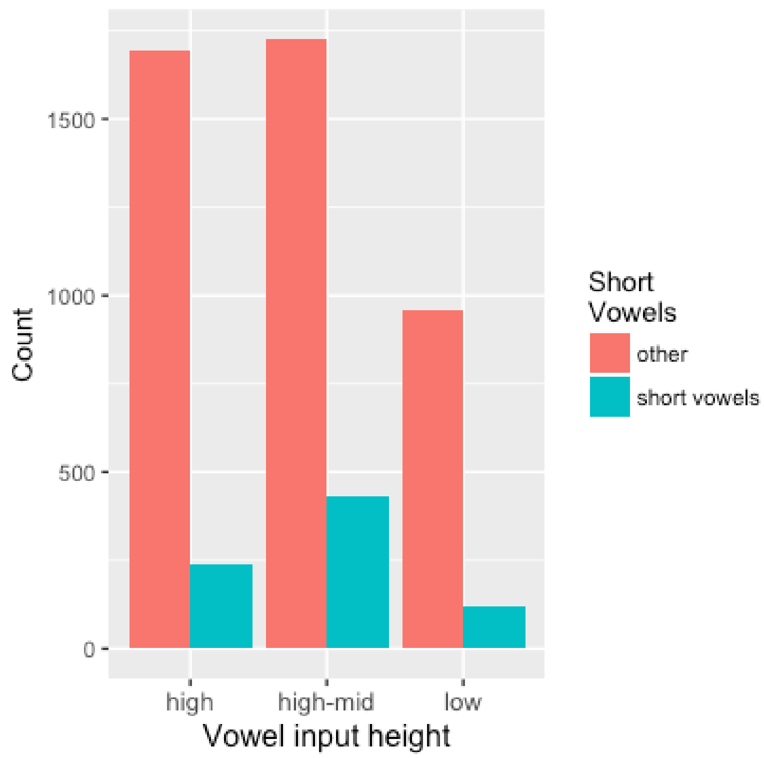

Figure 10.7 Output short vowels from stressed vowels by vowel input height

10.4 Retention of Russian stress

The last adaptation type of stressed vowels was retention of original Russian stress, that is, stress was imported in adaptations. This type of stressed vowel adaptation was the least common one compared to lengthening, diphthongization, and realizations as short vowels (a total of 232 words, which is only 4.5%). The best model of the dependent variable 'Russian stress retention' was a simpler phonological model. That is, the model with non-interacted significant predictors 'vowel input' and 'syllable position' was not significantly better than the phonological model (p = 0.6071, χ^2 = 0.9983). The best phonological model included input height and syllable position as significant predictors with no interaction between them and the random factors participant and Russian input word. A significant effect of input height when the reference level was 'high' revealed that high-mid vowels retained Russian stress significantly more often than high vowels (estimate = 1.8365, SE = 0.3263, z = 5.629, p = 1.81e-08). In contrast, low vowels retained Russian stress significantly less often as opposed to high vowels (estimate = -2.4991, SE = 0.7064, z = -3.538, p = 0.000404). Releveling of the category to 'low' showed that high and high-mid (estimate = 4.3356, SE = 0.6997, z = 6.197, p = 5.76e-10) vowels retained Russian stress significantly more frequently unlike low vowels. Furthermore, the reference level 'high-mid' confirmed that high and low vowels retained Russian stress significantly less often as compared to high-mid vowels. Figure 10.8 shows the tendency for stressed high-mid vowels to retain original Russian stress most often, unlike high and low vowels.

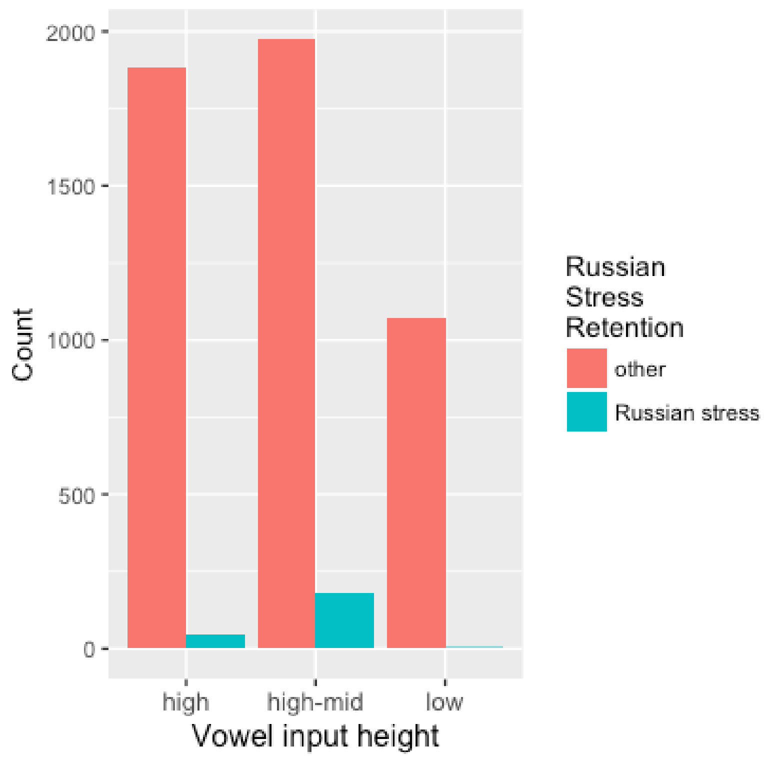

Figure 10.8 Output Russian stress retention by vowel input height

Furthermore, the model included a significant effect of syllable position, showing that stressed vowels in initial syllables retained Russian stress significantly less frequently compared to vowels in final syllables (estimate = -0.9240, SE = 0.3049, z = -3.030, p = 0.002445). Figure 10.9 shows fewer instances of retaining Russian stress when stressed vowels were in initial syllables.

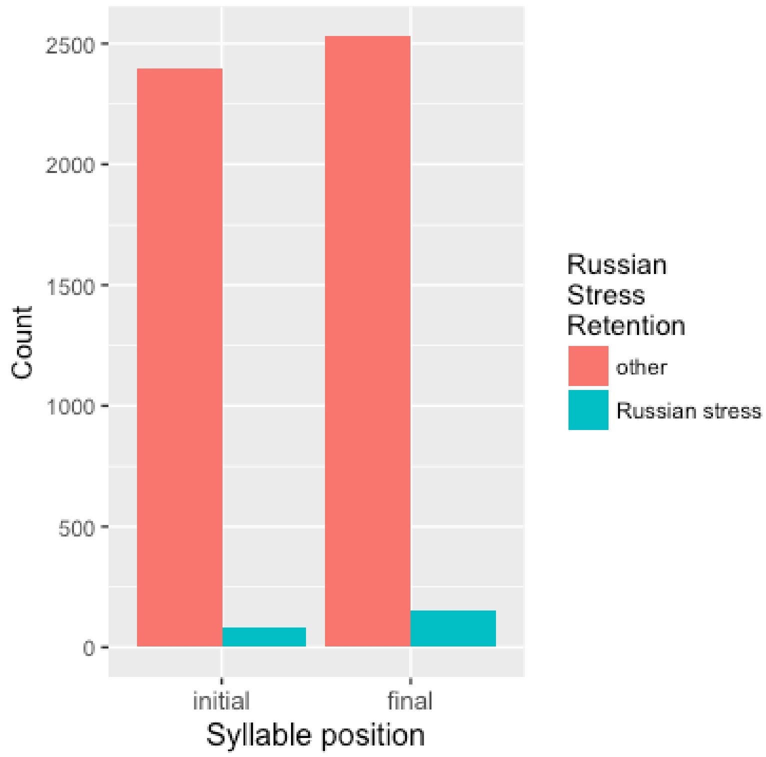

Figure 10.9 Output Russian stress retention by syllable position

Results of analyses of the dependent variable 'Russian stress retention' suggest that the tendency to retain Russian stress was most common for stressed high-mid vowels and stressed vowels in initial syllables rather than in final ones.

10.5 Summary and discussion

In sum, the analyses of the dependent variables Russian stress retention and short vowels revealed that when stressed vowels were produced as neither diphthongs nor long vowels, syllable position was significant in adapting them. Stressed vowels in final syllables were more susceptible not to be adapted as a diphthong or a long vowel, which are the most common stressed adaptation types. The results showed that stressed high-mid vowels had more variations in the ways they were adapted, and unlike high and low vowels, high-mid vowels displayed adaptations as short vowels or retentions of Russian stress more frequently. Word type also affected adaptations of stressed vowels as short vowels, as nonce words had most instances to adapting their stressed vowels as short.

A significant effect of word type was also found on vowel lengthening. Namely, there was more lengthening of stressed vowels among un-borrowed words, rather than in borrowed or nonce words. Furthermore, the hypothesis is confirmed that stressed high-mid vowels diphthongized significantly most often and stressed high and low vowels lengthened significantly most frequently. These findings are consistent with the previous findings on the role of vowel height in stressed adaptations (Dyachkovskiy, 1962; Sleptsov, 1964). Comparisons of phonological models and models with vowel input in their predictors showed that including the category vowel input instead of the two phonological categories input backness and input height did not make a model significantly better. That is, vowel input height is shown to be crucial in determining the type of stress vowel adaptations. Overall, participants behaved analogously in adapting stress as shown in established loanwords presented by Dyachkovskiy or Sleptsov. Moreover, there were no harmony effects to all the models, since stressed vowel adaptations were not contingent on whether the input words were harmonic in backness or not. It is noteworthy that lengthening and diphthongization of stressed vowels were not affected by syllable position, whereas it was significant in adaptations of stress as short vowels or retentions of Russian stress. This finding may be linked to the role of vowels in first syllables that could employ most common adaptation types of stressed vowels (i.e. lengthening and diphthongization) in a language with a rightward directionality of harmony spreading like Yakut.

Chapter 11: Phonological factors affecting ratings of Yakut nonce words

This section reports results of participants' ratings of 100 nonce Yakut words in audio files in the rating task that were rated on a scale from 1 to 5, '1' being the worst Yakut-like word, and '5' being the best Yakut-like word, focusing on the phonological factors of the Yakut nonce words. All 40 participants, including the three monolingual speakers, completed the rating task. Thus, the rating task's data frame consisted of a total of 4,000 ratings with 100 words for each of the 40 speakers. A research question posed is: What phonological factors of the vowels in the Yakut nonce words affected ratings? I hypothesize that the participants would rate words violating backness harmony (BH) and rounding harmony (RH) lower, and grammatical nonce words following BH and rounding harmony would be rated higher. Another hypothesis following from Chapter 10 on the phonological predictors driving harmony in production. That is, in the production task, participants produced more harmonic adaptations with back vowels (which are also rounded) rather than with front vowels (which are also unrounded). Hence, I hypothesize that participants would rate words containing back rounded vowels higher. The following nine phonological predictors of the Yakut nonce word ratings were tested using linear mixed-effects modeling: grammaticality, first and second vowel backness, first and second vowel height, first and second vowel length, and first and second vowel roundness. I demonstrate levels for each of the phonological categories in Table 11.1 below:

Table 11.1 Coding of the tested phonological categories

Predictor	# of levels	Levels
grammaticality	5	backness harmony (BH) violations; rounding harmony (RH) violations; grammatical backness harmony (BH); grammatical rounding harmony (RH); ungrammatical.
vowel backness	2	back; front.
vowel height	3	high; low; low-mid.
vowel length	3	diphthong; long; short.
vowel roundness	2	true (rounded); false (unrounded).

The category 'grammaticality' had five levels of both grammatical and ungrammatical words. The level 'BH violations' included words which vowels did not agree in backness, e.g., *tɛːba*. In turn, the 'RH violations' level concerned words that agreed in backness, like *mɛːtyŋ*, but had two kinds of violations of rounding harmony rules: a) unrounded vowels were followed by rounded vowels, e.g., *siːky*; b) high rounded vowels were followed by low rounded vowels, e.g., *kytœl*. The level 'grammatical BH' comprised words that agreed in backness and included only unrounded vowels within words, e.g., *biɛmir*, and the level 'grammatical RH' had words with rounded vowels in both or either of the syllables, with vowels following the RH rules, e.g., *bœːdyn* and *mɒːbɒ* (low rounded vowels followed by high and low rounded vowels); *tyʁyl* (high rounded vowels followed by high rounded vowels), and *tuːba* (high rounded vowels followed by low unrounded vowels). That is, words going under the 'grammatical RH' level also agreed in backness. Finally, the level 'ungrammatical' denoted violations of both BH and RH at the same time, that included words that also had rounded vowels in both or either of the syllables in them, like the word *tuɒsœχ*. Note that in the analyses presented in Section 11.1, the category 'grammaticality' was relevelled for the reference level 'ungrammatical'. Since Yakut has diphthongs, along with the quantity distinction between short and long vowels, the category 'vowel length' signified diphthongs as a separate level. All the predictors pertaining to phonological features of vowels, like vowel height, were in fact doubled, since features of both vowels were tested as predictors for the rating of each word. Random factors included in models of the rating task were 'Yakut nonce word' (hereafter, 'item') and 'participant'.

11.1 Results

The best model[44] of the rating task revealed that there was a significant interaction between the categories 'grammaticality' and 'second vowel backness'. In addition, the category 'first vowel

[44] Since violations of grammaticality of the nonce words in the rating tasks were organized separating well-formedness and ill-formedness of BH and RH, a second additional model involving separate categories 'RH' and 'BH' as predictors was computed. The category 'BH' included coding of agreement in backness within words. The category 'RH' had five levels: grammatical RH words, ungrammatical RH words, violations of RH in height, violations of RH in roundedness, and non-applicable words that had no rounded vowels in them. The best model showed significant effects of BH and RH, and a by-participant effect of RH and the random factor item. That model was compared to the best model of ratings reported in Section 11.1 using the ANOVA function, revealing that the model without distinctions of levels of the RH category and the added BH category was significantly better than the alternative model involving RH, BH, and second vowel height as significant predictors ($p = 0.0007639$, $\chi^2 = 16.836$). These results show that distinctions of the kinds of violations of RH were not significant in the ratings. Note that second vowel height did not produce a significant effect in the model with significant effects of RH and BH, although it significantly improved

roundness' appeared to be a significant predictor. As far as the random factors were concerned, a by-participant effect of 'grammaticality' (a random slope) was found along with the random factor item.

The significant interaction between grammaticality and second vowel backness showed that when words had BH violations and second vowels were front, participants rated them significantly higher than ungrammatical words with second front vowels (estimate = 0.8701, SE = 0.4210, t = 2.067). Similarly, the significant interactions showed that when the words had RH violations and second vowels were front, those words received significantly higher ratings as opposed to ungrammatical words with second front vowels (estimate = 0.8322, SE = 0.2855, t = 2.915). Figure 11.1 shows the effect of grammaticality on the ratings by second vowel backness.

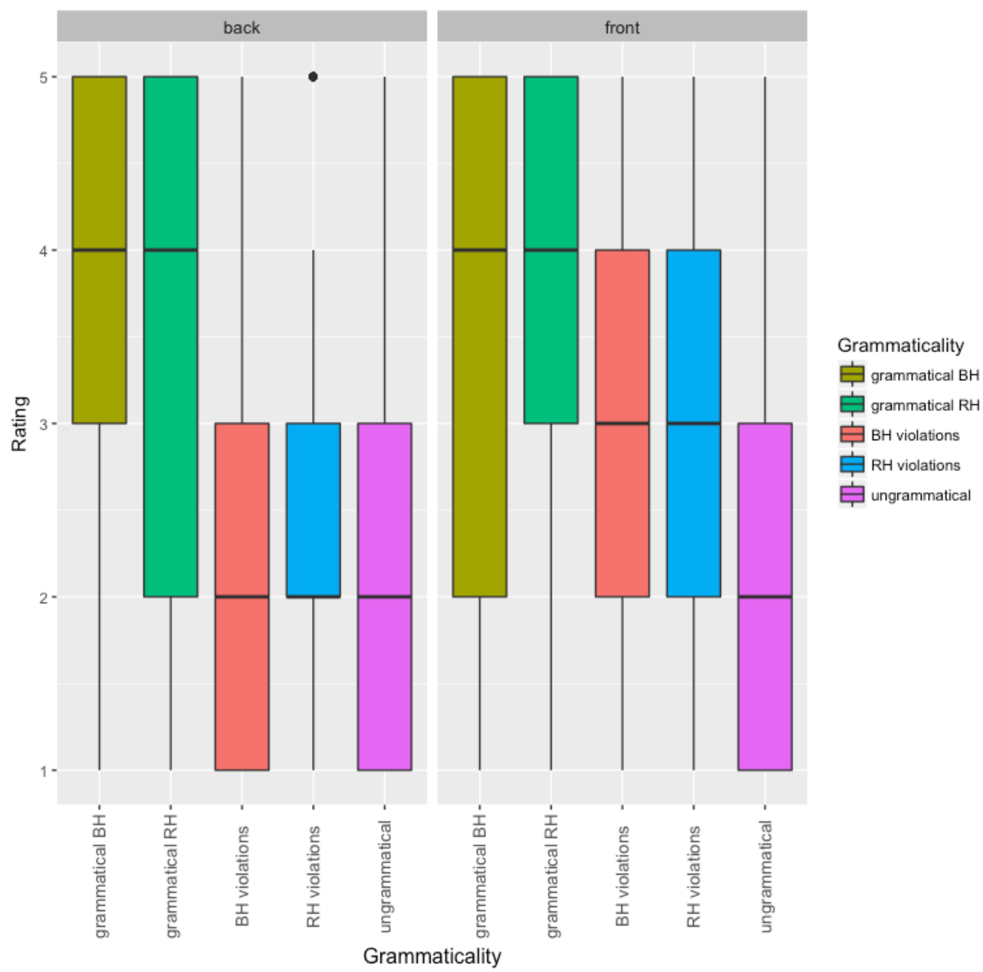

Figure 11.1 Ratings of nonce words by grammaticality and second vowel backness

the model fit, if compared to the model without second vowel height as a predictor (p = 0.004381, χ^2 = 10.861). By contrast, adding second vowel input height to the model reported in Section 11.1 produced only a marginal improvement in fit (p = 0.07867, χ^2 = 8.3781).

Furthermore, grammatical BH words were rated significantly higher than ungrammatical words (estimate = 2.3308, SE = 0.3209, t = 7.263); similarly, grammatical RH words received significantly higher ratings also compared to ungrammatical ones (estimate = 1.1400, SE = 0.2490, t = 4.578). Another grammatical category – RH violations – received overall significantly higher ratings as opposed to ungrammatical words (estimate = 0.5066, SE = 0.2208, t = 2.294).

Another significant predictor of the ratings was the category first vowel roundness, showing that words that had first rounded vowels got significantly higher ratings (estimate = 0.6508, SE = 0.1302, t = 4.998). Figure 11.2 illustrates this tendency.

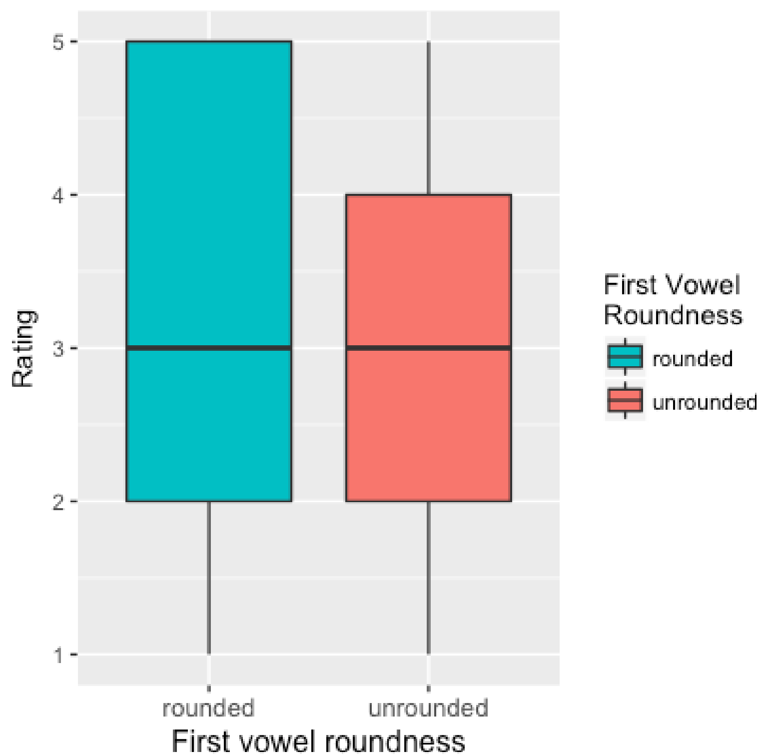

Figure 11.2 Nonce word ratings by first vowel roundness

In a next step, releveling of the category grammatical within the best model was carried out. When the reference level was ‘BH violations’, grammatical BH (estimate = 1.830000, SE = 0.316229, t = 5.787) and grammatical RH (estimate = 0.639236, SE = 0.305218, t = 2.094) words were rated significantly higher than BH violations. In addition, both grammatical BH words (estimate = -1.371794, SE = 0.434418, t = -3.158) and ungrammatical words with second front vowels received significantly lower ratings than BH violations with second front vowels.

Switching the reference level of grammaticality to 'RH violations' showed that grammatical BH (estimate = 1.824132, SE = 0.245503, t = 7.430) and grammatical RH (estimate = 0.633368, SE = 0.187821, t = 3.372) words received significantly higher ratings than RH violations. In turn, ungrammatical words (both BH and RH violations) were rated significantly lower as opposed to RH violations (estimate = -0.506632, SE = 0.220838, t = -2.294). Significant interactions between second front vowels and grammatical BH (estimate = -1.333877, SE = 0.304867, t = -4.375) and ungrammatical words received significantly lower ratings than RH violations with second front vowels.

The reference level 'grammatical BH' identified all four levels within the category grammaticality that were rated significantly lower than grammatical BH words: grammatical RH (estimate = -1.1908, SE = 0.2645, t = -4.502); BH violations (estimate = -1.8300, SE = 0.3162, t = -5.787); RH violations (estimate = -1.8241, SE = 0.2455, t = -7.430), and ungrammatical words (estimate = -2.3308, SE = 0.3209, t = -7.263). The reference level 'grammatical BH' also revealed that the following words with second front vowels that were rated significantly higher than grammatical BH words with second front vowels: BH violations, grammatical RH words (estimate = 0.9437, SE = 0.3170, t = 2.977), and RH violations.

Next, interesting results occurred after releveling the grammaticality category to the reference level 'grammatical RH'. That is, the three types of ungrammatical words which violate vowel harmony: BH violations; RH violations, and ungrammatical words were rated significantly lower as compared to grammatical RH words. Nevertheless, grammatical BH words were rated significantly higher than grammatical RH words (estimate = 1.1908, SE = 0.2645, t = 4.502). Finally, the reference level 'grammatical RH' showed that grammatical BH words with second front vowels were rated significantly lower than grammatical RH words with second front vowels.

Moreover, the best model of ratings revealed a by-participant effect of the category grammaticality, suggesting that participants reacted in various ways to grammaticality of the nonce words they rated. Figure 11.3 shows different ratings of grammaticality by all 40 participants.

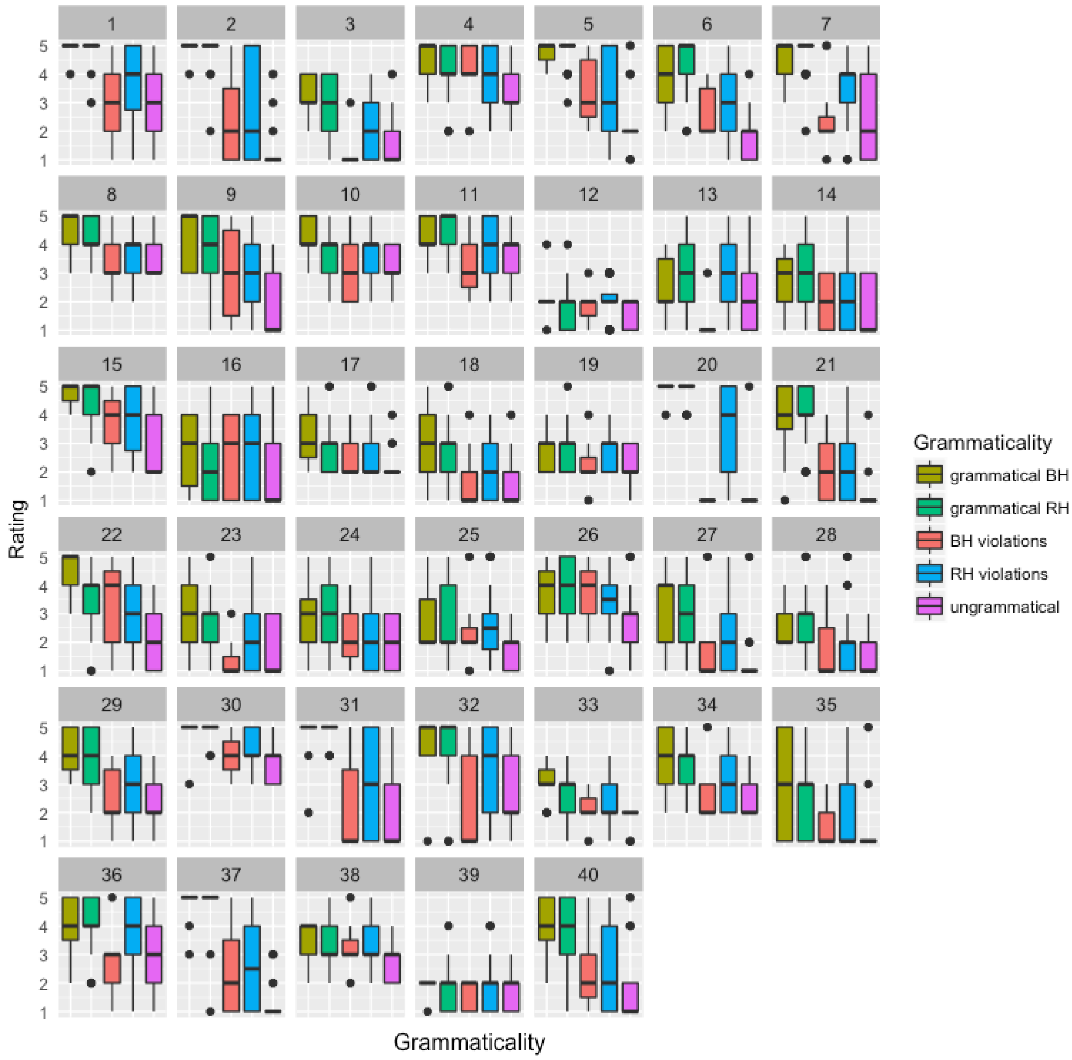

Figure 11.3 By-participant effect of the category grammaticality

As seen in Figure 11.3, different participants rated BH violations in various ways. Eight participants tended to rate BH violations higher than '3' (participants 4, 5, 8, 9, 15, 22, 26, 30). However, most participants had accurate perception of ill-formed words violating BH. In turn, RH violations were rated overall higher, and had more variations of ratings from '1' to '5', for example, for participants 2 and 31. Grammatical BH and RH words had highest ratings in general, especially among eight participants (numbers 1, 2, 5, 7, 20, 30, 31, 37). There were four participants who rated grammatical BH and RH words mostly lower than '3' also (participants 12, 19, 28, 39). Ungrammatical words that violated both BH and RH at the same time had a general tendency to be rated lower than '3' and not higher than '4'. Fifteen participants (numbers 2, 3, 5, 6, 12, 18, 20, 21, 25, 28, 33, 35, 37, 39, 40), generally rated ungrammatical words lower from '1' to ‘2’ showing their overall sensitivity to the ill-formed words violating vowel harmony. In contrast, three participants (numbers 8, 10, 30) tended to rate ungrammatical words relatively high from ‘3’ to ‘4’, however, these participants still overall lower than grammatical BH words, showing their reactions to harmony violations. Thus, various ways participants completed grammaticality judgments of the nonce words were attested.

As there were the three monolingual speakers who participated in the rating task, the next step after arriving at the best model of ratings was to assess whether bilingualism of the rest of 37 participants affected ratings in general. A new category ‘bilingualism’ was created that distinguished the monolingual speakers from the bilinguals. Then the bilingualism category was added to the significant predictors of the best model of ratings and was compared with the model without the bilingualism category, using the ANOVA function. The model showed that the added category bilingualism was not significantly better than the best model of ratings without the bilingualism category ($p = 0.2175$, $\chi^2 = 1.5207$). This result suggests that there was no significant difference in the ways participants rated the nonce words between bilinguals and monolinguals.

11.2 Summary and discussion

Results of analyses of the phonological predictors at play in the rating task demonstrate an overall good sensitivity of the participants to compliances with the rules of both BH and RH in the nonce words, and grammatical words following vowel harmony were rated significantly higher than disharmonic words. I also showed that grammatical BH words were rated significantly higher than grammatical RH words. Moreover, significantly higher ratings of RH violations than ungrammatical words that violated both BH and RH, suggest that participants were overall tolerant for RH violations. When it came to violations of BH and RH, I showed that those types of harmony violations were rated significantly higher when second vowels were front as opposed to ungrammatical words with second front vowels, as suggested by significant interactions of grammaticality and second vowel backness. This significant interaction also showed that second front vowels increased ratings of grammatical RH words, as opposed to grammatical BH ones with second front vowels. Participants also showed a significant bias towards first rounded vowels within words that increased the rate of overall ratings, as compared to first unrounded vowels. Despite general variability of ratings of grammaticality, there was an overall tendency for participants to rate grammatical BH and RH words higher. Ratings of RH violations showed a wide range of answers, with overall high ratings. In general, the lowest ratings were given to ungrammatical words.

Therefore, the hypothesis is confirmed that participants had highest ratings of grammatical BH and RH words, and lower ratings of words violating BH and RH. The other hypothesis is partly supported, that participants had a general bias towards rounded vowels, but only if they were in the first syllable position, resulting in higher ratings of words with first rounded vowels. There was no preference of back vowels in the participants' ratings, i.e. the proposed harmony trigger input back vowels, as shown in Chapter 10, did not affect participants' judgments when it came to the Yakut nonce words. Input backness played a significant role in the ratings, when interacted with grammaticality, second front vowels affected ratings of grammatical and non-grammatical words. For example, grammatical RH and BH words interacted with second front vowels increased ratings as compared to ungrammatical words with second front vowels. Additionally, I showed that bilingual speakers rated similarly to the monolinguals, which suggest that judgments of the Yakut nonce words were comparable between bilinguals and monolinguals.

Chapter 12: Role of sociolinguistic factors

This chapter investigates the role of sociolinguistic factors of the bilingual participants on Yakut-like adaptations (YLA) and ratings. The final set of tested sociolinguistic factors included five independent variables: residence, Russian spoken daily, reading and writing in Yakut and Russian, ratings of Russian skills, and age. I tested the random effects 'participant' and 'Russian input word'.

The research question posed in the analyses of the dependent variables Yakut-like adaptation and rating is: What sociolinguistic factors of the participants affected their adaptations of the target words and ratings? I hypothesize that the factors like age, residence, literacy, and ratings of use of Russian and Yakut, respectively, as well as Russian language skills influenced the overall adaptations and ratings of grammaticality in the nonce words. That is, better Yakut-like adaptations and accurate ratings of grammaticality would occur among older participants who lived in rural places. A more frequent engagement in Yakut as compared to Russian will contribute to better adaptations and grammaticality judgements. I hypothesize that participants' ratings of their Russian language skills would be at play too – participants who rated their Russian language skills higher would also have higher ratings of Yakut language skills, meaning there would be more Yakut-like adaptations and more accurate ratings of grammaticality.

Hence, I discuss information on the linguistic background of participants in Section 12.1, followed by analyses of correlations between different sociolinguistic factors in Section 12.2; in Section 12.3, I present results of linear mixed-effects modeling analyses of sociolinguistic factors affecting YLA, and sociolinguistic factors affecting ratings are discussed in Section 12.4; finally, I summarize the main findings of the chapter in Section 12.5.

12.1 Linguistic background of participants

After the sessions of the production and rating tasks, I inquired about age and permanent residence (urban versus rural) from each participant. The rest of the linguistic background information on the participants was derived from their answers on the questionnaire titled 'Language background information' (Appendix A) which they filled out immediately after the session. The three monolingual participants were all female speakers, two of them were 78, and the other one was 81, and they did not fill out the questionnaire, as it mainly focused on the extent of the linguistic engagement in Yakut and Russian. The two speakers lived in a rural place, and the third speaker lived in a predominantly Yakut-speaking urban place. The rest of this section is an overview of the participants' linguistic background information based on the 37 bilingual speakers.

All 37 bilingual speakers declared Yakut as their mother tongue, and all of them considered themselves as bilingual in Yakut and Russian. Except for one, all the participants predominantly spoke Yakut at home. Also, 34 participants confirmed the predominant language environment in childhood/adolescence to be Yakut, and three participants grew up "in an equally bilingual environment". The questionnaire also included a question asking whether there was a change of the predominant language environment during childhood or adolescence. It turned out that two participants switched to a predominantly Russian-speaking environment and another two, in turn, shifted to the Yakut-speaking environment between the ages of 0 to 10 years. During the adolescent years (age 10 to 18), eight participants moved to a predominantly Russian-speaking environment. Generally, participants were fairly homogenous with respect to the five categories about mother tongue, bilingualism, home language, the predominant language environment in childhood and adolescence, and change of the predominant language environment in childhood and adolescence; therefore, these responses were not considered in subsequent quantitative analyses.

Next, the participants estimated how much Russian they spoke daily, presented in Figure 12.1.[45] As visible in Figure 12.1, the majority of participants spoke less Russian than Yakut on a daily basis. However, several participants spoke Russian and Yakut equally, and there was one speaker who never spoke Russian and spoke only Yakut.

[45] All the figures in Chapter 12 are based on the bilingual speakers only.

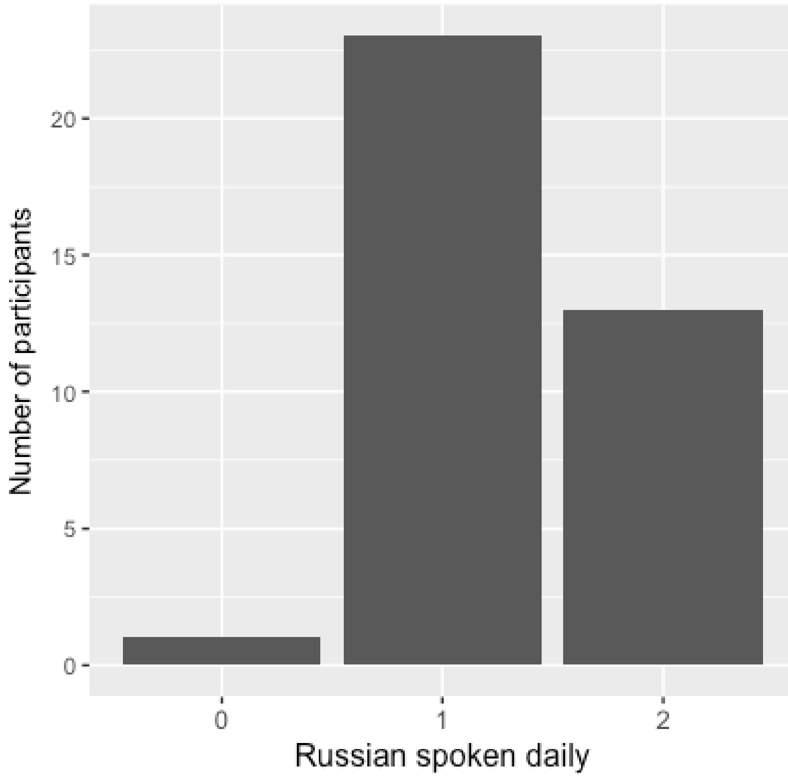

Figure 12.1 Answers to the question about "Russian spoken daily".

The rating scale (0-4): "0 Russian never Yakut always"; "1 Russian seldom Yakut usually"; "2 Russian 50% Yakut 50%"; "3 Russian usually Yakut seldom"; "4 Russian almost always Yakut almost never"

Regarding the language spoken at school or work (whichever is applicable), as shown in Figure 12.2, an equal number of participants spoke both Russian and Yakut evenly at work or school, and another half of participants spoke more Yakut than Russian. Next, five participants declared the main language at work or school to be Russian. In contrast, one speaker never spoke Russian at work/school. Moreover, three participants spoke more Russian rather than Yakut. In addition, six participants did not work nor go to school, and their answers are reflected in the 'NA' column.

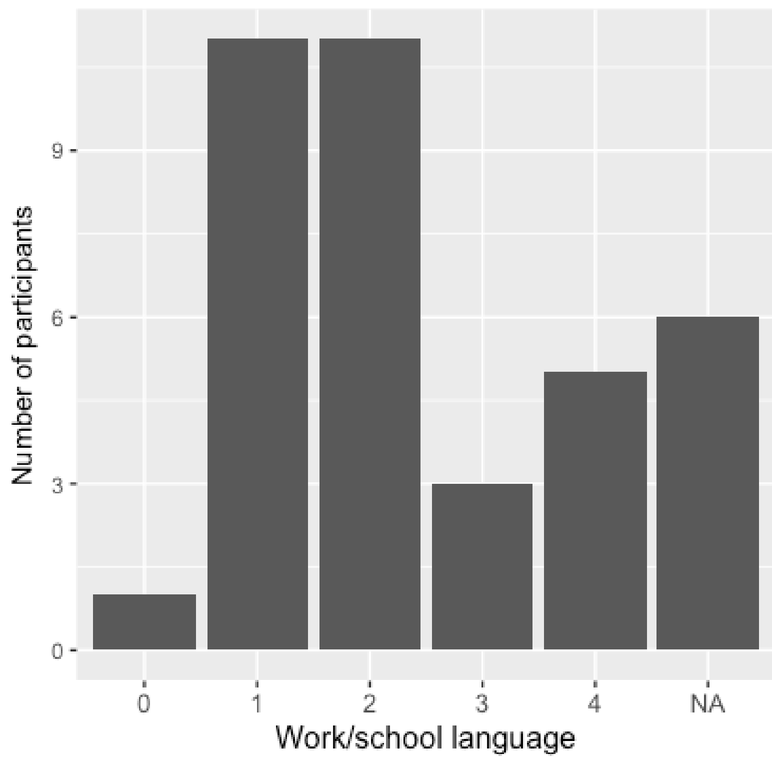

Figure 12.2 Answers to the question about “Work/school language”.

The rating scale (0-4): “0 Russian never Yakut always”; “1 Russian seldom Yakut usually”; “2 Russian 50% Yakut 50%”; “3 Russian usually Yakut seldom”; “4 Russian almost always Yakut almost never”

The next set of questions was about the extents of reading and writing in both Russian and Yakut. The participants chose their answers on a scale from 0 to 4, shown in Figures 12.3-12.6.

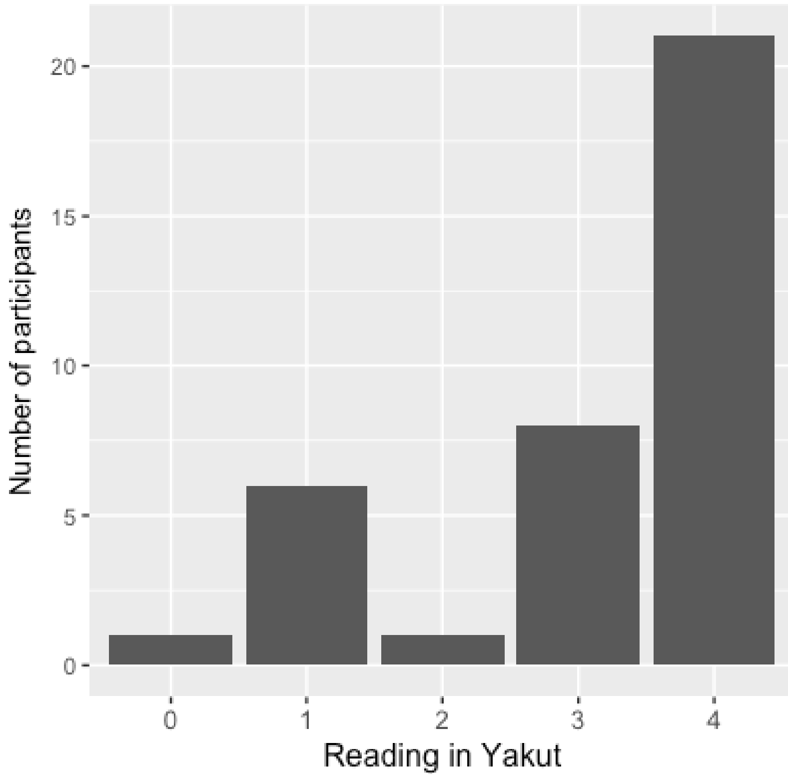

Figure 12.3 Answers to the question about “Reading in Yakut”.

The rating scale (0-4): “0 never”; “1 occasionally”; “2 few times a month”; “3 few times a week”; “4 every day”

Figure 12.3 shows that most participants read in Yakut every day, however some participants did so “few times a week”, more than the participants who only “occasionally” read Yakut text, one participant never read anything in Yakut, and another one did it only “few times a month”. Overall, most of the bilingual speakers read in Yakut on a daily basis.

As far as writing in Yakut was concerned, as visible in Figure 12.4, most participants wrote in Yakut every day, some participants did so only “occasionally”, and six participants wrote Yakut text “few times a week”, two participants found themselves never to be writing anything in Yakut, or one participant declared to be writing in Yakut “few times a month”.

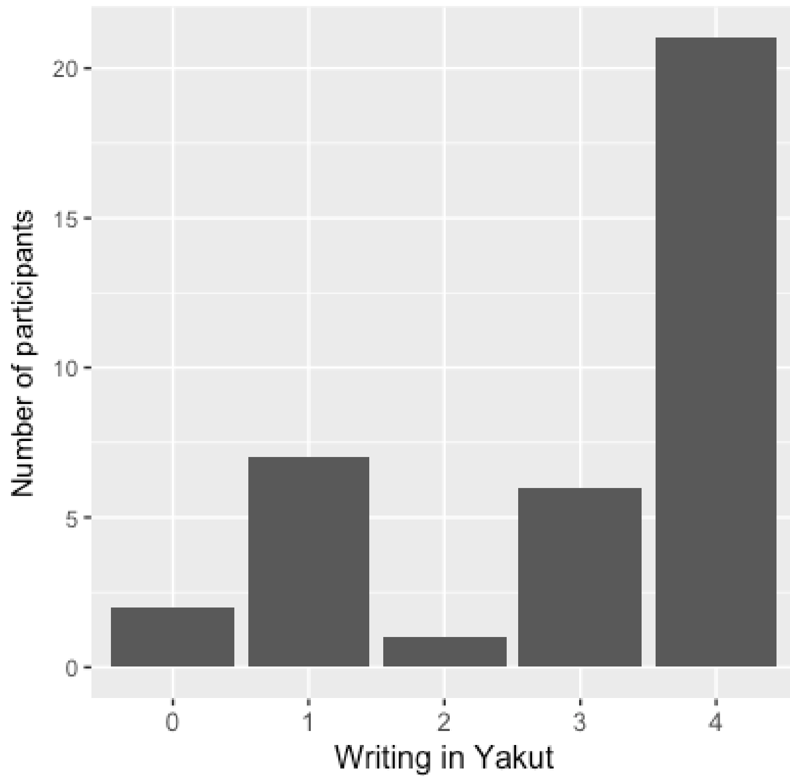

Figure 12.4 Answers to the question about “Writing in Yakut”.

The rating scale (0-4): “0 never”; “1 occasionally”; “2 few times a month”; “3 few times a week”; “4 every day”

Next, as compared to Yakut, the answers about reading and writing in Russian had fewer variations. As shown in Figure 12.5, the great majority of the participants read in Russian every day, and few participants only read Russian text “few times a week” or “occasionally”.

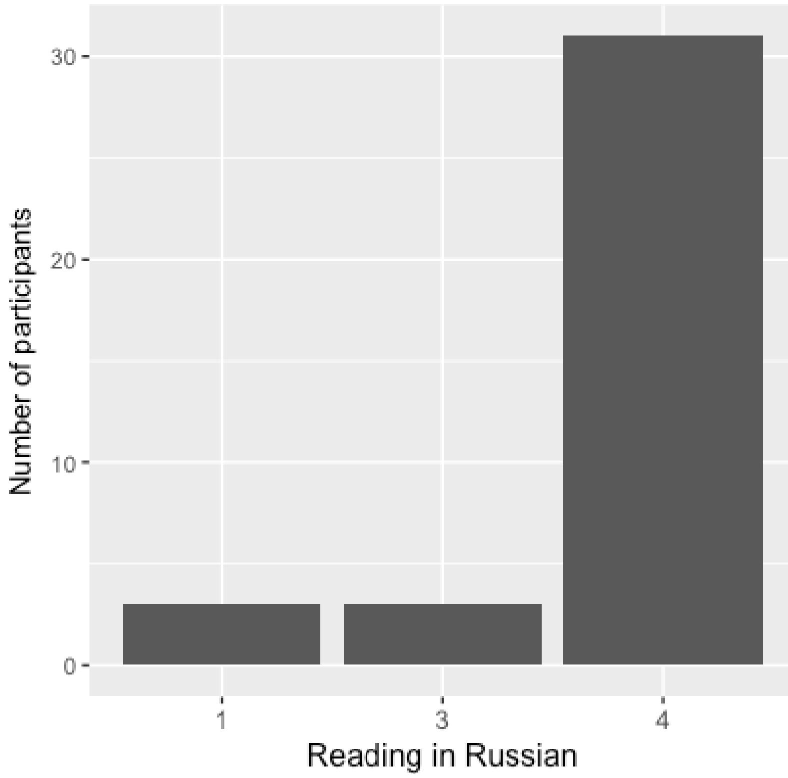

Figure 12.5 Answers to the question about "Reading in Russian".

The rating scale (0-4): "0 never"; "1 occasionally"; "2 few times a month"; "3 few times a week"; "4 every day"

Next, an overwhelming majority of participants wrote in Russian every day, however, ten participants did so "occasionally", and some speakers wrote Russian text "few times a week", as seen in Figure 12.6.

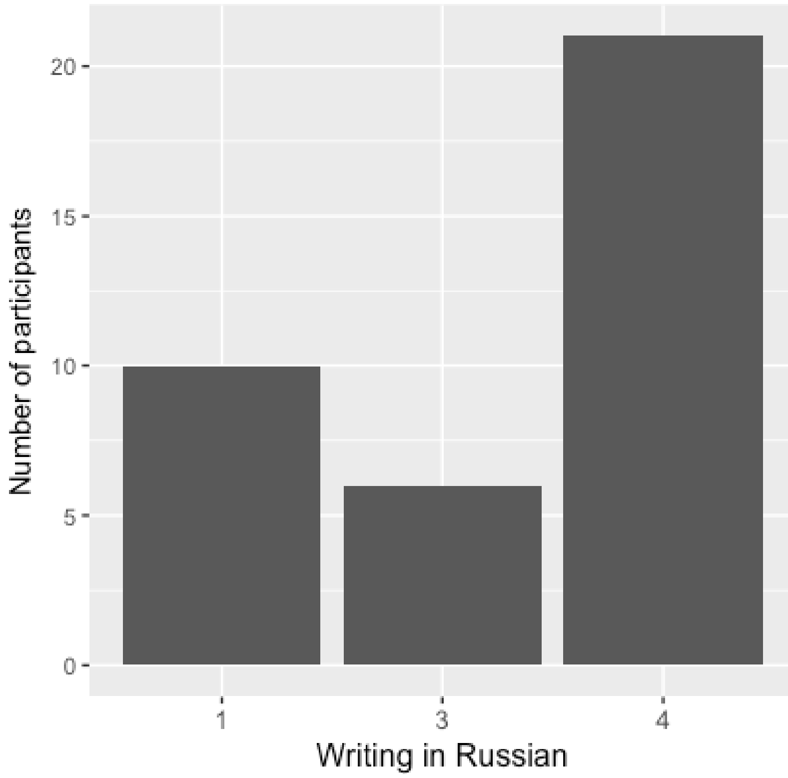

Figure 12.6 Answers to the question about "Writing in Russian".

The rating scale (0-4): "0 never"; "1 occasionally"; "2 few times a month"; "3 few times a week"; "4 every day"

Furthermore, the participants rated their Russian language skills in reading, writing, speaking and listening based on a four-point scale from lowest ("basic") to highest ("superior"). All the Russian language skills' ratings were based on the participants' self-judgements. The ratings of reading in Russian are the following: 13 speakers said their skills were "intermediate", another 13 considered their reading skills as "superior", and 11 participants chose "advanced". As for writing ratings, 17 participants estimated their writing skills to be "intermediate", 13 had "superior" abilities, and seven participants rated their writing as "advanced". The participants were quite modest in assessing their Russian speaking skills: 19 participants thought they were "intermediate", 13 opted for "advanced", only three participants had "superior" abilities, and two participants rated their Russian speaking as "basic". As far as the ratings of Russian listening were concerned, most speakers rated themselves higher: 18 participants chose "superior", 10 considered their Russian speaking skills to be "advanced", and nine thought their abilities in listening were "intermediate".

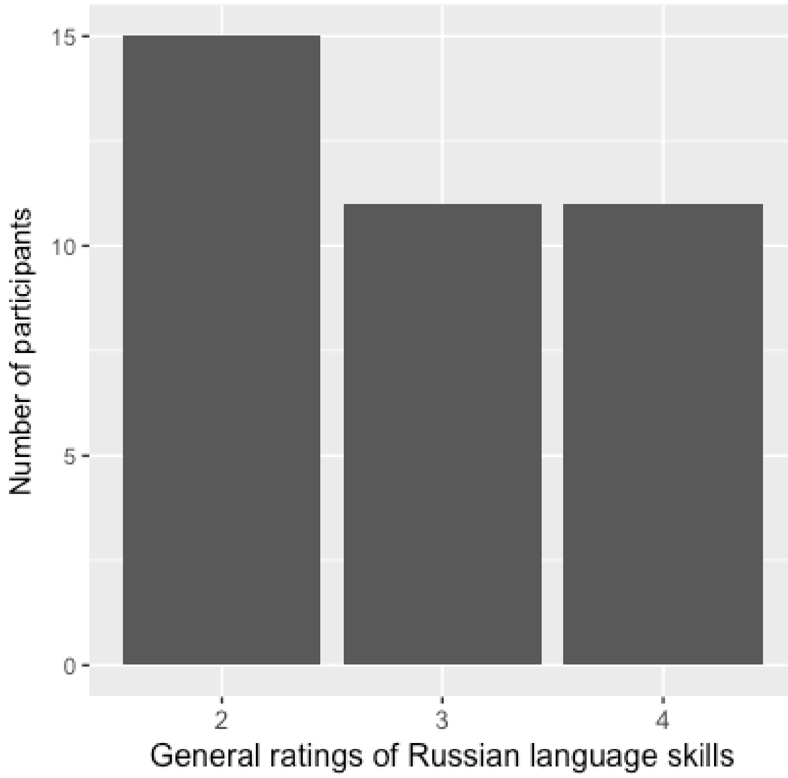

Figure 12.7 Answers to the question about "General ratings of Russian language skills".
The rating scale (1-4): "1 basic"; "2 intermediate"; "3 advanced"; "4 superior"

Finally, the questionnaire asked them to assess their Russian skills in general. As shown in Figure 12.7, the answers were fairly evenly distributed: most participants considered their overall Russian abilities to be "intermediate", some estimated their Russian as "advanced", and the others chose "superior". Note that none of the participants chose "basic" in estimating their general skills in Russian.

To sum up, the 37 bilingual speakers had a considerable daily linguistic engagement in Yakut, whether it included reading, writing or speaking the language. In turn, daily speaking in Russian occurred either seldom or equally often as speaking Yakut daily, despite an overall high rate of reading and writing in Russian on a daily basis.

12.2 Correlations between the sociolinguistic factors

This section presents correlation plots of sociolinguistic factors derived from the participants' answers in the 'Language background information' questionnaire. These correlations were used in creating new variables for subsequent linear mixed-effects modeling analyses involving sociolinguistic factors that combined several correlating sociolinguistic factors. For instance, if five sociolinguistic factors were closely correlated, those factors were added up and were divided by ‘5’ to arrive at a variable that combined all those five factors. Thus, the section describes new variables that were created based on the correlation plots.

First, a correlation plot of reading and writing in both languages is visualized in Figure 12.8.

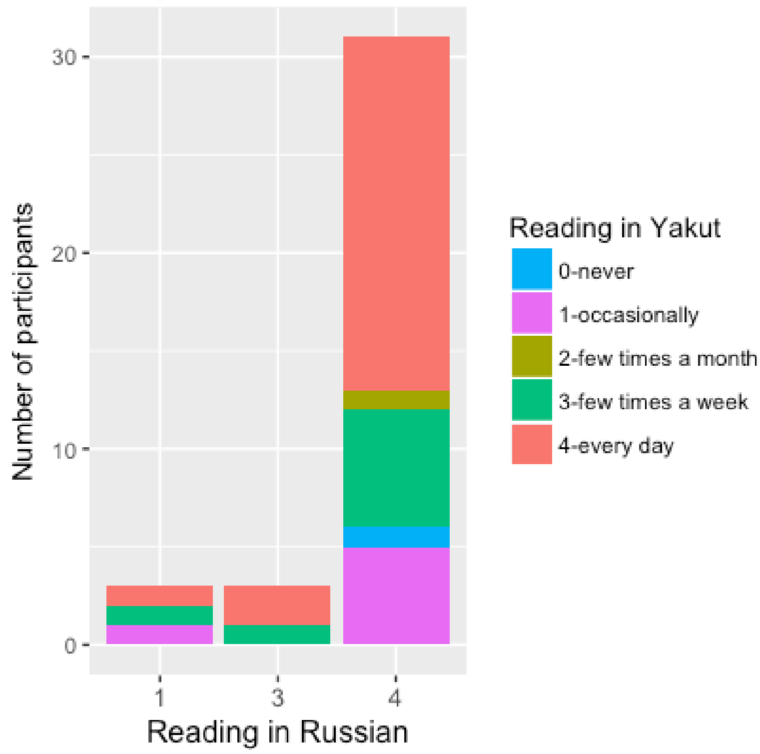

Figure 12.8 Correlation plot of reading in Russian and reading in Yakut.
The rating scale (0-4): “0 never”; “1 occasionally”; “2 few times a month”; “3 few times a week”; “4 every day”

Figure 12.8 shows that most participants who read in Russian “every day”, were also engaged in daily reading in Yakut. Fewer participants who read in Russian “every day” either read in Yakut “occasionally” or “few times a week”, including the individuals who “never” read in Yakut and “few times a month”. The three participants who read in Russian “occasionally”, read in Yakut either “occasionally”, “few times a week” or “every day”. In turn, other participants who read in Russian “few times a week” also read in Yakut “few times a week” or “every day”. Overall, it is shown that the extents of daily reading in both languages were closely correlated.

Next, Figure 12.9 plots the correlation between writing in both languages. Close correlations between the extents of writing in both languages were identified. The majority of participants who wrote in Russian “every day”, were also involved in daily writing in Yakut. Among the participants who read in Russian daily there were few who estimated the extents of reading in Yakut as “never”, “occasionally”, “few times a month”, and “few times a week”. Participants who read in Russian “few times a week”, read in Yakut “occasionally”, “few times a week”, or “every day”. In turn, most participants who only “occasionally” wrote in Russian, instead wrote in Yakut “every day”, with only one participant writing in Yakut only “few times a week” or three participants who “occasionally” wrote in Yakut. Unlike reading in both languages, the majority of participants wrote in both languages every day, it is shown that occasional writing in Russian entails more writing in Yakut

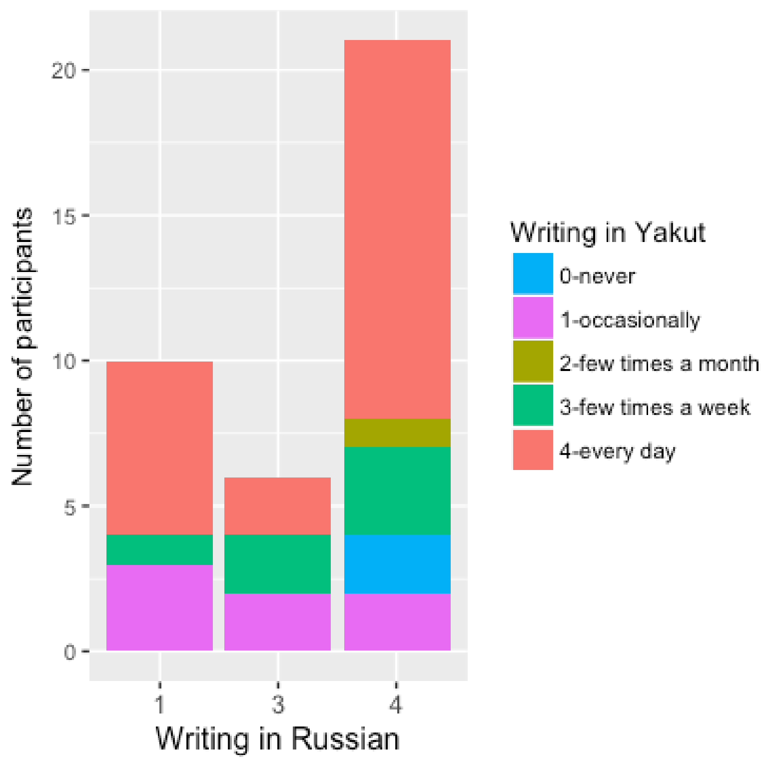

Figure 12.9 Correlation plot of writing in Russian and reading in Yakut.
The rating scale (0-4): “0 never”; “1 occasionally”; “2 few times a month”; “3 few times a week”; “4 every day”

Considering close correlations between the extents of reading and writing in either of the languages, a new variable ‘reading and writing in Yakut and Russian’ was calculated by adding the four categories ‘Writing in Yakut’, ‘Reading in Yakut’, ‘Writing in Russian’, and ‘Reading in Russian’ and dividing the sum by ‘4’.

Furthermore, the participants rated four basic language skills in reading, writing, speaking and listening in Russian and also assessed their general ratings of their Russian language skills. Each of the four skills was compared to the participants' overall ratings of Russian skills to establish their similarities. Visualizations of correlations between the skills and overall ratings are presented below, starting with reading skills presented in Figure 12.10.

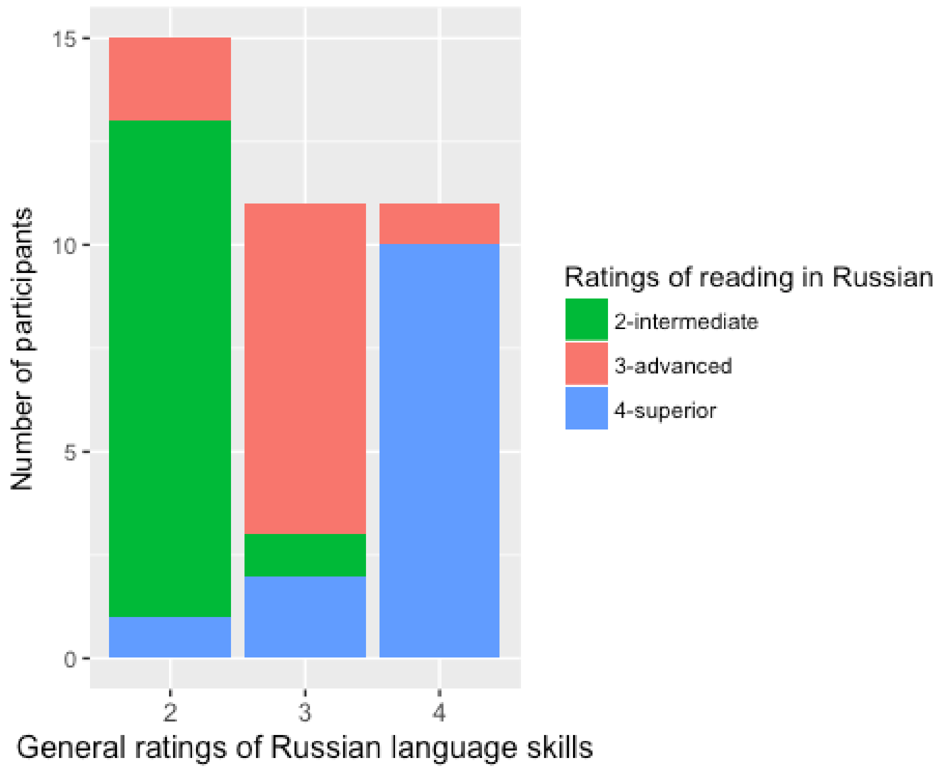

Figure 12.10 Correlation plot of general ratings of Russian skills and rating of reading in Russian. The rating scale (1-4): "1 basic"; "2 intermediate"; "3 advanced"; "4 superior"

Figure 12.10 demonstrates close correlations between the reading skills' ratings and overall ratings. Most participants who evaluated their general skills in Russian to be "superior" also rated their reading in Russian as "superior" while only few of them considered their Russian reading skills to be "advanced". General ratings of Russian skills as "advanced" were noticeably correlated with the ratings of reading in Russian as also "advanced" and with fewer ratings as "intermediate" and "superior". Participants who rated their Russian as "intermediate" overall, also rated their reading in Russian as "intermediate" most predominantly, with few ratings of it as "advanced" and "superior".

Similarly, Figure 12.11 reveals close correlations between overall ratings of Russian and participants' ratings of writing in Russian, as shown in Figure 12.11.

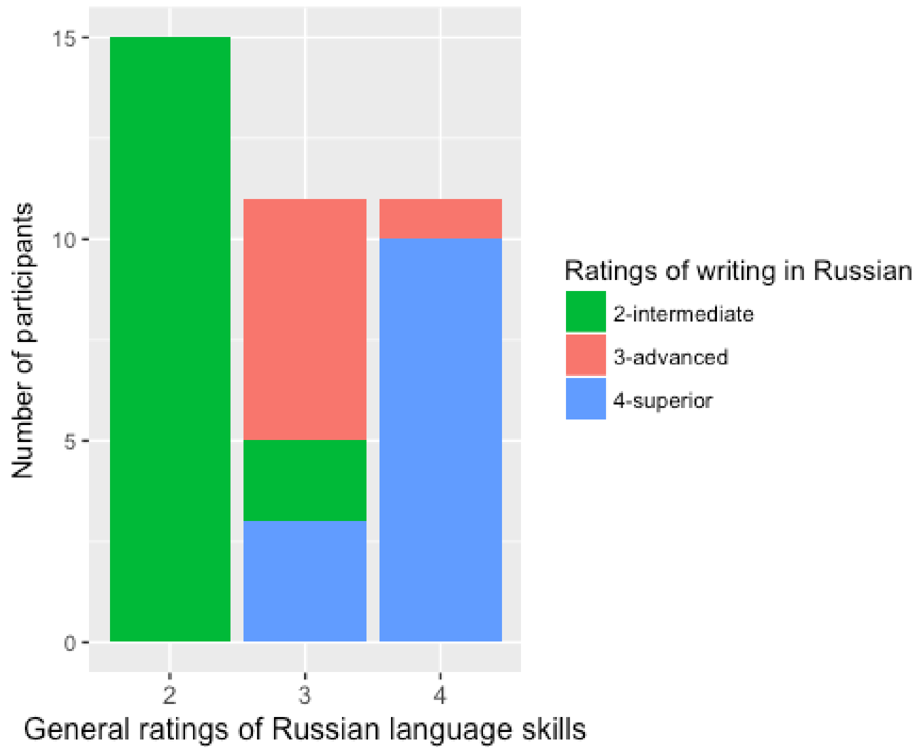

Figure 12.11 Correlation plot of general ratings of Russian skills and rating of writing in Russian. The rating scale (1-4): "1 basic"; "2 intermediate"; "3 advanced"; "4 superior"

That is, if participants rated their writing as "intermediate", then their overall ratings of Russian were also "intermediate". Relatively similar ratings of writing and general Russian skills are also observed for ratings of general skills as "superior", with very few participants rating their writing in Russian as "advanced". When participants rated their overall Russian language skills as "advanced", for the most part, they rated their writing as "advanced" too, with fewer ratings of it as "intermediate" and "superior".

Figure 12.12 illustrates an interesting tendency for the participants to rate their speaking skills in Russian slightly lower than their Russian reading and writing skills, as seen in Figure 12.12.

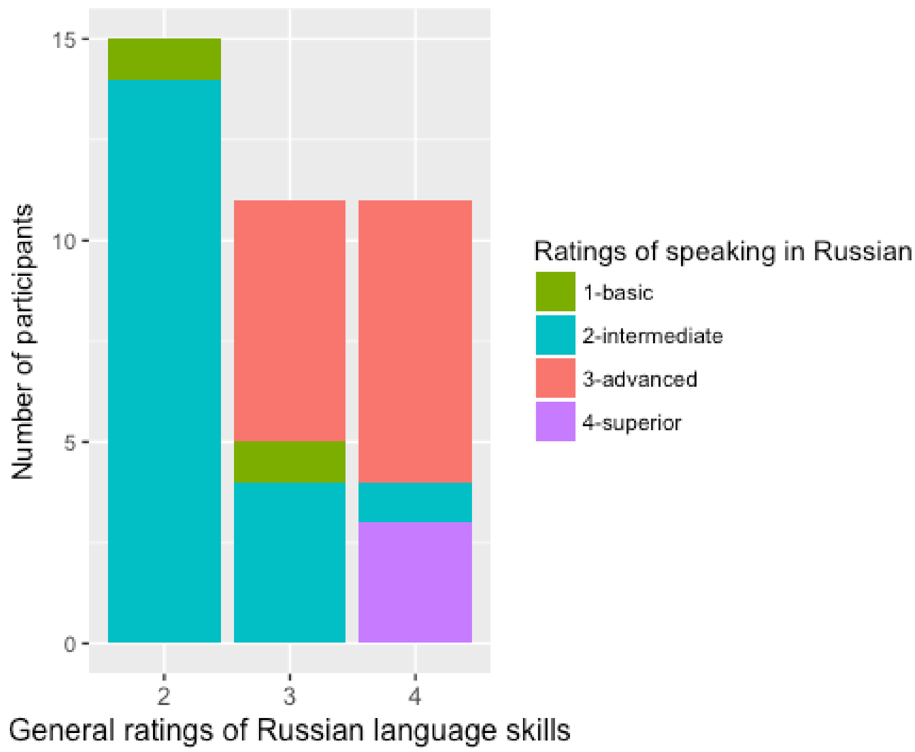

Figure 12.12 Correlation plot of general ratings of Russian skills and rating of speaking in Russian. The rating scale (1-4): “1 basic”; “2 intermediate”; “3 advanced”; “4 superior”

Most participants who rated their speaking skills in Russian as “intermediate” gave the same rating for their overall Russian skills with very few participants rating their speaking as “basic”. However, for most participants who rated their overall skills in Russian as “advanced”, their speaking ratings were “advanced”, or “superior” and very few opted for “basic”. Overall ratings of Russian as “superior” mostly correlated with “advanced” in speaking, with fewer ratings as “superior” and with very few ratings as “intermediate”. Ratings as “basic” only appeared in the ratings of speaking, and Figure 12.12 demonstrates this discrepancy: Some participants who overall rated their Russian language skills as “intermediate” and “advanced” estimated their speaking as (only) “basic”.

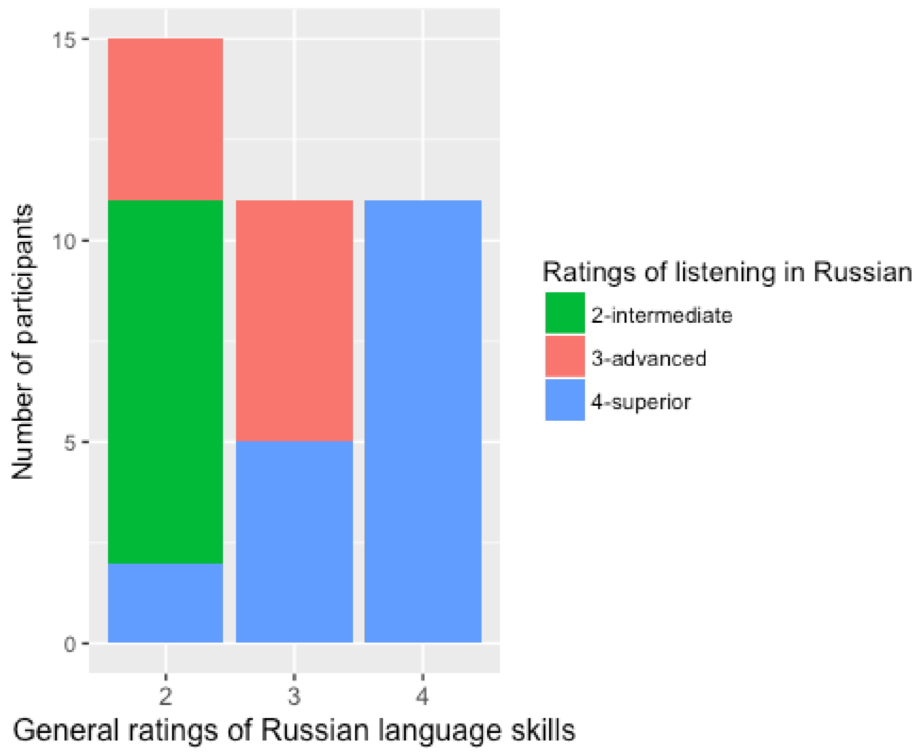

Figure 12.13 Correlation plot of general ratings of Russian skills and rating of listening in Russian. The rating scale (1-4): “1 basic”; “2 intermediate”; “3 advanced”; “4 superior”

Finally, the ratings of listening skills and overall ratings of Russian were similar, as shown in Figure 12.13. Figure 12.13 shows that all participants who rated their listening skills as “superior” rated their overall Russian skills the same way. Participants who rated their Russian as “advanced” overall rated their listening in Russian as either “advanced” or “superior”. The overall ratings of the participants’ Russian as “intermediate” mostly correlated with listening ratings as “intermediate” and with fewer ratings of listening as “advanced” and “superior”.

As Figures 12.10-12.13 demonstrate, in general, the ratings of the four individual Russian language skills were in comparable correlations with the overall ratings of language skills in Russian. Therefore, all the five ratings of Russian language skills were the basis of a new variable called ‘ratings of Russian skills’ that was calculated by adding the five categories ‘Rating of reading in Russian’, ‘Ratings of writing in Russian’, ‘Ratings of speaking in Russian’, ‘Ratings of listening in Russian’, and ‘General rating of Russian language skills’ and dividing the sum by ‘5’.

Furthermore, correlations between the variables ‘Russian spoken daily’ and ‘work/school language’ are visualized in Figure 12.14.

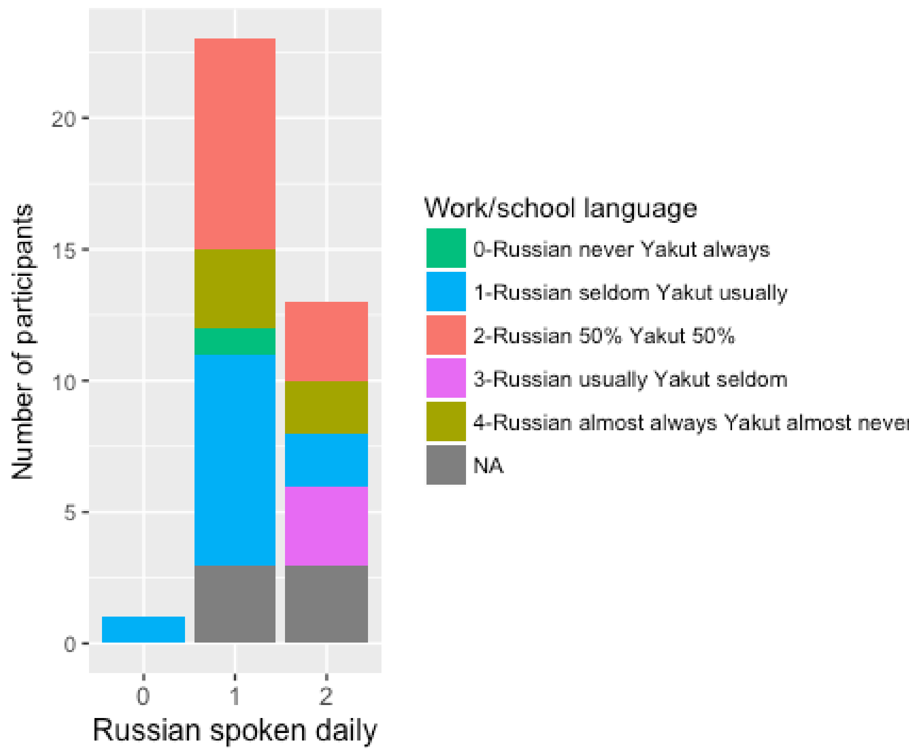

Figure 12.14 Correlation plot of 'Russian spoken daily' and 'work/school language'.

The rating scale (0-4): "0 Russian never Yakut always"; "1 Russian seldom Yakut usually"; "2 Russian 50% Yakut 50%"; "3 Russian usually Yakut seldom"; "4 Russian almost always Yakut almost never"

Most participants declared that they spoke "Russian seldom Yakut usually" on a daily basis, and at work or school spoke Russian to various extents ranging from "Russian never Yakut always" to "Russian almost always Yakut almost never". Participants who spoke Russian and Yakut equally on a daily basis also displayed a wide range of linguistic engagement in Russian at work/school starting from "Russian seldom Yakut usually" to "Russian almost always Yakut almost never". There was only one participant who declared that they never spoke Russian in their daily life. Figure 12.14 shows that participants who spoke Russian daily to different extents also spoke Russian at work or school. Also, considering that six bilingual speakers did not work nor went to school due to retirement or for other reasons, the category 'work/school language' had insufficient number of participants due to those participants. Thus, the 'work/school language' category was not included in subsequent linear mixed-effects models, instead, the category 'Russian spoken daily' was tested.

Summing up, the correlation plots led to the creation of the two combining variables – 'reading and writing in Yakut and Russian' and 'ratings of Russian skills', and showed vivid correlations between daily speaking in Russian and 'work/school language'.

12.3 Sociolinguistic factors affecting Yakut-like adaptations

The dependent variable YLA (refer to Chapter 9 for the explanation of this variable's coding) was tested to assess specific sociolinguistic factors that affected adaptations in general: reading and writing in Yakut and Russian; ratings of Russian skills; residence; Russian spoken daily; and age. No other predictors beside the listed five predictors were tested.

The best model of YLA included the significant predictor residence only. Additions of the other four sociolinguistic predictors, including their interactions, did not result in a significantly better model than including the category residence alone. The model had the random factors participant and Russian input word. The model indicated that urban residents had significantly fewer Yakut-like adaptations as compared to rural residents (estimate = -1.2416, SE = 0.3828, z = -3.244, p = 0.00118). Note that of the 37 bilingual participants there were 21 rural (56.8%) and 16 urban (43.2%) residents. Figure 12.15 illustrates the significantly fewer Yakut-like adaptations among the urban residents.

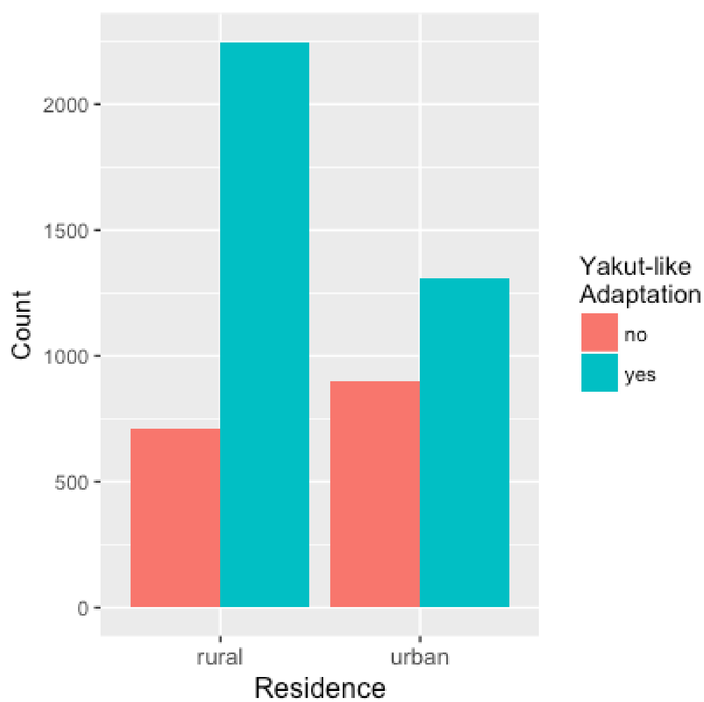

Figure 12.15 Output Yakut-like adaptations by residence

Considering that in the Republic of Sakha urban residents tend to speak more Russian in their daily lives than rural residents (see e.g. Ferguson, 2015, 2016), there is a possibility that the urban residents spoke more Russian than the rural residents which impacted their production. Thus, to assess whether there was a difference between the extents of speaking Russian daily among rural and urban residents, I checked correlations between the categories Russian spoken daily and residence, as seen in Figure 12.16.

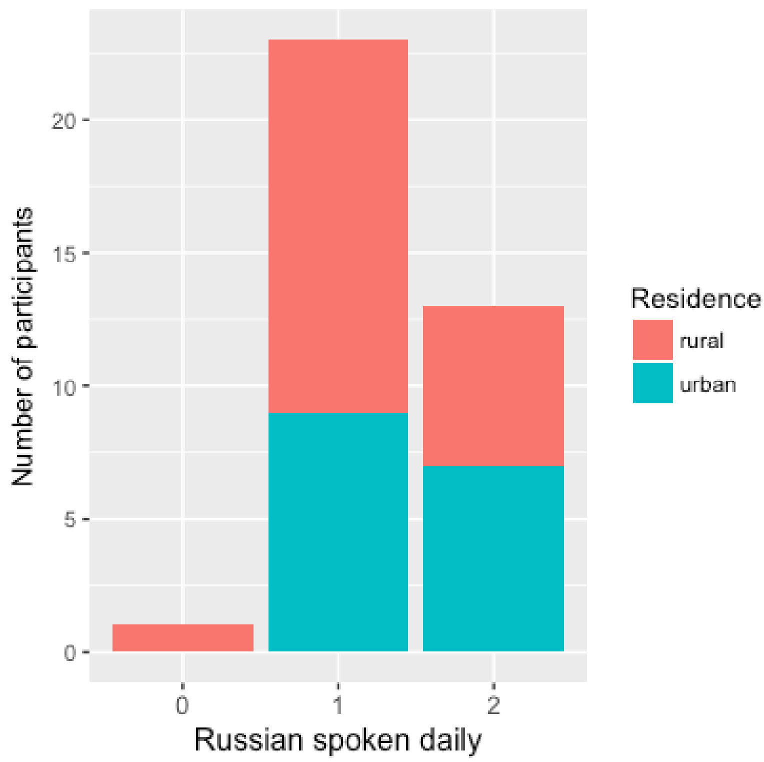

Figure 12.16 Correlation plot of 'Russian spoken daily' and 'residence'.

The rating scale (0-4): "0 Russian never Yakut always"; "1 Russian seldom Yakut usually"; "2 Russian 50% Yakut 50%"; "3 Russian usually Yakut seldom"; "4 Russian almost always Yakut almost never"

The correlations indicate that both rural and urban residents spoke Russian daily, and there was no substantial discrepancy in the extents of the daily linguistic exposure in Russian between the two kinds of residents. That is, six participants (28.6%) out of 21 bilingual rural residents, and seven participants (43.8%) from a total of 16 bilingual urban residents, respectively, reported that they spoke "Russian 50% Yakut 50%". Thus, more urban residents (i.e. nearly half of them) spoke Russian and Yakut relatively to equal extents as opposed to rural residents. Furthermore, there was no radical difference in the overall proportions of the answers "Russian seldom Yakut usually" between rural versus urban residents: the majority of 14 rural residents (66.7%) and nine urban residents (56.3%), respectively. This result suggests that on a daily basis, both urban and rural residents primarily spoke less Russian as opposed to Yakut. Note that one bilingual rural resident declared that they never spoke Russian and always spoke Yakut. Hence, the main difference in the extents of daily speaking Russian between rural and urban residents is that proportionally more urban residents spoke Russian and Yakut to equal extents daily compared to rural residents.

To summarize, these results indicate that the only significant sociolinguistic predictor was residence, the other factors like literacy, ratings of Russian skills, and age did not significantly contribute to better or worse Yakut-like adaptations.

12.4 Sociolinguistic factors affecting ratings of Yakut nonce words

Linear mixed-effects modeling analyses of ratings of grammaticality in the nonce words (see Chapter 11) were carried out to reveal the sociolinguistic factors that contributed to participants' judgements. Although the monolingual speakers also completed the rating task, the analyses comprised the 37 bilingual speakers only. The monolingual participants did not fill out the questionnaire written in Russian, as noted above. Moreover, as was reported in Section 11.1, the monolingual speakers did not behave significantly differently in the rating task than the bilinguals; therefore, an inclusion of the monolinguals was not crucial.

The tested sociolinguistic factors were the same as in the previous section and the category 'grammaticality' with the reference level 'ungrammatical', as reported in Chapter 11, was included as an additional predictor. The 'grammaticality' category included violations and compliances with vowel harmony in the nonce words, specified in the five levels: BH violations, RH violations, grammatical BH, grammatical RH, and ungrammatical (violations of both BH and RH). The purpose of the analyses is to find out whether each of the five individual sociolinguistic factors affected the participants' judgements of grammaticality of the nonce words.

A model simultaneously containing interactions between grammaticality and all the sociolinguistic factors did not converge. Thus, as the first step, all five sociolinguistic factors were interacted with the category grammaticality in separate models. As the second step, each interaction between grammaticality and a sociolinguistic factor that showed a significant effect in a model of its own was added to a model as a predictor of ratings. As a result, two pairs of significant interactions were revealed: grammaticality and ratings of Russian skills and grammaticality and age. The significant interaction between grammaticality and ratings of Russian skills suggested that participants who rated their Russian language skills higher also rated grammatical BH words significantly higher (estimate = 0.220149, SE = 0.088669, t = 2.483); similarly, grammatical RH words were rated significantly higher when participants had higher ratings of Russian skills (estimate = 0.242388, SE = 0.072242, t = 3.355). Furthermore, significant interactions of grammaticality and age indicated that older participants rated grammatical BH (estimate = -0.011957, SE = 0.004551, t = -2.627) and grammatical RH (estimate = -0.001047, SE = 0.003708, t = -3.842) words significantly lower than younger participants. Besides the significant interactions, significant effects of grammatical BH (estimate = 1.308673, SE = 0.380521, t = 3.439) and grammatical RH (estimate = 1.234061, SE = 0.310024, t = 3.981) words were determined, showing that those grammatical vowel harmony words were rated significantly higher. However, a by-participant effect of grammaticality was found to significantly improve the model and was significantly better than the model without this random slope (p = <2.2e-16, χ^2 = 202.78). As soon as the complex random factor was added, both significant interactions (grammaticality and ratings of Russian skills and grammaticality and age) in the predictors weakened and became insignificant: the interaction between grammatical BH words and ratings of Russian skills (estimate = 0.220149, SE = 0.168636, t = 1.305), grammatical RH words and ratings of Russian skills (estimate = 0.242388, SE = 0.167635, t = 1.446), grammatical BH words and age (estimate = -0.011957, SE = 0.008656, t = -1.381), and grammatical RH words and age (estimate = -0.014247, SE = 0.008605, t = -1.656). Recall that a by-participant effect of grammaticality was also found in Chapter 11 (see especially Figure 11.3) where general tendencies of correct judgments of vowel harmony were reported.

These results show that there are no significant interactions between grammaticality and sociolinguistic factors affecting ratings. A by-participant effect of grammaticality, i.e., different participants' reactions to the grammaticality of the rated nonce words, turned out to play a key role in the ratings.

12.5 Summary and discussion

Despite the presence of various sociolinguistic factors characterizing the participants, only one sociolinguistic factor was significant in the adaptations. Specifically, residence alone was the significant predictor of Yakut-like adaptations. As was hypothesized, urban residents produced significantly fewer Yakut-like adaptations compared to rural residents. Daily conversations both at home and at work and school in rural places are predominantly conducted in Yakut, whereas urban residents are exposed to Russian to various extents on a daily basis, including work or school, since language environment in urban places tends to entail some linguistic engagement in Russian. However, there was no substantial difference between the extents of daily speaking Russian between rural and urban residents, both speakers tended to speak less Russian and more Yakut daily. The difference was in the speaking of both languages to equal extents daily, indicating that more urban, rather than rural, residents spoke 50% Russian and 50% Yakut.

As for the analyses of nonce word ratings and effects of the sociolinguistic factors, none of the sociolinguistic factors occurred to be significant. The participants were not consistently influenced by the sociolinguistic factors per se in their ratings of grammaticality. Instead, the participants' judgments of grammaticality were guided by their individual reactions to grammatical and ungrammatical vowel harmony words, rather than the sociolinguistic factors.

Chapter 13: Discussion and conclusion

In this dissertation, I investigated vowel adaptations in Yakut from Russian by Yakut speakers in on-line production and rating tasks. The aim of this dissertation was to reveal phonological input predictors that drive applications of vowel harmony and Yakut-like adaptation by modern bilingual speakers in on-line adaptations. Hence, different research questions and hypotheses were posed to answer the main research question of the dissertation. I summarize the findings chapter by chapter below.

In Chapter 8, patterns of most-frequent vowel realizations of each of the five vowels in both stressed and unstressed variations in first and second syllables were used to test the hypothesis that the factors input backness and roundness, input height, the quality of an individual vowel input, stress and syllable position would be significant in the regularity of adaptations of the five vowels. I found that vowels in first syllables, unreduced vowels, and harmonic words agreeing in backness significantly drove more productions of most-frequent adaptations, i.e. showed less variability. Adaptations of /e, o/ showed more variability than those of the other vowels. Moreover, out of the two high-mid vowels, the vowel /o/ had less variability than /e/. The hypothesis was confirmed that indeed, most-frequent vowel adaptations were contingent on vowel input, stress and syllable position, as high and low vowels had more consistent patterns of adaptations than high-mid vowels. Overall, first syllable vowels were adapted more uniformly with less variation than second vowels. Stress played a role in whether vowels lengthened and diphthongized.

Analyses of phonological input features of vowels driving vowel harmony and adaptations presented in Chapter 9 tested the hypothesis that the input vowel features backness/roundness, height, stress, vowel sharedness, vowel reduction, and syllable position would be significant in driving vowel harmony and Yakut-like adaptation. I found that the phonological predictors input backness/roundness and height were important in driving harmony. Adaptations were better when both input vowels agreed in backness/roundness, i.e. when the input was already harmonic. Specifically, front vowels overall were worse triggers of harmony than back vowels, and front vowels were better triggers of harmony when both vowels in the input were front than either of the front vowels alone. In addition, vowel harmony was applied better in borrowed words than in nonce and un-borrowed ones, showing that on-line adaptation followed vowel harmony less consistently than established loanwords. Then I explored research questions about predictors of vowel harmony in input words agreeing (harmonic) and disagreeing (disharmonic) in backness. In disharmonic words, low vowels individually in either of the syllables produced significantly more backness harmony words, and low vowels in second syllables led to more rounding harmony words. As the only low input vowel in Russian is /a/, the interpretation is that the vowel /a/ in disharmonic words was a harmony trigger, which was also confirmed by a significant effect of first vowel input. Next, backness harmony adaptation in harmonic words was contingent on first vowels only, that is, front vowels in first syllables led to significantly fewer backness harmony words than back vowels. Furthermore, the two high-mid vowels and first rounded vowels were better triggers of rounding harmony in harmonic words compared to high-mid vowels in second syllables and unrounded vowels, respectively. Finally, I tested a research question regarding faithfulness to input vowels' backness and roundness. I hypothesized that back/rounded input vowels would be more faithful to their backness and roundness features than front/unrounded ones. The hypothesis was confirmed. Also, first syllable and stressed vowels were most faithful to the backness feature. I also found that vowels in borrowed words, especially in second syllables, were less faithful to the backness feature as compared to nonce and un-borrowed words. Finally, faithfulness to roundness showed interactions between syllable and height, stress and roundness, and stress and height.

In Chapter 10, I tested input features of vowels and words that affected the ways stressed vowels became long, diphthongs, short vowels, or showed retention of Russian stress. Previous studies (e.g., Dyachkovskiy, 1962; Sleptsov, 1964) showed that in general, stressed Russian vowels tended to lengthen and diphthongize. I hypothesized that in line with Dyachkovskiy's and Sleptsov's studies, participants would produce stressed high and low vowels as long, and high-mid vowels as diphthongs. The hypothesis was confirmed. High and low vowels lengthened more often than high-mid vowels, and stressed vowels in un-borrowed words significantly lengthened more often than nonce words. In contrast, stressed high-mid vowels most often became diphthongs, unlike high and low vowels. Moreover, stressed vowels in first syllables and high and low vowels, respectively, had a lesser tendency to become short or to retain Russian stress. In addition, stressed vowels in nonce words also tended to shorten more than stressed vowels in borrowed and un-borrowed words.

Furthermore, in Chapter 11, I analyzed the effects of phonological input predictors of vowel quality and grammaticality, meaning compliance with the backness and rounding harmony rules, on participants' ratings of the nonce Yakut words that the participants heard in audio files. The research question concerned perceptual sensitivity to vowel harmony, and specific vowel harmony compliances and violations that influenced the participants' judgments of grammaticality. I found that words that had backness harmony and rounding harmony violations with front vowels in them were rated significantly higher than non-harmonic words including back vowels. Moreover, participants rated grammatical backness harmony and rounding harmony, and most importantly, rounding harmony violations significantly higher as opposed to backness harmony violations. Higher ratings were also given to words containing first rounded vowels than to those with first unrounded vowels. There was by-participant variation in the sensitivity to vowel harmony violations.

Finally, in Chapter 12, sociolinguistic factors affecting Yakut-like adaptation and ratings were analyzed. Sociolinguistic factors were derived from language background questionnaires and inquiries about age and residence during the sessions. The research question was whether the sociolinguistic factors were significant in the adaptations and judgments of grammaticality in the ratings. I hypothesized that older people who lived in rural places, and who spoke less Russian daily, would have more Yakut-like adaptation and more accurate judgments of the grammaticality of the rated words. However, only residence was significant in adaptations in general. And as for the ratings, there was no significant fixed effect, instead, it was a by-participant effect of grammaticality that played a role in the participants' ratings.

This chapter reviews the main findings and discusses implications of the study. In Section 13.1, I discuss input predictors of vowels and words that affect application of vowel harmony and Yakut-likeness; I present discussions on whether the adaptations are phonetic and phonological in Section 13.2, followed by Section 13.3, where I briefly review the theoretical frameworks of vowel adaptation and present OT analyses of the production task data; in Section 13.4, I discuss sociolinguistic factors that affected the adaptations and ratings, and I conclude by considering the implications of the study and suggestions for future research directions in Section 13.5.

13.1 Role of predictors derived from input vowels and words

This section discusses input characteristics of vowels and words that influenced vowel harmony and Yakut-likeness.

13.1.1 Syllable position

Syllable position played a key role in vowel adaptations, showing that input-output correspondences for vowels in first syllables generally followed most-frequent vowel adaptations with less variability, whereas second syllable vowels displayed more variability. Previously it was shown that Russian vowels were adapted either independently, dictated by stress, consonants and syllable positions, or as a result of vowel harmony, when they were contingent on surrounding and preceding vowels (Dyachkovskiy, 1962; Sleptsov, 1964). Both studies did not have statistical analyses, so no significant effect of syllable position was established. In this study, I confirm that vowels in first syllables followed most-frequent vowel adaptations significantly more often than second syllable vowels, i.e. showed less variability in adaptation.

As far as application of vowel harmony is concerned, the role of syllable position was attested in several instances. In harmonic words, first front vowels induced productions of fewer backness harmony words, i.e. more adaptations following backness harmony appeared when the first vowel was back. Similarly, first rounded vowels (which are also back) in harmonic words led to significantly more rounding harmony, too. However, the height of second vowels was important in driving rounding harmony in input disharmonic words. Specifically, second low vowels were better triggers of rounding harmony in the disharmonic input than second high vowels. Previously, the role of syllable in driving harmony in loanwords was found in harmony languages that have transparent vowels, as in Finnish (e.g., Kimper, 2011; Ringen & Heinämäki, 1999, Välimaa-Blum, 1999), and Hungarian (e.g., Ringen & Kontra, 1989). These studies show that syllable position in harmony languages with transparent vowels, especially final syllables, played an important role in the emergence of disharmony. The difference of these studies from this one is that in those studies participants were provided with the root, and were asked what suffix versions to use, thus no adaptation of vowels in the root occurred.

In applications of backness harmony and rounding harmony, when it came to harmonic words agreeing in backness, vowels in first syllables were crucial in driving harmony. Feature spreading was pointed out by Harrison (1999), where the value [back] is spread rightward from the vowel in the initial syllable. In the same manner, I suggest that the backness value in first syllables in input words is important when the words are already harmonic in the input, whereas in input disharmonic words, vowels in first and second syllables are important. Based on Harrison's examples of "accidentally harmonic" (Pre-specified disharmonic segments, para. 3) loanwords, it is evident that words that had only back or only front vowels in them were also adapted as harmonic in Tuvan, for example, *fidik* from the Russian word *ˈvidik* ‘video cassette, film’ that was also borrowed from English (Pre-specified disharmonic segments, para. 3). In this case, I propose that when vowels already agree in backness in the source language, the [+back] feature of a vowel in the first syllable determines a better application of backness harmony than the [-back] feature and roundedness (the [+round] feature) of first vowels leads to productions of more rounding harmony words than unroundedness.

Another key role of syllable position was revealed in analyses of faithfulness to backness and roundness of input vowels. Overall, vowels in second syllables were less faithful to their backness feature than vowels in first syllables, in contrast, the roundness feature tended to be faithfully preserved in second syllables. Back vowels in first syllables were more faithful to their [+back] feature than front vowels. A general tendency of back vowels to preserve their backness value especially in first syllables in Yakut can be accounted for by the positional faithfulness constraint discussed by Beckman (1997), when vowels in first syllables of the root served as triggers of height harmony in Shona. I suggest that backness harmony in Yakut is triggered by vowels in first syllables, as in Tuvan (Harrison, 1999), specifically, in Yakut, positional faithfulness to back vowels in first syllables subsequently triggered backness harmony and spreading of the [+back] feature, whereas when it came to rounding harmony, faithfulness to the roundness value in second syllables was a precondition of rounding harmony applications.

Syllable position played a significant role in adaptations of stressed vowels. Clearly, stress in first syllables was more prone to conform to the most-frequent adaptation patterns to be realized as long vowels and diphthongs, which is broadly consistent with Dyachkovskiy’s (1962) and Sleptsov’s (1964) studies. Short vowels and retention of Russian stress tended to occur from input stressed vowels in second vowels, rather than in first syllables. These findings point to the general saliency of vowels in first syllables in languages with the rightward spreading of vowel harmony, like in Yakut.

Furthermore, higher ratings were given to rounded vowels in first syllables than to unrounded vowels in first syllables, which I link to the general rightward directionality of spreading of the [+round] feature value in the Yakut rounding harmony system. Thus, first rounded vowels always signal application of rounding harmony, and when participants heard words with rounded vowels in the first syllable, they might have instantly regarded them as more native-like and those words were rated higher. In other words, when prompted by first rounded vowels, participants assumed that rounding harmony was applied, and rounding harmony indicates resemblance to Yakut.

13.1.2 Word type

In analyses of application of backness harmony, rounding harmony, and Yakut-like adaptation, word type played a significant role, when, as expected, borrowed words had most adaptations following vowel harmony, since participants were generally familiar with the loanwords from the source language. A large number of harmonic adaptations of already borrowed words point to the fact that established loanwords strictly conformed to vowel harmony (e.g., Sleptsov, 1964). Moreover, vowels in borrowed words (i.e. established loanwords) were less faithful to the input backness feature, as opposed to adaptations of vowels in nonce and un-borrowed words. Specifically, whereas overall vowels in first syllables tended to be preserved more faithfully, vowels in second syllables in nonce and un-borrowed words were more faithful to the backness feature value of input vowels than second syllable vowels in borrowed words. This finding suggests that in order to conform to the vowel harmony rules, earlier loanwords tended to surface unfaithfully in regards to their input feature specifications, as opposed to on-line adaptations of nonce and un-borrowed words by bilingual speakers who were inclined to attend to the input characteristics of vowels and words, even at the cost of disharmonic and non-native like words in production.

Already borrowed words were previously used in experiments with inflection tasks, which primarily focus on suffixal vowels (e.g., Ringen & Heinämäki, 1999; Ringen & Kontra, 1989), rather than adaptations of the root. In this study, the borrowed words served as a warm-up activity and adaptations of entire words at the same time, in case participants did not know output correspondent loanwords from the input. In fact, the participants were actively engaged in *actual* adaptations when it came to nonce and un-borrowed words. The results showed that nonce and un-borrowed words did not differ significantly from each other. As suggested by Peperkamp and Dupoux (2003), in on-line adaptations by native speakers, one should include nonce words, and a number of studies involved nonce words in their experiments (e.g., Detey & Nespoulus, 2008; Kimper, 2011; Vendelin & Peperkamp, 2004; Vendelin & Peperkamp, 2006). The aim to include nonce words only is generally dictated by the idea to avoid a bias of general familiarity of the speakers with stimulus words. In fact, as proponents of the phonetic stance of loanword adaptation, Peperkamp and Dupoux and Vendelin and Peperkamp intended to get pure phonetic data.

I suggest that inclusion of un-borrowed words from the source language is the same as the inclusion of nonce words in terms of application of vowel harmony. Although Russian-Yakut bilinguals knew the Russian un-borrowed words, there was no distinction in terms of how they treated them from the completely novel nonce words they had not heard before.

Although there was no significant difference between nonce and un-borrowed words in application of vowel harmony, nonce and un-borrowed words differed in adaptations of stressed vowels. Stressed vowels in un-borrowed words lengthened significantly more often than in nonce words. As for adaptations of stressed vowels as short, in nonce words stressed vowels shortened significantly more frequently than in borrowed and un-borrowed words. This suggests that bilingual speakers employ different strategies in adapting stress for nonce and un-borrowed words. Namely, the most common adaptation of stressed vowels as long was prevalent for un-borrowed words that participants are familiar with in the source language. And the uncommon adaptation of stress as short vowels tended to apply to novel nonce words that are unfamiliar to the participants. I propose that familiarity of bilingual speakers with un-borrowed words in the source language enabled them to use the most common strategy of stress adaptation (lengthening), and unfamiliarity with nonce words prompted the participants to resort to the infrequent way of stress adaptation as short vowels.

To sum up, I have demonstrated that Russian-Yakut bilingual speakers employed the core-periphery hierarchy in regards to word type of input Russian words. Overall, better vowel harmony adaptations of borrowed words can be explained by their proximity to the native sublexicon following Itô and Mester's (1999) convention, the borrowed words that participants adapted already triggered their vocabulary of 'established loans' that they needed to map from input to output. Un-borrowed words, on the other hand, belong to 'unassimilated foreign' words, which belong to the peripheral fourth sublexicon with respect to native words (p. 64), therefore, participants applied better vowel harmony in borrowed words than in un-borrowed ones. However, the position of nonce words in the core-periphery hierarchy, to my knowledge, is not discussed in the studies of loanword adaptations, as the previous studies involved actual words (e.g., Cabré, 2009; Cohen, 2013; Kertész, 2003). The question whether nonce words belong to the sublexicon of unassimilated foreign words or whether they belong to the next peripheral stratum in respect to unassimilated foreign words, up to date remains open. In this study, I have demonstrated that there was no significant difference in the way participants adapted nonce versus un-borrowed words, therefore I speculate that merging nonce words in the stratum of unassimilated foreign words would be appropriate.

13.1.3 Stress

Previous studies have found a significant role of stress in loanword adaptations in harmonic languages (e.g., Ringen & Heinämäki, 1999; Ringen & Kontra, 1989; Sleptsov, 1964; Sy, 2006;). Unlike the previous studies, where stress played an important role in vowel harmony and disharmony, in this study, stress as a predictor did not play a significant role in vowel harmony applications. In earlier studies, stress was regarded as a significant feature in driving vowel harmony in Russian loanwords in Yakut, as the vowel quality of a stressed vowel was considered to be the most prominent, unlike the unstressed ones (e.g., Kulakovskiy, 1946; Sleptsov, 1964). These claims may stem from the fact that earlier loanwords in Russian were adapted mainly through perception and stress was regarded as the most prominent feature in the word (e.g., Kulakovskiy, 1946; Sleptsov, 1964). In this study, instead of the acoustic input, stress was cued in the written presentation in the Russian input words, which can be linked to the lack of significance of stress. While in studies on Hungarian (Ringen & Kontra, 1989), and in Finnish (Ringen & Heinämäki, 1999), the participants were also provided with the written input only, they still found an effect of stress in vowel adaptations, although not supported by statistical analyses. In a later study, Kimper (2011) ran linear mixed-effects modeling on Ringen and Heinämäki's data and revealed a significant effect of height, but did not specify what input features of vowels were specifically tested. Thus, I suggest that once a study does not have a statistically supported effect of stress in driving harmony, claims about the importance of stress in harmony and disharmony in loanwords should not be taken at face value.

In this study, most importantly, stress played a significant role in whether stressed vowels were adapted as long, diphthongs, short vowels, or retained Russian stress, rather than in driving vowel harmony. The results are in line with the previous studies in showing that high and low vowels tended to lengthen and mid vowels diphthongized (e.g., Anderson, 1995; Dyachkovskiy, 1962; Samsonova, 1959; Sleptsov, 1964). In earlier loanwords, the fact that there was a general tendency for mid vowels to diphthongize and for high and low vowels to lengthen was mainly accounted for by their acoustic similarities to stressed Russian vowels (e.g., Dyachkovskiy, 1962; Sleptsov, 1964). Stress is considered a salient feature, and one of the repair strategies of stress preservation in loanwords is vowel lengthening (e.g., Kenstowicz, 2007), which is also present in Yakut. Although Anderson (1995: 369) regards vowel lengthening and diphthongization in Yakut as replacement of stress in loanwords and claims that stress shifts to the regular word-final syllable, I regard the repair strategies as lengthening and diphthongization of vowels as stress preservation from the input. In other words, Russian loanwords that reflect the source language's stress have two primary stressed syllables, one expressed by length in a non-final syllable, and fixed stress in a final syllable. Recall that stress in Yakut is not acoustically prominent (Samsonova, 1959). Regarding stress shift, in adaptations based on perception in other languages, like Selayrese (Broselow, 2009) or Finnish and Hungarian (Fenyvesi & Zsigri, 2006), stress shift was employed dictated by the native phonology of fixed stress. However, in Yakut, even established loanwords adapted perceptually generally displayed systematic lengthening of high and low vowels, and mid vowels diphthongized (e.g., Dyachkovskiy, 1962; Sleptsov, 1964). The strategic decision of the modern bilingual Russian-Yakut speakers to reflect stress in the form of lengthening and diphthongization can also be influenced by their knowledge of the source language and their familiarity with Russian stress in general, which is reflective of Kang's (2010b) hypothesis that a closer language contact with the source language induces speakers to preserve stress more efficiently.

Furthermore, presence of stress in the input overall could assist in the backness and roundness features' preservation. Although stress per se did not predict the application of vowel harmony, in interaction with other features, it may suggest an effect on faithfulness of the input vowels to the backness and roundness features. Specifically, stressed non-high vowels were more faithful to their roundness feature than unstressed non-high vowels. That is, stress could facilitate the roundness feature of non-high vowels to surface faithfully, considering that height and roundness features are important in driving rounding harmony in disharmonic words. Less faithfulness to backness was established among front vowels, especially in stressed positions. That is, the negative effect of front vowels got more pronounced when combined with stress. Thus, I propose that stress may suggest facilitation of important driving features of harmony, that are otherwise insignificant as a predictor, to surface faithfully so that they serve as harmony triggers. For example, when testing faithfulness to roundness, the statistically non-significant predictor height significantly interacted with stress and strengthened the positive effect for non-high vowels, and as shown in analyses of output harmony, non-high vowels are triggers of rounding harmony in disharmonic words.

An interpretation that generally stress added more saliency to the certain feature values in their role of driving harmony can also be supported by Ringen and Kontra's (1989) findings, when in Hungarian, more back vowels in the suffixes were chosen in the disharmonic roots with /e/ following stressed back vowels, rather than unstressed back vowels.

13.1.4 Vowel input backness

Two front vowels in both syllables of input words contributed to significantly better Yakut-like adaptation and vowel harmony, whereas individual front vowels in either of the syllables were worse harmony triggers than back vowels. Even when both input vowels were front (i.e. harmonic), this resulted in fewer harmonic outputs than when both vowels were back. These findings, i.e. that back vowels were better harmony triggers, in some respect concur with Harrison's (1999) observation that in Kuu Kitsi's rounding harmony system, back vowels consistently serve as triggers and targets of harmony, unlike front vowels. Harrison's examples evidence the fact that even in languages that do not have transparent vowels per se, there is an inclination for specifically front vowels to display a transparent-vowel like behaviour. Transparent vowels tend to be front rather than back, like in Finnish (e.g., Ringen & Heinämäki, 1999), and in Hungarian (e.g., Ringen & Kontra, 1989). In this study, front vowels in Yakut, just like in Finnish or Hungarian with front transparent vowels, did not behave as harmony triggers to the same degree as back vowels. The observation that back vowels have a distinct advantage over front vowels in spreading their backness value, as opposed to front vowels, and ultimately leading to harmony, is not new. Välimaa-Blum (1999) clarified that in Finnish, back vowels spread their backness feature from left to right regardless of an interference of front vowels, whereas further (uninterrupted) front vowels' feature spreading was precluded by back vowels. This finding is in contrast to Kaun (2004), who identified front rounded vowels to be stronger triggers of rounding harmony than their back counterparts. She claims that because back vowels are more stable phonetically as compared to front vowels, front rounded vowels trigger harmony to gain a perceptual advantage. Thus, Kaun's finding suggests the positional markedness approach, as the harmonic weak feature spreads to strong targets (as seen in Walker, 2005). In Yakut, as the strong feature [+back] tends to spread its feature in *backness* harmony, the language favours the positional faithfulness approach (as in Beckman, 1997; also see Lloret, 2007).

Faithfulness to the input features and harmony triggers are related. In terms of faithfulness to the backness feature, there was more faithfulness to first back vowels, whereas front vowels, even when stressed, displayed less faithfulness to the [-back] value in the output. As discussed by Lin (2009), vowels' backness surfaced faithfully from English to Standard Mandarin more than the height and roundness values. In Yakut, not just faithfulness to the backness value was attested, but most importantly, faithfulness to back vowels, and especially in first syllables was shown, which I suggest to be driven by the rules of left-to-right spreading of the backness value in the native phonology. These findings also motivate the possibility of underspecification. Harrison (1999), following Steriade (1995) claims that the feature [back] is underspecified in all vowels following the initial vowel in backness harmony languages. As an extension of Harrison's claim, I suggest in Yakut, the feature [+back] is specified specifically in word-initial syllables and the feature [-back] is underspecified, since in productions more back vowels in first syllables surfaced faithfully to the [+back] feature value than in second syllables. Whereas Harrison treats both [+back] and [-back] values as equally operational in the Tuvan backness harmony system, in Yakut, back vowels in first syllables are shown to be more active than their front counterparts. I propose that in adaptations, Yakut speakers take all the features into account and apply vowel harmony (or disharmony) but regard the input [+back] feature in the first syllable as a strong potential feature spreading vowel.

The backness feature of vowels also played a role in the rating task, when backness harmony and rounding harmony violations were generally rated higher with second front vowels compared to second back vowels. According to Suomi (1983), listeners focus on vowels specifically in first syllables to identify F2 of the entire word, which signifies the distinction in backness and roundness. Considering that front vowels are phonetically weaker than back vowels (e.g. the roundness contrast in front vowels) (Kaun, 2004), I suggest that participants paid more attention to first back vowels and neglected the F2 difference of a phonetically less stable front vowel in the following syllable of a disharmonic word. In the case of rounding harmony violations, the possibility of why the listeners rated rounding harmony violations with particularly front vowels higher is connected to Kaun's (1995, 2004) claim that perceptually rounding of front vowels is harder to detect in contrast to back rounded vowels. Note that all words with rounding harmony violations agreed in backness. Consequently, participants might have been misguided by the comparatively blurred roundness distinction in front vowels which affected their ratings. In addition, although generally participants were good at discriminating grammaticality of the nonce words, they still produced words violating vowel harmony - 977 words violating backness harmony (18.9% out of 5,160 words in total) and 1,098 words (33.6%) not conforming to the rules of rounding harmony (from a total of 3,265 words). I agree with Harrison (1999) that disharmony should not be regarded as an exceptional phenomenon in a harmony language, and in line with Kertész (2003), as mentioned earlier, I regard loanwords as operating on a different stratum distinct from the core native sublexicon.

13.1.5 Vowel input roundness

Unlike the Tuvan harmony system, where the feature [-round] is active in rounding harmony applications (Harrison, 1999), in Yakut, I propose that the [+round] feature is more active than [-round] in driving rounding harmony. The data of the production task suggests that the roundness feature is crucial. Namely, unrounded input vowels per se in either of the syllables produced fewer output rounding harmony words than rounded ones did, and this effect was also attested in harmonic words agreeing in backness, when first unrounded vowels led to fewer rounding harmony applications. These results show that the input vowel feature [+round] is the trigger of rounding harmony in on-line adaptations also. As back vowels are shown to be better backness harmony triggers, and the two back input vowels /o, u/ are also rounded, I have demonstrated that there is an overall bias towards better vowel harmony adaptations in Yakut when it comes to input back/rounded vowels. In the overall best model of rounding harmony, rounded vowels in either of the syllables triggered more rounding harmony application, which is consistent with Kaun's (1995) claim that triggers of rounding harmony are rounded vowels that spread their roundedness features to target unrounded segments. In Tuvan, where native phonology also employs the rightward spreading of roundedness, leftward spreading of the input [+round] feature was attested in Mongolian loanwords (Harrison, 1999).

Overall, more faithfulness to the roundness feature is shown among unrounded vowels than rounded ones. Moreover, participants rated nonce words containing first rounded vowels higher than words with first unrounded vowels. Since the Yakut harmony system exhibits a rightward directionality in the spreading of the feature [+round] conditioned by the height of vowels (e.g., Kaun, 1995; Sasa, 2009), all native words with rounding harmony start with a rounded vowel in the first syllable, not vice versa. When listeners hear a first rounded vowel, it indicates that rounding harmony will have been applied. In case of absence of a rounded vowel, no instant positive indication of resemblance to a Yakut word occurs. This finding suggests that first rounded vowels overall signalled the general well-formedness of incoming words motivated by the native rounding harmony system. Furthermore, rounding harmony violations (disharmonic rounding harmony words) were rated higher than backness harmony violations. Recall that rounding harmony violations always agreed in backness. A general perceptual difference of backness harmonic versus disharmonic combinations in the nonce words is in line with Suomi, McQueen, and Cutler's (1997) findings that Finnish listeners were faster in detecting the word *hymy* 'smile' within the disharmonic nonce word *puhymy* rather than in the fully harmonic *pyhymy*. Just like the Finnish listeners who recognized actual words embedded in disharmonic nonce words faster than in harmonic contexts, Russian-Yakut bilingual listeners were more efficient in identifying and rating backness disharmonic words lower than backness harmonic words that violated the rounding harmony rules. Besides, in Yakut, rounding harmony is achieved on condition that vowels within words follow the backness harmony rules; this regularity is common in Turkic languages implying that "Rounding harmony (RH) follows backness harmony" (Harrison, 1999, Rounding harmony, para. 1). Note that in the production task, 1,098 words violated rounding harmony (33.6%) from 3,265 applicable words, whereas only 977 words (18.9%) had backness harmony violations, which suggest that participants were more tolerant to rounding harmony violations in both production and perception.

13.1.6 Vowel input height

A general tendency for low and high-mid vowels to trigger harmony, especially in disharmonic words, was revealed in better applications of Yakut-likeness and vowel harmony. In contrast to Cohen (2013), who identified high vowels as better harmony triggers in English loanwords in Hebrew than low vowels conditioned by UG tendencies, I suggest that in Yakut, non-high vowels are better triggers of vowel harmony in disharmonic words. In harmonic words, however, second high-mid vowels produced fewer rounding harmony words, and especially when combined with first high vowels. As presented by Cohen, Hebrew does not have vowel harmony in its native phonology, and vowel harmony only arises in loanwords. I agree that when there is an emergence of the unmarked, patterns that are not operative in the core stratum are more strongly linked to the predispositions of UG. Clearly, in Yakut non-high vowels tend to better trigger vowel harmony than high vowels, which is specific to the native phonology. This result is in line with Kaun (2004), who found that since rounded non-high vowels appear with less rounding in perception, they tend to become harmony triggers, unlike "perceptually more stable" (p. 96) high vowels.

Another possible explanation for why the input high vowels /i, u/ did not facilitate vowel harmony applications could be linked to their 'extreme' positions in the vowel space (i.e., on the two upper leftmost and rightmost edges), as pointed out by Crothers (1978). Therefore, characteristics of the two high vowels also conveyed the widest horizontal movements of F2 within the vowel space to distinguish backness (e.g., Crothers, 1978; Suomi, 1983). Following Kaun's (1995) claim that because rounded non-high vowels are phonetically weaker than high vowels and therefore are better harmony triggers, I speculate that motivated by the high vowels' larger distance with respect to each other and their profound distinction between the backness feature values, the Yakut speakers favoured less distant and less distinctively peripheral lower vowels in the vowel space to be triggers of harmony, and specifically, *rounding* harmony. This finding suggests the positional markedness approach in rounding harmony in Yakut, when phonetically weak segments serve as triggers to increase their perceptual saliency (in contrast to backness harmony, which implies positional faithfulness, as argued above in Section 13.1.4).

Furthermore, stressed high-mid vowels tended to shorten or retain Russian stress, unlike high and low vowels. Although there is a general tendency for Russian input mid vowels to diphthongize due to their acoustic similarity to the Yakut diphthongs (e.g., Dyachkovskiy, 1962; Sleptsov, 1964), in contrast to the other vowels they exhibited a tendency not to conform to the most-frequent adaptations of stressed vowels as long or diphthongs. In fact, generally high-mid vowels had more variability in the output, which, following Lin (2009), can be linked to the overall saliency of peripheral high and low vowels compared to mid vowels. As shown by Dyachkovskiy or Sleptsov, the stressed Russian vowel /ˈe/ acoustically has an on-glide corresponding to /i/ and stressed /ˈo/ has an on-glide /u/. Thus, stressed high-mid vowels are more ambiguous in terms of their height, as they simultaneously carry characteristics of high vowels. Thus, this ambiguity of the height feature in high-mid vowels yields more variations in their adaptations. Moreover, overall less faithfulness to the roundness feature was observed in non-high vowels in second syllables and even in more salient stressed positions. This finding is also consistent with Lin (2009) who showed that mid vowels were less likely to faithfully map their feature value than high and low vowels.

13.2 Adaptation: phonetic and phonological accounts

In this study, adaptations were based on the silent reading of Russian input words presented orthographically. When cued by orthography, speakers tend to adapt phonologically rather than phonetically, as graphemes give access to categories of the source language (Dohlus, 2005; Peperkamp & Dupoux, 2003). Moreover, no full deactivation of the source language is claimed to occur among bilingual speakers (Paradis & LaCharité, 1997). Even if the recommendations by Peperkamp and Dupoux are followed regarding the online adaptation data collection methodology, and the Russian-Yakut bilingual speakers were provided with the auditory input of nonce words only, there is a high probability that they would still engage in grapheme-to-phoneme mappings between Yakut and Russian, similar to Vendelin and Peperkamp's (2006) experiments with French-English bilingual speakers adapting English nonce words. Whereas earlier loanwords were adapted perceptually by monolingual Yakut speakers (Böhtlingk, 1851/1964; Kulakovskiy, 1946; Sleptsov, 1964) and adaptations were essentially phonetic, as modern bilingual speakers have access to the categories of the Russian phonology one could presume that it leads to more phonological, rather than phonetic adaptations. In fact, the most common vowel adaptations of the five Russian input vowels showed both phonological and phonetic adaptations. The general mappings of Russian vowels, i.e. most-frequent adaptations, point to an overall categorical proximity between input and output vowel correspondents. In other words, based on the most-frequent adaptations of the unstressed /a, e, i, o, u/ as /ɑ, ɛ, i, ɒ, u/ respectively, I view the vowel adaptations as having shared categorical features with the input, and thus being similar featurally. For example, the shared height and roundness features between the low unrounded vowels /a/ and /ɑ/, or the shared backness, roundness and height features between the front unrounded mid vowels /e/ and /ɛ/. Besides, as far as the shared vowels between Yakut and Russian are concerned, it is harder to determine if adaptations of the vowels /i, u/ are phonetic or phonological, or a combination of both, as more acoustic measurements of the Yakut vowels are needed to determine their precise phonetic characteristics.

Furthermore, recall that the high-mid vowels /e, o/ had the most variation compared to the high and low vowels /a, i, u/, which is consistent with Lin's (2009) claim that in terms of faithful feature mapping, mid vowels had more variability than peripheral high and low vowels in English loanwords in Standard Mandarin. Nevertheless, general lengthening and diphthongization of stressed vowels reveal a phonetic adaptation. It is well attested that in Russian, stressed vowels are longer than their short correspondents (e.g., Avanesov, 1964), and that a pre-sound occurs before the Russian stressed high-mid vowels (e.g., Dyachkovskiy, 1962). Earlier loanwords, when they were adapted perceptually (e.g., Sleptsov, 1964), were guided by those acoustic realizations of stressed vowels, and were adapted accordingly, reflecting those phonetic characteristics, so that high-mid vowels tended to diphthongize most frequently in adaptation. Although in the present study participants were not given any auditory input, they still generally adapted the stressed vowels with lengthening and diphthongization. This finding also raises the possibility that participants had a subconscious knowledge of phonetic realizations of the input words and vowels from the source language and have developed some general phonological mapping rules that take stress into account.

Therefore, regarding the on-going debate between phonetic and phonological stances of loanword adaptation, following Paradis and LaCharité (2011), I regard phonetic adaptations as more important for monolinguals, whereas phonological adaptations are more common among bilinguals who are familiar with the phonological categories of the source language. This study indicates that adaptations are not strictly phonetic or phonological, but rather a combination of both stances, as shown in earlier studies (e.g., Ito, et al., 2006; Kochetov, 2008).

13.3 Theoretical frameworks of adaptation of vowel harmony

Recent analyses of vowel harmony were largely conducted within the OT framework (e.g., Kenstowicz, 2009; Ringen & Vago, 1998; Walker, 2012), including vowel harmony studies in loanwords (e.g., Cabré, 2009; Cohen, 2013, Ringen & Heinämäki, 1999), where interactions of both faithfulness and markedness constraints of the borrowing language have accounted for grammars at play driving vowel harmony in adaptations. Analyses of loanwords through the native phonology's constraints afforded by the principles of a constraint-based approach in OT contributes to the understanding of loanword nativization (Golston & Yang, 2001: para. 3), as opposed to rule-based phonology where adding novel rules to the grammar would be necessary in accounting for loanword adaptations, since input of a foreign word displays illegal structures underlyingly not present in the native phonology (Peperkamp, 2004: 341).

Although the OT framework in studies of loanwords in particular has provided an opportunity to engage constraints of the borrowing language's grammar from the predictable input of the source language, its strict input-output orientation has motivated the emergence of other frameworks, such as Stochastic OT (e.g., Boersma, 1997) and Harmonic Grammar (e.g., Coetzee & Pater, 2008), which are still based on the OT constraint-based approach. These recent frameworks allow some variability in the output which is not permitted in the strict OT framework that aims for a single (and most optimal) winner from the input. Besides, classic OT principles are suitable in analyses of native words, for instance, like vowel harmony in Turkish, Igbo, etc. in Walker (2012) or vowel harmony in (established) loanwords in Hebrew (Cohen; 2013). In this case, application of the classical OT framework is justified, since interactions of constraints of the native phonology are aimed to present a single (and predictable) output candidate whether from the native sublexicon or from the one of established loanwords, if viewed in the core-periphery convention.

Let us turn to analyses of vowel harmony[46] in participants' productions of borrowed words within the OT framework, since the borrowed words have recognized input-output correspondences, and any other candidate distinct from the output, i.e., the established loanword, is ruled out. I acknowledge the fact that there was output variation even in the productions of borrowed words with an expected output, and other frameworks, like Stochastic OT, would still be suitable in analyses of the data. The purpose of the following analyses within the classical OT framework, however, is to show interactions of the specific constraints of the native phonology that drove vowel harmony application in the established loanwords.

Thus, I randomly select the input Russian word *ˈzontik* 'umbrella', which was included as a borrowed word in the production task. Note that the input word is disharmonic in backness. The output competing candidates in the tableaux below are actual productions of the borrowed words by the participants. All winning candidates are actual loanwords (in this case, *suɒntʃuk*), since most participants produced the borrowed words as their expected output - 1,091 out of 1,584 produced borrowed words (68.9%). For comparison purposes only, I include the participants' actual productions of the borrowed words in the following tableaux (28, 31, 33) as suboptimal candidates to illustrate what fatal violations of the constraints of the native grammar those candidates incur which leads to disharmony. In other words, I show the constraint ranking active in the vowel

[46] As I analyze exclusively vowel adaptations in this dissertation, consonant adaptations are disregarded.

harmony application in established loanwords. I acknowledge the fact that the OT analyses presented below are *not* complete accounts of Yakut vowel harmony, but rather the demonstration of the specific constraints active in the nativization of the Russian input.

Since earlier and established loanwords have completely undergone vowel harmony (Böhtlingk, 1851/1964; Sleptsov, 1964), I include the undominated alignment constraint that Harrison (1999) presents in the description of backness harmony, based on Smolensky (1993).

(23) **ALIGN [αBACK]- WD**
Align [αback] with edge of word (Smolensky, 1993,
as cited in Harrison 1999, Formal analysis of BH, para. 1).

The alignment constraint in (23) ensures that the feature [+/-back] is aligned with the word domain's edge (Harrison, 1999, Formal analysis of BH, para. 1). In other words, this constraint checks that all vowels within a word (i.e. domain of harmony) share one harmonizing feature [back], since backness harmony in Yakut affects all vowels in the entire word. That is, a violation of the alignment constraint occurs when there is a vowel bearing a contrasting feature within the harmony domain, distinct from the specified harmonizing feature of the domain, like an intervening [+back] vowel segment in the harmony domain specified for the harmonizing feature [-back]. Pulleyblank (1996: 297) clarifies that in the forms with full harmony, within the harmonic domain, the harmonic feature is aligned with both left and right edges, i.e. all vowels agree in the harmonic feature specification of the harmonic domain.

After a careful overview of Russian loanwords in general, I conclude that Yakut preserves all vowel segments from the input, which is the reflection of Preservation of Paradis and LaCharité's (1997) Theory of Constraints and Repair Strategies Model (TCRS). Instead of deleting vowels, loanwords exhibit insertion to conform to the phonotactic rules of the language, either to repair complex onsets, like internal epenthesis in *sɛrɛbiɛj* 'lot' from the input *ˈʐrebij* or edge epenthesis in *ustudʒuɒn* 'student' from *stuˈdent*, and to resolve word-medial consonant clusters, as in *ɯhɯːrɯɲːɯk* 'zhirnik' from *ˈʐirnik*, where there is also an edge epenthesis word-initially. Moreover, some loanwords display more vowels and consonant insertions not motivated by repairing illegal consonant clusters nor consonants in the onsets, for instance in *sɛliɛɲːɛ* 'village' from *seˈlo*. Thus, the constraint of the native phonology regarding insertions of segments is:

(24) **MAX-IO**
Input segments must have output correspondents
('No deletion') (Kager, 2009; 67).

Since established loanwords consistently have backness harmony and show preservation of segments from the input, the two constraints are unranked with respect to each other, i.e. both ALIGN [αBACK]-WD and MAX-IO constraints are highest-ranking. Moreover, if MAX-IO is the highest-ranking undominated constraint, since neither a review of established loanwords (see Dyachkovskiy, 1962; Sleptsov, 1964, for instance) nor the adaptations in the present study indicate instances of deletion, I identify another faithfulness constraint that militates against epenthesis in (25). A DEP-IO constraint penalizes inserted segments, and considering that stressed Russian vowels systematically lengthen and diphthongize by inserting additional segments in the output that are not correspondent with the input, the constraint is frequently violated in loanword phonology.

(25) **DEP-IO**
Output segments must have input correspondents
('No epenthesis') (Kager, 2009: 68).

Most importantly, as shown by Dyachkovskiy and Sleptsov, there is a tendency for stressed vowels in Russian loanwords to become long (or diphthongs) in general. Since Russian has obligatory main stress (see Melvold, 1989), all loanwords from Russian contain a long vowel or diphthong, although not always with the strict input-output correspondences. In other words, not all stressed vowels lengthen or diphthongize (e.g. Sleptsov, 1964), for instance, in *kiːnɛ* 'movie' from *kiˈno*, the second stressed /ˈo/ is realized as the short /ɛ/, where in turn, the unstressed input /i/ lengthened in the output. Insertion of an additional segment not correspondent to the input segment constitutes a violation of the DEP-IO constraint, as the second vowel segment of the long vowel has no correspondent input segment.[47] Clearly, the DEP-IO constraint is systematically violated in loanword phonology, therefore it is the lowest-ranking.

The input word *ˈzontik* is disharmonic, however, it surfaced as harmonic *suɒntʃuk* with all

[47] I regard diphthongs and long vowels as consisting of two segments. For example, Kenstowicz (2007: 320) in OT analyses of stress adaptation in English loanwords in Fijian, shows that an output *ˈkoːˈloni* 'colony' that has lengthening of the first syllable vowel /oː/ from the input /koloni/, constitutes one violation of the DEP-MORA constraint which bans the epenthesis of a mora. I use DEP-IO as an umbrella constraint that penalizes inserted segments in both diphthongs and long vowels in the output.

back vowels within the word. It shows that the input feature [-back] is not preserved faithfully. In (26) I introduce the faithfulness constraint which ensures that the feature [back] is preserved:

(26) **IDENT-IO**(back)
Let α be a segment in the input, and β be a correspondent of α in the output.
If α is [γback], then β is [γback] (Kager, 2009; 260).

Since vowels frequently change their input specifications for the feature [back] to conform to the rules of vowel harmony, the IDENT-IO(back) constraint is ranked lower and is dominated by the unranked ALIGN [αBACK]-WD and MAX-IO. Furthermore, as visible in the output candidate *suɒntʃuk*, the roundedness feature of /u/ also surfaced unfaithfully to the input unrounded vowel /i/. This tendency incurs a violation of another faithfulness constraint introduced in (27):

(27) **IDENT-IO**(round)
An output segment has the same value for [round] as its input correspondent (Kager, 2009; 409).

Both faithfulness constraints are crucially unranked with respect to each other, as Yakut permits violations of IDENT-IO(back) and IDENT-IO(round).

As none of the participants in the production task produced a word with deletion, I only show interactions between the alignment (23) and the faithfulness (25, 26, and 27) constraints, where the former outranks the latter. The tableau in (28) shows how backness harmony is applied to the input disharmonic word.

(28) Application of backness harmony to the disharmonic input[48]

Input: /ˈzontik/ ‘umbrella’	ALIGN [αBACK]-WD	IDENT-IO (back)	IDENT-IO (round)	DEP-IO
a. zuɒntʃik	*!			*
b. ☞ suɒntʃuk		*	*	*

The winning candidate (28b) does not incur a violation of the highest ranked ALIGN [αBACK]-WD constraint while it violates the low-ranking IDENT-IO(back) and IDENT-IO(round), since the front unrounded vowel /i/ in the input surfaces as the back rounded /u/. The losing candidate (28a) is ruled out, since it is disharmonic in backness despite satisfying the low-ranking

[48] Candidate (28a) is participant no. 5’s production.

IDENT-IO(back) and IDENT-IO(round). As the winning candidate (28b) demonstrates, any attempt to have disharmonic output candidates would be ruled out by the highest-ranking ALIGN [αBACK]-WD that bans disharmony in backness. Finally, both candidates violate the lowest-ranking DEP-IO constraint for inserting an additional segment (as the output diphthong /uɒ/ contains two segments) from the single input segment /o/.

In tableau (28) the initial vowel in the input is rounded, and the feature [+round] is spread leftward. However, a loanword like *bœtyːk* 'rooster' from the input *peˈtux* shows regressive spreading of roundedness, which is well attested in loanwords in Turkic languages (e.g., Harrison, 1999; Kaun, 2004). Recall that unlike backness harmony, where all vowels must agree in backness within a prosodic word, in rounding harmony, not all vowels agree in the feature [round]. Therefore, as opposed to the alignment constraint of backness harmony, where the feature [back] is aligned with both edges of the word, it is necessary to specify the edges of the roundedness feature alignment within the prosodic word. All things considered, following Kaun (2004), I include the following alignment constraint which ensures that rounded vowels are on the prosodic word's leftmost edge, which means that no unrounded vowel can intervene between a rounded vowel and the prosodic word's leftmost edge:

(29) **ALIGN-L([RD], PRWD)**
The autosegment [round] is aligned with the left edge of the Prosodic Word
(based on Kaun, 2004: 104).

Kaun (2000) posited the gestural uniformity constraint presented in (30) that militates against distinct heights of two adjacent rounded vowels in order to attain a uniform gesture of a specific feature. The loanword *bœtyːk* exhibits two successive rounded vowels that have different height values, however, in Yakut it is grammatical to have such a sequence: a low rounded vowel followed by a high rounded vowel.

(30) **GESTUNI[RD]**
The feature [round] should be realized with a uniform mechanism of articulation
(Kaun, 2000: 99).

Incidentally, in Yakut, all rounding harmony words have backness harmony instantaneously, so ALIGN [αBACK]-WD is unranked with respect to ALIGN-L([RD]), thus I do not include the former undominated constraint in the tableaux below. Neither do I include IDENT-IO(back) which is crucially unranked with IDENT-IO(round). I demonstrate the interactions of the constraints (29) and (30), including the low-ranking IDENT-IO(round) in the example of the input *pe*ˈ*tux*:

(31) Regressive spreading of rounding harmony[49]

Input: /peˈtux/ 'rooster'	ALIGN-L([RD], PRWD)	GESTUNI[RD]	IDENT-IO(round)	DEP-IO
a. bɛtyːk	*!			*
b. ☞ bœtyːk		*	*	*

The winning candidate (31b) shows that rounded vowels are aligned with the leftmost edge of the prosodic word. By contrast, the losing candidate (31a) includes an unrounded vowel followed by a rounded one, and thus incurs a fatal violation of the highest-ranking ALIGN-L([RD], PRWD) constraint. The winning candidate (31b) violates the low-ranking GESTUNI[RD] due to the low-mid vowel /œ/ followed by the high vowel /y/, and the candidate (31a) vacuously satisfies GESTUNI[RD] as it does not have two rounded vowels of different heights.

In the native phonology of the rounding harmony system, unrounded vowels also occur preceded by rounded vowels, conditioned by the height of the rounding harmony triggers and targets, i.e., if a rounded high vowel is followed by a low vowel, the latter does not become rounded (see Kaun, 1995). Thus, an ALIGN-R([RD]) constraint that ensures the alignment of the [+round] feature on the prosodic word's rightmost edge (Kaun, 2004), is ranked below ALIGN-L([RD], PRWD). Interaction of the three constraints ALIGN-L([RD], PRWD)>> GESTUNI[RD]>> ALIGN-R([RD], PRWD) accounts for the rounding harmony system in Yakut, which specifically shows the crucial role of height for rounding harmony triggers and targets. Recall that high rounded vowels do not spread their roundedness feature to the following low vowels, therefore an output *uruːpar* 'megaphone' from the input ˈ*rupor* is grammatical, in contrast to *uruːpɒr* where the high vowel /u/ acts like a rounding harmony trigger by spreading roundedness to the following low vowel, thus violating the rounding harmony rules.

(32) **ALIGN-R([RD], PRWD)**
The autosegment [round] is aligned with the right edge of the Prosodic Word (based on Kaun, 2004: 104).

The loanword *uruːpar* exhibits edge epenthesis of the vowel /u/ to the input's word initial

[49] Candidate (31a) is participant no. 10's production.

consonant /r/ dictated by the phonotactic rules of the native phonology, as /r/ does not appear in the word-initial position in Yakut (Krueger, 1962/2012). As seen in the tableau (31) for the word *bœty:k*, two successive rounded vowels again have different heights here, however, the candidate wins since it satisfies the highest-ranked ALIGN-L([RD], PRWD). However, to preclude the illegal sequence *u-ɒ* from the input *ˈrupor*, the ALIGN-R([RD], PRWD) constraint is outranked by GESTUNI[RD] to activate de-rounding of the low vowel aligned with the right edge of the prosodic word, presented in the tableau (33):

(33) Emergence of unrounded vowels preceded by high rounded vowels in RH[50]

Input: /ˈrupor/ 'megaphone'	ALIGN-L([RD], PRWD)	GESTUNI [RD]	ALIGN-R([RD], PRWD)	IDENT-IO (round)	DEP-IO
a. uru:pɒr		*!			**
b. ☞ uru:pɑr			*	*	**
c. ru:pɒr		*!			*

As visible in the table (33), all three candidates satisfy the highest-ranking ALIGN-L([RD], PRWD) constraint, as the first (leftmost) vowels in (33a-c) are all rounded. The winning candidate (33b) *uru:par* incurs violations of the low-ranking constraints dominated by GESTUNI[RD], since unrounded vowels are allowed on the right edge of prosodic words in Yakut. The candidates (33a) and (33b) are ruled out as they incur fatal violations of the high-ranking GESTUNI[RD], which militates against two adjacent rounded vowels of different heights. The winning candidate also violates the low-ranking IDENT-IO(round) for the unfaithful mapping of the feature [round] from the input rounded /o/, which surfaced as the unrounded /ɑ/. Both losing (33a) and winning (33b) candidates violate the lowest-ranked DEP-IO twice for inserting a vowel word-initially, and for lengthening the input short stressed vowel. The other losing candidate (33a) incurs one violation of DEP-IO for lengthening of the short input /u/.

Thus, I have demonstrated the grammar of the native phonology at play in application of vowel harmony in established loanwords. In essence, adaptations of earlier established loanwords were driven by the highest-ranking alignment constraints permitting vowels of the same backness value within a prosodic word and ensuring that rounded vowels are aligned with the prosodic

[50] Candidate (33a) is participants no. 13, 19, 39's productions; and candidate (33c) is participants no. 7, 9, 15, 25, 26's productions.

word's left edge, thus facilitating rightward spreading of rounding. Yakut grammar also encourages preservation of vowel segments, expressed by the highest-ranking MAX-IO. Adaptations in Yakut avoid illegal sequences of high rounded vowels preceding low rounded vowels, since GESTUNI[RD], which militates against two successive rounded vowels of different height, is ranked above the alignment constraint that ensures rightmost alignment of rounded vowels within a prosodic word. Clearly, in the Yakut rounding harmony system, not all vowels have to be rounded, and unrounded vowels do occur word-finally, whereas sequences like *u-ɒ* and *y-œ* are illegal in the native phonology (Sasa, 2009). Established loanwords also show that the feature values [back] and [round] have a tendency to surface unfaithfully from the input word of the source language, hence, the faithfulness constraints IDENT-IO(back) and IDENT-IO(round) are low-ranking in the loanword phonology. Within the OT framework, I have determined the constraint rankings that account for the surface forms of the established loanwords that systematically conform to the grammar of the native phonology and undergo complete vowel harmony. In (34) I present the conclusive rankings of constraints of vowel harmony in established loanwords:

(34) Conclusive rankings for vowel harmony application in loanwords in Yakut

ALIGN [αBACK]-WD, ALIGN-L([RD], PRWD), MAX-IO >> GESTUNI[RD] >> ALIGN-R([RD], PRWD) >> IDENT-IO(back), IDENT-IO(round) >> DEP-IO

With the conclusive rankings of the constraints active in application of vowel harmony in loanwords, I turn to the analyses of the production data for adaptations of nonce and un-borrowed words with the same set of ranked constraints. I use the same combination of the input vowels *ˈo-i* as in the input word /ˈzontik/, which is adapted as *suɒntʃuk* in (28), i.e. with the output harmonic vowel sequence *uɒ-u*. An un-borrowed word *ˈbotik* 'boot' with the same vowel and stress combination was adapted by a total of 36 participants.[51] I focus on the vowel adaptations only and disregard consonant adaptations, that is, when two words have different consonants but have the same vowel combinations within words, they will be regarded as a single pattern of adaptation, like the sequence *uɒ-u* in two words *buɒtʃuk* and *buɒtuk* with two different word-medial consonants. Thus, I select the four most-frequent variations of adaptation of the input vowels /ˈo/ and /i/ in the word *ˈbotik*: twelve participants (33.3%) adapted the vowels as *uɒ-u*, which is the

[51] Participant no. 24 did not adapt the word.

most-frequent adaptation and has the same vowel sequence as the borrowed word *suɒntʃuk*; five participants (13.9%) adapted it as a disharmonic sequence of vowels *ɒː-i*, but faithful to the input roundness and backness features, with lengthening of the input stress; and another five participants (13.9%) also produced a disharmonic output word with the vowels *uɒ-i* with the diphthongization of the input stressed vowel /ˈo/; and three participants (8.3%) produced a harmonic word *bœːtyk* with all front vowels in it. I present analyses of the most-frequent adaptations of the input word *ˈbotik* in the tableau (35):

(35) Adaptation of the disharmonic input un-borrowed word /ˈbotik/

Input: /ˈo-i/	ALIGN [αBACK]-WD	ALIGN-L([RD], PRWD)	MAX-IO	GESTUNI [RD]	ALIGN-R([RD], PRWD)	IDENT-IO (back)	IDENT-IO (round)	DEP-IO
a. ☞ uɒ-u						*	*	*
b. ɒː-i	*!				*			*
c. uɒ-i	*!				*			*
d. œː-y				*!		*	*	*

The winning candidate (35a) shows that the same ranking of the set of constraints as for established loans is applicable to analyses of the production task data, as the harmonic output *uɒ-u* displays the most-frequent adaptation. However, the next most-frequent adaptations of the input were the disharmonic vowel sequences *ɒː-i* and *uɒ-i* that violate the same constraints. Both candidates (35b-c) are ruled out by the highest-ranking ALIGN [αBACK]-WD, which penalizes candidates disagreeing in backness. Although the two candidates satisfy the IDENT constraints, as they faithfully preserve the backness and roundness features, when it comes to disharmonic input words, complete faithfulness, especially to the backness features, leads to disharmony in the output. Furthermore, there is an interesting observation regarding the stress adaptation in *ɒː-i* and *uɒ-i*, as the input stressed high-mid vowel /ˈo/ is adapted as long and as a diphthong, despite the common pattern of diphthongization of input stressed high-mid vowels in established loanwords. This observation suggests that the bilingual speakers employ various strategies in stress adaptation, considering that adaptation of the stressed /ˈo/ as the long /ɒː/ is classified as 'rare' by Sleptsov (1964). Finally, the candidate (35d) loses to the winner (35a) due to incurring a fatal violation of GESTUNI[RD], as the adjacent rounded vowels /œː/ and /y/ in *œː-y* have different height values. A generalization that can be derived from the data in (35) is that all input stressed vowels were either lengthened or diphthongized, with a high tendency to reflect the input stress in the output. Most importantly, none of the most-frequent vowel adaptations of the input word *ˈbotik* violated the highest-ranking MAX-IO and ALIGN-L([RD], PRWD), showing that no deletion of a vowel segment nor de-rounding of the input leftmost rounded vowel occurred.

To test this analysis a disharmonic input word with a back rounded vowel /u/ on the rightmost edge of the input word preceded by an unrounded vowel /e/, I choose the same set of vowel combinations *e-ˈu* as in the borrowed input word *peˈtux* 'rooster', analyzed above in (31). Adaptation of this disharmonic word exhibits regressive spreading of roundness to conform to the rules of rounding harmony with the output vowel sequence *œ-yː* in the loanword *bœtyːk*. A total of 36 participants[52] adapted a nonce disharmonic word *leˈrut* and it had two most-frequent adaptations: sixteen participants (44.4%) adapted the vowels in the input word as the disharmonic combination *e-uː*, and ten participants (27.8%) realized the vowels as the harmonic sequence *œ-yː*, just like the vowels in the borrowed word *bœtyːk*. Bearing in mind that the most-frequent adaptation is disharmonic, I demonstrate that the ranking of the constraints that outputs fully harmonic candidates is not always reflective of the most-frequent adaptation in the production data.

(36) Adaptation of the disharmonic input nonce word /leˈrut/

Input: /e-ˈu/	ALIGN [αBACK]-WD	ALIGN-L([RD], PRWD)	MAX-IO	GESTUNI [RD]	ALIGN-R([RD], PRWD)	IDENT-IO (back)	IDENT-IO (round)	DEP-IO
a. e-uː	*!	*						*
b. ☞ œ-yː				*		*	*	*

The fact that most participants were inclined to preserve the backness and roundness features of the disharmonic word at the cost of disharmony in the output shows that for some bilingual speakers, faithfulness to the input features is more important than application of vowel harmony. Hence, I demonstrate that if the same constraint ranking with an orientation to a fully harmonic candidate as the winner is used, the most frequent disharmonic candidate of the on-line adaptation is ruled out by the highest-ranking alignment constraints. It is noteworthy that based on the losing candidate (36a), the ALIGN-L([RD], PRWD) constraint tends to be violated when the input leftmost

[52] Participant no. 23 did not adapt the word.

vowel is unrounded and the rightmost is rounded. In contrast, no de-rounding of the second input rounded vowel is attested in the most-frequent adaptation here. Therefore, I propose that backness, roundness and height features of vowels, and whether they occur in first or second syllables, are crucial in predicting harmony and disharmony in adaptation. Note that the candidate (36a) shows an importation of the Russian phoneme /e/, and no instance of importations was attested in earlier loanwords that mapped all vowels to Yakut correspondents. As noted by Paradis and LaCharité (2011: 776), fluent speakers of the source language often resort to importations in the contexts of data elicitation, as they are highly tolerant for sounds and structures of the source language.

As presented in this dissertation, disharmony and non-Yakut-like adaptation occur in on-line adaptations among the modern bilingual Russian-Yakut speakers, and analyses of the data within the classical OT approach is not fully suitable. Furthermore, as online adaptations are characterized as "foreign words that are borrowed 'here-and-now'" (Peperkamp, 2004: 342) and they do not yet belong either to the native or to the established loanwords sublexicon, it is expected that they allow more variability which *can* be accounted for within the framework of Stochastic OT, for instance. In this study, with respect to the analyses of vowel harmony in on-line adaptations from Russian into Yakut, I used linear mixed-effects models to reveal significant input predictors that drive vowel harmony and Yakut-like adaptation. Since the main research question of this dissertation was to explore Yakut grammars applicable in loanword phonology, given the empirical nature of the data and variability in adaptation, I consider analyses within the frameworks of Stochastic OT would be most relevant. Then, the findings derived from the linear mixed-effects models in this dissertation would lead to the establishment of a set of markedness and faithfulness constraints that I would implement in analyses of vowel harmony and other research questions applicable in loanword applications. Nevertheless, considering the dissertation's main research question, involvement of statistical analyses of the data using linear mixed-effects model was, all things considered, most pertinent and befitting.

In sum, I suggest that there is no one single framework that is the most optimal to implement in studies of vowel harmony or vowel adaptations. A preference of one framework or theory over the other is contingent on the specific research questions and the methodology. The purpose of a theoretical framework is to adequately signify grammars and principles at play in the language. Each emerging framework provides new insights and approaches that improve understanding mechanisms behind the linguistic phenomenon like vowel harmony, for instance, and this trend is ongoing.

13.4 Sociolinguistic factors in adaptations and ratings

Analyses of the role of sociolinguistic factors determined that most sociolinguistic factors, like age, did not affect adaptations. Instead, the most significant sociolinguistic factor in production was linked to residence – urban versus rural – in that urban residents produced significantly fewer Yakut-like adaptation. As shown by the correlation plot in Figure 12.16 of Chapter 12, there is no drastic difference in the extent of speaking Russian daily among rural versus urban residents, as the majority of participants (66.7% rural and 56.3% urban) declared that they spoke Russian seldom and primarily spoke Yakut. The fact that rural residents outperformed urban residents in productions of more Yakut-like adaptations can be accounted for by the difference between the extents of code-mixing and daily exposure to Russian between urban and rural residents. Thus, in a linguistic anthropological study, Ferguson (2016) discusses an association of rural residence in the Republic of Sakha (Yakutia) with increased purity of speaking in Yakut among bilingual speakers, whereas living in urban areas, particularly in the capital city Yakutsk, entails speaking more Russian daily and code-mixing. Taking Ferguson's observation into account, I suggest that in adaptations, the quality as opposed to quantity of speaking the language may play an important role. In other words, whether Yakut speakers employ a lot of code-mixing rather than speaking purely (with less code-mixes) and extents of daily language contact with the source language may have impacted adaptations.

13.5 Implications and directions for future research

In this dissertation, I established the following vowel input predictors to be significant in the applications of vowel harmony and Yakut-like adaptation: backness, height, and roundness, and position in the word where these vowel categories occur (first or second syllable). Word type was also shown to be significant, confirming that in general, borrowed words, i.e. established loanwords, better conform to vowel harmony due to the general knowledge of the Russian-Yakut speakers of the borrowed words' output forms from the input of the source language. This dissertation reinforces understanding of the driving mechanisms of loanword adaptations among bilingual speakers and clarifies the extents they conform to the grammars of the phonology of the native language in on-line adaptations. The results presented in this dissertation have implications of both linguistic and sociolinguistic relevance.

Linguistic findings of this dissertation can contribute to the understanding of phonological input predictors that drive adaptations among bilingual speakers, considering distinct phonologies of the source and the borrowing languages. Considering that Russian does not have vowel harmony, evidently, most incoming words have vowels that do not agree in backness. I have shown that particularly the back rounded and non-high vowels are better harmony triggers that facilitate increased native-like adaptations and application of vowel harmony. As for individual vowel adaptations, their categorical realizations were most consistent in first syllables, and their length was contingent on input stress, when unstressed vowels tended to shorten and stressed vowels were inclined to lengthen or diphthongize. Given the universal rightward directionality of harmony spreading (Cohen, 2013), the finding of this dissertation points to the special status of initial vowels in the positional hierarchy within a word in predicting individual vowel adaptations with less variability. Moreover, I proposed that input back vowels in initial syllables are particularly strong backness harmony triggers that spread their backness feature rightward, which points to the positional faithfulness approach in backness harmony. In rounding harmony, however, as overall non-high vowels were good rounding harmony triggers, and non-high vowels are phonetically weaker than high vowels (Kaun, 2004), I proposed the positional markedness approach takes place in the Yakut rounding harmony system, as weak triggers target phonetically strong salient segments.

A possible limitation is that this dissertation focuses almost exclusively on bilingual speakers who are literate in both languages. Due to a small number of monolinguals, the study does not enable me to clarify the input predictors of the Russian vowels and words active among monolingual speakers in applications of vowel harmony and Yakut-like adaptation comparable to those earlier, phonetic-based adaptations (Sleptsov, 1964). Specifically, providing the auditory input to monolingual speakers would potentially mimic those perceptual based adaptations. Bilingual speakers are aware of the phonetic characteristics of the input vowels presented in the Russian orthography, and they did manifest both phonetic and phonological adaptations. Thus, this result implies a more complex interaction of the two approaches of loanword adaptations - phonetic and phonological - which is congruent with Lin (2008), for instance. It is important to point out that the majority of modern Russian-Yakut bilingual speakers study the Yakut language in formal education, thus acquire and employ both written and spoken forms of the language, i.e. have a metalinguistic awareness of their mother tongue (e.g., Ferguson, 2013, 2015, 2016).

From a sociolinguistic stance, I have suggested that in the context of a minority language under the influence of a dominant linguistic and cultural group, less language contact with the dominant language leads to more conformity to the native phonology and native-like adaptations among bilingual speakers. This study has potentials to be replicated in other minority languages where there is a clear disparity between the extents of contact with the dominant language within a region. Controlling sociolinguistic predictors systematically would facilitate a deeper understanding of bilingual speakers' productions, as they displayed native and non-native like adaptations of the input vowels and their sequences within produced words.

Future research which includes descriptions of formant measurements of the Russian vowels produced by Russian speakers and the Yakut vowels produced by bilingual or monolingual Yakut speakers would be of interest to determine phonetic characteristics and distinctions in the vowels between both languages, as previous studies focus on reports comparing duration measurements between Russian and Yakut vowels (Dyachkovskiy, 1962) and acoustic measurements of pitch movements, intensity and duration cueing the vowel quantity distinction in Yakut (Vasilyeva, et al., 2016). Thus, if complete phonetic characteristics of Russian and Yakut vowels were made available, it would give an opportunity to further assess adaptations (more phonetic or phonological) among bilingual speakers. Furthermore, plans for future research include greater involvement of monolingual speakers in order to explore the role of auditory input and the specific phonological input predictors of Russian vowels and words active among monolinguals.

13.6 Conclusion

To conclude, the main finding of this dissertation is that adaptation of the native phonology in the incoming words of the dominant source language takes place consistently among the modern Russian-Yakut bilingual speakers, and that the speakers have generally strong perceptual abilities in discerning legal and illegal forms in their native language. The extents of more native-like adaptations and vowel harmony application are suggested to depend on the phonological characteristics of input words and vowels.

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Appendix A: Language background information questionnaire (English translation from Russian)[53]

Language Background Information

Participant code: (Filled by the researcher)

1. Is Yakut your mother tongue?

Yes No

2. Do you consider yourself bilingual?

Yes No

3. How much time a day you speak Russian?

0	1	2	3	4
Russian never Yakut always	Russian seldom Yakut usually	Russian 50% Yakut 50%	Russian usually Yakut seldom	Russian almost always Yakut almost never

4. What language do you speak *most often* with the other people in your home?

0	4
Mostly Yakut	Mostly Russian

5. Do you work outside the home?
Or are you a student?

Yes No

6. If yes, is the language of the workplace/school Russian?

0	1	2	3	4
Russian never Yakut always	Russian seldom Yakut usually	Russian 50% Yakut 50%	Russian usually Yakut seldom	Russian almost always Yakut almost never

[53] The language background information questionnaire was printed out on paper with the official Department of Linguistics/Faculty of Arts of University of Alberta's letterhead.

7. In what predominant language environment did you spend your childhood and adolescence years (from 0 to 18 years)?

a. in Russian-speaking environment   b. in Yakut-speaking environment
c. in an equally bilingual environment

8. Was there a change in the predominant language environment during your childhood and adolescence years?

Yes   No

9. If there was a change in the predominant language environment during your childhood and adolescence years, indicate the time and change:

a. from 0 to 10 years, a change to Russian-speaking environment
b. from 0 to 10 years, a change to Yakut-speaking environment
c. from 10 to 18 years, a change to Russian-speaking environment
d. from 10 to 18 years, a change to Yakut-speaking environment
e. from 0 to 10 years, a change to equally bilingual environment
f. from 10 to 18 years, a change to equally bilingual environment

10. How often do you read text in Yakut?

a. Every day   b. Few times a week   c. Few times a month   d. Occasionally   f. Never

11. How often do you write text in Yakut?

a. Every day   b. Few times a week   c. Few times a month   d. Occasionally   f. Never

12. How would you rate your Russian skills in the following areas?

	Basic	Intermediate	Advanced	Superior
Reading				
Writing				
Speaking				
Listening				
Overall				

13. How often do you read text in Russian?

a. Every day   b. Few times a week   c. Few times a month   d. Occasionally   f. Never

14. How often do you write text in Russian?

a. Every day   b. Few times a week   c. Few times a month   d. Occasionally   f. Never

Appendix B: Production task item list

FOUR CATEGORIES

CATEGORY 1: The stressed [+back/+round] vowels preceded and followed by the unstressed [-back/-round] vowels.

Combination 1.

Syllable 1	Syllable 2
[+back/+round] V	[-back/-round] V
Stressed /o/	Unstressed [-back/-round] V

No. of the pair	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
1	o...i	ˈlonik	ˈbotik ‘boot’	Input: ˈzontik ‘umbrella’ Expected output: suɒntʃuk
2	o...e	ˈmopen^j	ˈkoren^j ‘root’	Input: ˈmore ‘sea’ Expected output: muɒrɑ
3	o...a	ˈmonka	ˈdotʃka ‘daughter’	Input: ˈkoʂka ‘cat’ Expected output: kuɒskɑ

Combination 2.

Syllable 1	Syllable 2
[-back/-round] V	[+back/+round] V
Unstressed [-back/-round] V	Stressed /o/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
4	i...o	mi ˈsor	si ˈrop ‘syrup’	Input: kiˈno ‘movie’ Expected output: kiːnɛ
5	e...o	seˈvoj	peˈsok ‘sand’	Input: seˈlo ‘village’ Expected output: sɛliɛɲːɛ
6	a...o	taˈtom	kaˈpot ‘hood’	Input: zaˈvod ‘factory’ Expected output: sɒbuɒt

Combination 3.

Syllable 1	Syllable 2
[+back/+round] V	[-back/-round] V
Stressed /u/	Unstressed [-back/-round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
7	u...i	ˈmufik	ˈkustik ‘bush’	NA
8	u...e	ˈkupenʲ	ˈʂuler ‘swindler’	Input: ˈustʲe ‘estuary’ Expected output: uːstuja
9	u...a	ˈzurka	ˈpuma ‘puma’	Input: ˈsumka ‘bag’ Expected output: suːmkɑ

Combination 4.

Syllable 1	Syllable 2
[-back/-round] V	[+back/+round] V
Unstressed [-back/-round] V	Stressed /u/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
10	i...u	niˈkur	ʂiˈpun ‘a swan-like bird’	Input: ziˈpun ‘collarless robe’ Expected output: supːuːn
11	e...u	leˈrut	beˈgun ‘runner’	Input: peˈtux ‘rooster’ Expected output: bœtyːk
12	a...u	vaˈpun	laˈtuk ‘lettuce’	Input: paˈstux ‘shepherd’ Expected output: bɒstuːk

CATEGORY 2: The stressed [-back/-round] vowels preceded and followed by the unstressed [+back/+round] vowels.

Combination 1.

Syllable 1	Syllable 2
[-back/-round] V	[+back/+round] V
Stressed [-back/-round] V	Unstressed /u/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
13	i...u	ˈʂikur	ˈfikus ‘rubber plant’	NA
14	e...u	ˈeluk	ˈberkut ‘golden eagle’	NA
15	a...u	ˈpanus	ˈkaktus ‘cactus’	Input: ˈfartuk ‘apron’ Expected output: bɑːrtɯk

Combination 2.

Syllable 1	Syllable 2
[+back/+round] V	[-back/-round] V
Unstressed /u/	Stressed [-back/-round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
16	u...i	puˈnit	muˈʐik ‘guy’	NA
17	u...e	luˈpenʲ	kuˈpets ‘merhant’	Input: stuˈdent ‘student’ Expected output: ustudʒuɒn
18	u...a	suˈlak	suˈdak ‘pike perch’	Input: uˈgar ‘intoxication’ Expected output: ugɑːr

Combination 3.

Syllable 1	Syllable 2
[-back/-round] V	[+back/+round] V
Stressed [-back/-round] V	Untressed /o/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
19	i...o	ˈmivo	siˈfon ‘syphon’	Input: ˈpivo ‘beer’ Expected output: piːbɛ
20	e...o	ˈpevor	ˈleto ‘summer’	Input: ˈmesto ‘place’ Expected output: miɛstɛ
21	a...o	ˈvavor	ˈtabor ‘camp’	Input: ˈpasport ‘passport’ Expected output: pɑːspɑr

Combination 4.

Syllable 1	Syllable 2
[+back/+round] V	[-back/-round] V
Unstressed /o/	Stressed [-back/-round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
22	o...i	moˈtir	moˈskit ‘mosquito’	Input: moˈtiv ‘motive’ Expected output: mɑtɯːp
23	o...e	moˈmets	foˈrelʲ ‘trout’	Input: oˈbed ‘lunch’ Expected output: ɛbiɛt
24	o...a	voˈmar	moˈralʲ ‘ethics’	Input: toˈvar ‘goods’ Expected output: tɑbɑːr

CATEGORY 3: The stressed [+back/+round] vowels preceded and followed by the [+back/+round] vowels.

Combination 1.

Syllable 1	Syllable 2
[+back/+round] V	[+back/+round] V
Unstressed /o/	Stressed [+back/+round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
25	o...o	doˈʐok	toˈpor ‘axe’	Input: moˈtor ‘motor’ Expected output: mɒtuɒr
26	o...u	goˈmulʲ	gorˈbun ‘humpback’	Input: xoˈmut ‘burden’ Expected output: χɒmuːt

Combination 2.

Syllable 1	Syllable 2
[+back/+round] V	[+back/+round] V
Stressed [+back/+round] V	Unstressed /o/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
27	o...o	ˈxorod	ˈgolod ‘hunger’	Input: ˈgorod ‘city’ Expected output: kuɒrɑt
28	u...o	ˈzupor	ˈdulo ‘muzzle’	Input: ˈrupor ‘megaphone’ Expected output: uruːpɑr

Combination 3.

Syllable 1	Syllable 2
[+back/+round] V	[+back/+round] V
Unstressed /u/	Stressed [+back/+round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
29	u...u	kuˈʐuk	kurˈkulʲ ‘greedy man’	Input: tʃuˈgun ‘cast iron’ Expected output: tʃuguːn
30	u...o	suˈlok	kuˈlon ‘pendant’	Input: uˈrok ‘lesson’ Expected output: uruɒk

Combination 4.

Syllable 1	Syllable 2
[+back/+round] V	[+back/+round] V
Stressed [+back/+round] V	Unstressed /u/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
31	u...u	ˈdulup	NA	NA
32	o...u	ˈpozduk	ˈobrutʃ ‘hoop’	Input: ˈgolub^{j} ‘pigeon’ Expected output: χɒluːp

CATEGORY 4: The [-back/-round] vowels preceded and followed by the [-back/-round] vowels.

Combination 1.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Stressed [-back/-round] V	Unstressed /i/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
33	i...i	ˈbinik	ˈvintik ‘small screw’	Input: ˈʐirnik ‘oil lamp’ Expected output: ɯhɯːrɯɲːɯk
34	e...i	ˈveʐik	ˈmerin ‘gelding’	Input: ˈʐrebij ‘lot’ Expected output: sɛrɛbiɛj
35	a...i	ˈrasik	ˈvalik ‘roll’	Input: ˈbantik ‘bow’ Expected output: bɑːntʃɯk

Combination 2.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Unstressed /i/	Stressed [-back/-round] V

No.	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
36	i...i	tiˈtir	imˈbir^{j} ‘ginger’	Input: fiˈtil^{j} ‘wick’ Expected output: bitiːl
37	i...e	piˈlets	siˈren^{j} ‘lilac’	Input: biˈlet ‘ticket’ Expected output: biliɛt
38	i...a	ʂiˈvar	piˈrat ‘pirate’	Input: izˈba ‘peasant's house’ Expected output: ɯːspɑ

Combination 3.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Stressed [-back/-round] V	Unstressed /e/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
39	i...e	ˈtipenʲ	ˈlivenʲ ‘heavy rain’	Input: ˈʂifer ‘slate’ Expected output: siːpɛr
40	e...e	ˈnelet	ˈsever ‘north’	Input: ˈperets ‘pepper’ Expected output: biɛrɛs
41	a...e	ˈmaler	ˈpalets ‘finger’	Input: ˈlagerʲ ‘camp’ Expected output: lɑːʁɯr

Combination 4.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Unstressed /e/	Stressed [-back/-round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
42	e...i	veˈtilʲ	keˈfir ‘kefir’	Input: reˈʐim ‘regime’ Expected output: ɛrɛsiːm
43	e...e	veˈpenʲ	meˈtelʲ ‘blizzard’	Input: tseˈment ‘cement’ Expected output: siɛmɛn
44	e...a	seˈnalʲ	peˈdalʲ ‘pedal’	Input: meˈdalʲ ‘medal’ Expected output: mɛtɛːl

Combination 5.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Stressed [-back/-round] V	Unstressed /a/

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
45	i...a	ˈziʂa	ˈʂina ‘tire’	Input: ˈmiska ‘bowl’ Expected output: miːskɛ
46	e...a	ˈpelka	ˈtema ‘topic’	Input: ˈferma ‘farm’ Expected output: piɛrmɛ
47	a...a	ˈzaga	ˈlava ‘lava’	Input: ˈlampa ‘lamp’ Expected output: lɑːmpɑ

Combination 6.

Syllable 1	Syllable 2
[-back/-round] V	[-back/-round] V
Unstressed /a/	Stressed [-back/-round] V

	Russian vowels	Nonce word	Un-borrowed word	Borrowed word
48	a...i	tsaˈtil^j	kaˈdril^j 'square dance'	Input: arˈtist 'actor, artist' Expected output: ɑrtɯːs
49	a...e	taˈmer	zaˈmer 'sample'	Input: arˈtel^j 'team' Expected output: ɑrtɯɑl
50	a...a	vaˈpar	kaˈban 'boar'	Input: xaˈlat 'robe' Expected output: χɑlɑːt

Appendix C: List of Yakut nonce words for the rating task

Category 1: Nonce words following backness harmony rules.

All the vowels are [+back]

1. χɒbus
2. tɑmɑl
3. kɯtɯk
4. butus

All the vowels are [-back]

1. kɛbɛ
2. ɲibɛs
3. sœtyŋ
4. tyʁyl

All the vowels are [+back], with long vowels

1. mɯkɯːs
2. tɑːlɯs
3. bɒsuːr
4. χɒsɒː

All the vowels are [-back], with long vowels

1. bɛtiːt
2. bœːdyn
3. siːtir
4. kyːmɛ

All the vowels are [+back], with diphthongs

1. tɯɑmɑj
2. busuɒ

All the vowels are [-back], with diphthongs

1. biɛmir
2. tytyœs

Category 2: Nonce words violating backness harmony rules – vowels with different backness features within a word.

The initial vowel is [+back]

1. sɯmis
2. tubɛr
3. mɑniŋ
4. χɒbis

The initial vowel is [-back]

1. simɑn
2. dʒymɑχ
3. bɛtɯk
4. sœmuk

The initial vowel is a diphthong followed by a vowel with a different backness feature

1. bɯɑnɛr
2. tuɒsœχ
3. siɛbɑr

4. yœmɑχ

<u>The vowel in one of the syllables is long [+back]</u>

1. bytɯː
2. suːbɛs
3. tœsɑː
4. mɒːtys

<u>The vowel in the syllables is long [-back]</u>

1. tɛːbɑ
2. dɑtœːr
3. tyːtɒŋ
4. utiː

Category 3: Nonce words following rounding harmony rules.

<u>All the vowels are [-back/+round]</u>

1. bynys
2. œtys
3. tœsœp
4. bygɛs

<u>All the vowels are [+back/+round]</u>

1. kumur
2. tɒbur
3. bɒsɒr
4. subɑr

<u>The words have [-back/+round] vowels and diphthongs</u>

1. syœbɛj
2. syryœ

<u>The words have [+back/+round] vowels and diphthongs</u>

1. tuɒmɑn
2. suruɒ

<u>The words have [+back/+round] long vowels</u>

1. kunuːr
2. mɒtuːs
3. mɒːbɒ
4. tuːbɑ

<u>The words have [-back/+round] long vowels</u>

1. mysyːr
2. bœkyːr
3. tʃœrœː
4. syːbɛ

Category 4: Nonce words violating rounding harmony rules – high rounded vowels precede low rounded vowels.

<u>All the vowels are [+back/+round]</u>

1. utɒs
2. bugɒ
3. tutɒŋ

4. tʃusɒr

<u>All the vowels are [-back/+round]</u>

1. kytœl
2. dʒybœ
3. dytœr
4. tylœ

<u>The words have [-back/+round] vowels and diphthongs</u>

1. syœbœ
2. yœtœr
3. dʒyœkœ

<u>The words have [+back/+round] vowels and diphthongs</u>

1. buɒtɒs
2. uɒtɒŋ
3. tuɒmɒj

<u>The words have [+back/+round] vowels and long vowels</u>

1. suːbɒ
2. butɒːr
3. tuːtʃɒl

<u>The words have [-back/+round] vowels and long vowels</u>

1. kyːbœ
2. mylœː
3. syːʁœn

Category 5: Nonce words violating rounding harmony rules – unrounded vowels precede rounded vowels.

<u>All the vowels are [+back]</u>

1. sɯtɒn
2. ɑbɒχ
3. ɯkur
4. ɑgul

<u>All the vowels are [-back]</u>

1. inys
2. bɛsy
3. ɲityŋ
4. dʒɛry

<u>The words have [+back] vowels and long vowels</u>

1. ɯmɒːj
2. χɑlɒː
3. kɯːtus
4. ɑːkur

<u>The words have [-back] vowels and long vowels</u>

1.ilœː
2. sihœːr
3. siːky
4. mɛːtyŋ

<u>The words have [+back] vowels and diphthongs</u>

1. kɯɑbur
2. mɑsuɒ
<u>The words have [-back] vowels and diphthongs</u>
1. biɛbyk
2. tʃɛryœ

Appendix D: Consent form (English translation from Russian)[54]

CONSENT FORM

UNIVERSITY OF ALBERTA

CONSENT TO PARTICIPATE IN RESEARCH

Yakut loanword phonology with respect to borrowing Russian words.

You are asked to participate in a research study conducted by Lena Vasilyeva (the investigator/the principal investigator)**, from the** Department of Linguistics **at the University of Alberta in Canada, the city of Edmonton.**

If you have any questions or concerns about the research, please feel free to contact the investigator at lvasilye@ualberta.ca, or her academic supervisor Dr. Anne-Michelle Tessier at annemich@ualberta.ca

PURPOSE OF THE STUDY
In this study the investigator will collect data of responses from native speakers of Yakut, in order to analyze the phonology of Russian loanwords into Yakut.

PROCEDURES
You as a participant will have a single session that consists of the reading and the rating tasks. The session will last for about one hour. In the reading task you will read: a) actual Russian borrowings into Yakut; b) actual Russian words that have not been borrowed into Yakut; c) read Russian nonce words to sound like Yakut by giving opinions on how a Russian nonce word would sound if it was borrowed into Yakut. The responses will be captured by a sound recorder. In the rating task, you will hear recorded Yakut nonce words in sound files on a power point presentation on the principal investigator's laptop and rate each word from 1 to 5. The rating will reflect your judgments on how well each nonce word sounds like a Yakut word. The response 1 is "very unlikely", and 5 is "very likely". You will fill out a sheet of paper where each word will be given an individual number and circle their rating's answers for each nonce word you have heard from 1 to 5. The principal investigator's headphones will be optionally provided, or you have an option to listen to words using your personal headphones or to listen to the recorded nonce words directly from the laptop. After the session, you will fill out a questionnaire written in Russian that includes questions about your language background information.

If you are interested in the outcomes (research findings) I will ask you to leave your email addresses to me so that I send you a link to the published article on this study. Besides this situation I will not conduct any follow-up sessions after the completion of the interview.

POTENTIAL RISKS AND DISCOMFORTS
There is no risk in this study for you. All the sentences in the recordings that contain identifiable information will be removed and deleted. The principal investigator will not include any personal information except for your age and gender of at the time of the session. Each recording and answers of the rating task will be given personal numbers. All the identifiable data will be encrypted.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY
You will not receive any marked benefit from the participation in the study.

PAYMENT FOR PARTICIPATION
You will not be paid for taking part in the research.

[54] The consent form was printed out on paper with the official Department of Linguistics/Faculty of Arts of University of Alberta's letterhead.

CONFIDENTIALITY

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study.

All the recordings will be kept confidential. Each recording and the rating answer will be given a personal number. The collected data will be stored on a password-secured personal computer to which the public has no access.

Any identifiable personal information will be removed and destroyed from the recordings.

You have a right to review the audio-tapes and if you wish to erase any part from the interview it will be done immediately by the principal investigator in front of you. Any withdrawn data will be deleted within 30 days after the session.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Alberta Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Research Ethics Office
University of Alberta
308 Campus Tower
8625 – 112 Street
Edmonton, AB T6G 1K8
Canada
E-mail: reoffice@ualberta.ca
Ph. 780-492-0459 Fax: 780-492-9429

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I have read the information provided for the study "Yakut loanword phonology with respect to borrowing Russian words" as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____

Name of Participant (please print)

___________________________________ ______________

Signature of Participant Date

Appendix E: Procedures of transcriptions by external transcribers

1. First external transcriber

With the purpose to achieve utmost accuracy in the transcriptions and to avoid any native speaker's bias to certain sounds, an external transcriber was hired and funded by Dr. Anne-Michelle Tessier's SSHRC (Social Sciences and Humanities Research Council) Insight Grant (IG) (Number: 435-2015-0176).

The external transcriber is a female native English speaker, and a PhD Candidate in the Department of Linguistics whose research area is phonetics.

1.2 Materials for the first external transcriber

A list of 50 words was prepared for the transcriptions, which included 20 nonce, 20 un-borrowed and ten borrowed words per participant. A total of five participants were selected that represented each of the five decades of the age group: a female speaker in her 20s, a male speaker in his 30s, a male speaker in his 40s, a female speaker in her 50s, and finally, a female speaker in her 60s.[55]

The lists of nonce and un-borrowed words included all vowel phonemes in different syllable positions with stressed and unstressed variations. The vowels in the nonce words in the first syllables were front, and in the second syllables they were back. In turn, with the purpose of balancing out the backness features in both lists, the first vowels in the un-borrowed words were back, and front in the second syllable. Hence, each of the stressed and unstressed five vowel phonemes were combined with vowels with different backness values in preceding and following syllables. Below (1) are the lists of nonce and un-borrowed words prepared for the external transcriber:

(1) Lists of nonce and un-borrowed words for the external transcriber

a. Nonce words

Russian vowel	First syllable	Second syllable	Input Russian word
o	Stressed /o/	Unstressed back vowel	ˈpozduk
	Unstressed /o/	Stressed back vowel	goˈmul^j
	Unstressed front vowel	Stressed /o/	miˈsor
	Stressed front vowel	Unstressed /o/	ˈmivo

[55] The 60s was the highest age category among the bilingual speakers in this study.

a	Stressed /a/	Unstressed back vowel	ˈpanus
	Unstressed /a/	Stressed back vowel	taˈtom
	Unstressed front vowel	Stressed /a/	ʂiˈvar
	Stressed front vowel	Unstressed /a/	ˈziʂa
i	Stressed /i/	Unstressed back vowel	ˈʂikur
	Unstressed /i/	Stressed back vowel	niˈkur
	Unstressed front vowel	Stressed /i/	tsaˈtilʲ
	Stressed front vowel	Unstressed /i/	ˈrasik
u	Stressed /u/	Unstressed back vowel	ˈdulup
	Unstressed /u/	Stressed back vowel	suˈlok
	Unstressed front vowel	Stressed /u/	vaˈpun
	Stressed front vowel	Unstressed /u/	ˈeluk
e	Stressed /e/	Unstressed back vowel	ˈpevor
	Unstressed /e/	Stressed back vowel	leˈrut
	Unstressed front vowel	Stressed /e/	piˈlets
	Stressed front vowel	Unstressed /e/	ˈtipenʲ

b. Un-borrowed words

Russian vowel	First syllable	Second syllable	Input Russian word
o	Stressed /o/	Unstressed front vowel	ˈbotik
	Unstressed /o/	Stressed front vowel	foˈrelʲ
	Unstressed back vowel	Stressed /o/	kuˈlon
	Stressed back vowel	Unstressed /o/	ˈdulo
a	Stressed /a/	Unstressed front vowel	ˈpalets
	Unstressed /a/	Stressed front vowel	kadˈrilʲ
	Unstressed back vowel	Stressed /a/	suˈdak
	Stressed back vowel	Unstressed /a/	ˈdotʃʲka
i	Stressed /i/	Unstressed front vowel	ˈlivenʲ
	Unstressed /i/	Stressed front vowel	siˈrenʲ
	Unstressed back vowel	Stressed /i/	mosˈkit
	Stressed front vowel[56]	Unstressed /i/	ˈvalik
u	Stressed /u/	Unstressed front vowel	ˈkustik
	Unstressed /u/	Stressed front vowel	muˈʐik
	Unstressed back vowel	Stressed /u/	kurˈkulʲ
	Stressed back vowel	Unstressed /u/	ˈobrutʃʲ
e	Stressed /e/	Unstressed front vowel	ˈmerin
	Unstressed /e/	Stressed front vowel	peˈdalʲ
	Unstressed back vowel	Stressed /e/	kuˈpets
	Stressed back vowel	Unstressed /e/	ˈʂuler

[56] There was an exception on the list of the un-borrowed words when the first preceding vowel before the vowel /i/ in the word /ˈvalik/ was front. This inconsistency was noticed upon completion of the transcriptions.

The list also included ten borrowed words, and those words were selected based on the probability that participants produced them correctly and consistently due to their high frequency in the Yakut lexicon, as shown in (2). The data in (2) include all the Yakut vowel phonemes including the diphthongs. I ensured that the vowels in all the words represented as many Yakut vowels as possible. The ‘X’ mark for each vowel indicates the vowel that is present in a word. However, the borrowed words (loanwords) did not contain the vowels /y, œː, ɒː, yœ/, therefore, they are left blank in the table.

(2) Vowels in borrowed words

Input:	Expected:	i	iː	y	yː	ɯ	ɯː	u	uː	ɛ	ɛː	œ	œː	ɑ	ɑː	ɒ	ɒː	iɛ	yœ	ɯɑ	uɒ
ˈlagerʲ	lɑːʁɯr					X									X						
ˈmesto	miɛstɛ									X								X			
fiˈtilʲ	bitiːl	X	X																		
moˈtiv	mɑtɯːp						X							X							
ˈsumka	suːmkɑ								X					X							
arˈtelʲ	ɑrtɯɑl													X						X	
uˈrok	uruɒk							X													X
meˈdalʲ	mɛtɛːl									X	X										
ˈgolubʲ	χɒluːp								X							X					
peˈtux	bœtyːk				X							X									

A total of 250 tokens were prepared for the external transcriber, that is 50 words each for all five participants. Each participants’ token for each word was extracted in individual wave files, and all tokens were organized in separate files with the participants’ identifying numbers. The tokens were numbered and labelled by the word type.

The transcriber was also given the participants’ short information, indicating their number, gender and age. Most importantly, the vowel categories of both Russian and Yakut vowels were provided, without signifying which vowel was Russian and Yakut (3):

(3) Vowel categories for the external transcriber

	Front	**Back**
Close	/i/, /iː/, /ˈi/, /y/, /yː/, /iɛ/, /yœ/	/ɯ/, /ɯː/, /u/, /uː/, /ˈu/, /ɯɑ/, /uɒ/
Close-mid	/e/, /ˈe/	/o/, /ˈo/
Open-mid	/ɛ/, /ɛː/, /œ/, /œː/	
Open	/a/, /ˈa/	/ɑ/, /ɑː/, /ɒ/, /ɒː/

The stressed vowels in (3) represented Russian vowels. The idea of these vowel categories was to provide ‘pure’ Yakut and Russian phonemes per se. The purpose of these categories was not to limit the range of vowels that could be outside of the conventional vowel categories in the languages. That is, the transcriber was free to transcribe long Russian vowels, or stressed Yakut vowels or diphthongs with different vowel sequences if they occurred in the participants' productions.

Conductive to giving a better idea of the Yakut vowels, the external transcriber was introduced to sound files recorded by me that contained words that had all 8 vowels in sample disyllabic words. In addition, there were words that had the same vowel in both syllables, where one was long and the other one was short. Finally, there were four words that represented the four Yakut diphthongs. The words were inserted in a PowerPoint presentation accompanied by transcriptions. The Yakut word samples are given in (4):

(4) Samples of Yakut words for the external transcriber

<u>All eight vowels in disyllabic word samples:</u>

/tilɛχ/ 'heel'
/œrys/ 'river'
/kɯlɑr/ 'cross-eyed'
/ɒʁus/ 'bull'

<u>Short and long vowel distinction. Words with long and short vowel phonemes:</u>

/kijiːt/ 'daughter-in-law'
/syːryk/ 'runner'
/mɛːnɛ/ 'random'
/tœlœː/ 'pay (imperative)'
/ɯtɯːr/ 'cries'
/uluː/ 'great'
/sɒtɒːr/ 'wipe (imperative)'
/sɑnɑː/ 'thought'

<u>Examples of the four diphthongs:</u>
/tiɛrgɛn/ 'yard'
/kyœmɛj/ 'throat'
/kɯrɯɑ/ 'frost'
/suɒrʁɑn/ 'blanket'

Additionally, I recorded five Russian words containing the five vowels with an identical vowel in both syllables of each word, and I delivered them to the transcriber. The purpose was to have the transcriber get familiarized with the stress distinction in Russian. The recorded five words had one stressed vowel, and the other one was unstressed: *ˈpara* ‘couple’, *ˈpepel* ‘ash’, *toˈpor* ‘axe’, *ˈpilit* ‘saws’, *tuˈlup* ‘sheepskin coat’.

The external instructor was instructed to categorize the vowels by focusing on vowels of the disyllabic words produced by the participants. She categorized vowels by choosing from the provided vowel categories that she perceived in the first and second syllable positions of the disyllabic words. I also said to her that if vowels were outside of the vowel categories, she could transcribe vowels in a word based on her judgments. Furthermore, the external transcriber was told to disregard consonants in her transcriptions. In case of epenthetic vowels,[57] she was instructed to reflect them in the transcriptions also. In addition, she was asked to transcribe vowels mostly based on her perception and to read spectrograms, when necessary. A total of 250 words (five participants with 50 words each) were transcribed by the external transcriber.

1.3 First round of transcriptions by the external transcriber

After the first round of the transcriptions by the external transcriber was completed, meaning the vowels were categorized in each of the syllables of the produced words, they were compared with my initial transcriptions. In each word, if a vowel was identical with my transcription, it was labelled as ‘same’ in a spreadsheet. Words with vowel transcriptions different from my initial transcriptions were selected and transferred to another spreadsheet for the second round of transcriptions. Out of 500 input-output vowels in the total of 250 disyllabic words, 304 vowels were transcribed identically between me and the external transcriber (60.8%) and 196 vowels represented different transcriptions between us (39.2%). In addition, we transcribed one epenthetic vowel the same way, one epenthetic vowel was different in both transcriptions, and the external transcriber perceived two epenthetic vowels that were not transcribed by me. Overall, I perceived and transcribed 12 epenthetic vowels in the initial transcriptions on the list prepared for the external transcriber.

1.4 Second round of transcriptions by the first external transcriber

The external transcriber was not informed precisely which of the vowels and in which syllable were transcribed dissimilar to mine. The purpose of not informing her about the specific

[57] Epenthetic vowels are the vowels that are not output correspondents of the Russian input vowels in the target disyllabic words.

vowels that were different from my initial transcriptions was to identify consistent discrepancies between me and the external transcriber. Also, an intention was to verify if there were various ways certain vowels were perceived between me as a native Yakut speaker and her as a non-native speaker. Thus, a list of 156 words that included the 196 vowels with different transcriptions in both or one of the syllables including epenthetic vowels was prepared for the second round of transcriptions.

Upon the completion of the second round of the transcriptions by the external transcriber, vowels in the first and second rounds for the 156 words were compared with each other. The external transcriber had 83 vowels that were transcribed in two different ways in both rounds, and 74 vowels were consistently transcribed the same during the first and second rounds. Besides, she transcribed 11 epenthetic vowels which were not perceived nor transcribed in my initial transcriptions. In turn, three epenthetic vowels present in my initial transcriptions were not reflected by the external transcriber in either of the rounds. If an entire word in both syllables coincided with my initial transcriptions in either first or second rounds, and ultimately, if both syllables at one of the two rounds were categorized the same between me and the external transcriber, then those vowels were withheld from further transcriptions by an external transcriber. Thus, 26 words (16.7% of the 156 words) were excluded from further considerations, until I conducted final revision transcriptions. The rest of the words that still had different transcriptions in both rounds, were selected for a second external transcriber that included 157 vowels with different transcriptions in a total of 130 words (83.4% of the 156 words).

2. Second external transcriber

With the purpose to establish an occurring tendency in the way the vowels were perceived by a native speaker versus a non-native speaker of Yakut, a second external transcriber was requested to transcribe the words which the first transcriber transcribed dissimilarly from my initial transcriptions during both rounds. Those differences were the vowels that the first external transcriber transcribed the same or in two different ways in both rounds and had ultimately occurred different from my transcriptions. The second external transcriber is a post-doctoral fellow in the Department of Linguistics and a male native English speaker. His main areas of research also concern phonetics and phonology.

2.1 Materials for the second external transcriber

I compared the two rounds of the first external transcriber with my initial transcriptions, then I selected words with vowels that had most consistent differences from my initial transcriptions for further transcriptions by the second external transcriber. The nine vowels /e, ɛ, œ, ɯː, u, uː, ɯɑ, uɒ, ɑ/ were chosen that were consistently transcribed in a different way between me and the first external transcriber. The nine different vowels reflect my initial transcriptions of them, as /e/, /ɛ/, /œ/, etc. Since different transcriptions of these vowels occurred in specific words, I indicated the numbers for the words, syllables, participants, including word type. In addition, I created a column 'vowel quality' where I identified the vowel quality feature that was common between me and the first external transcriber, e.g., if there was a difference in the transcriptions of the height of the vowels, like /e/ versus /ɛ/, and if the backness feature was the same between the transcriptions, I specified those vowels as 'front unrounded'. Thus, my transcriptions of the vowel /e/ had 14 specific words, where /e/ was transcribed in a different way by the first external transcriber. I show the sums of the numbers of words with different transcriptions of the selected nine vowels: /e/ - 14; /ɛ/ - 11; /œ/ - 7; /ɯː/ - 7; /u/ - 14; /uː/ - 14; / ɯɑ/ - 8; /uɒ/ - 19; /ɑ/ - 13. Hence, total of 107 words[58] were arranged for the second external transcriber. The cut-off numbers I used for selecting the vowels for further transcriptions was a vowel that was transcribed dissimilarly fourteen or more times between me and the first external transcriber.

2.2 Procedure

If the differences between my transcription and the first external transcriber for each vowel in a word were binary, the question was straightforward, like 'Is it /e/ or /ɛ/?' and I specified the syllable number where that vowel occurred. If the differences were greater than two, like the correspondent vowel had three or more different transcriptions, the question was more general - 'What is the vowel?' There was one transcription session with the second external transcriber, where I asked the questions for each word indicating a syllable number while he was listening to the sound files through the headphones. His responses were immediately recorded in a spreadsheet. He was also instructed to categorize the vowels based on perception; however, he was also asked

[58] Some words were included more than once on the list of 107 words, where individual vowels in them in different syllables were asked separately for the transcriptions.

to look at spectrograms whenever it was necessary. The vowel categories' list, which is the same training material as for the first external transcriber, was provided to him for reference.

3. Results of the external transcribers' transcriptions

Once the sessions with the external transcribers were complete, I compared the second external transcriber's transcriptions with my initial and the first transcriber's two rounds of transcriptions. Each of his transcriptions was classified as belonging to one of three groups: similar with my transcription, similar with the first external transcriber's transcription, dissimilar to the previous three transcriptions. Note that by classifying the vowel transcriptions as 'similar', I disregarded suprasegmental features like vowel length and stress. For instance, if the first external transcriber transcribed a vowel as the long /ɯː/ and the second external transcriber perceived it as the short /ɯ/, then those transcriptions were classified as "similar" provided the vowel phonemes were the same. Below (5) is the chart of the nine vowels and results of the comparisons:

(5) Transcription comparisons

Vowel	Total number of vowels in the words	1st and 2nd external transcribers' similar	2nd external transcriber and initial transcriptions similar	2nd external transcriber's dissimilar transcriptions
e	14	7 (50%)	5 (35.7%)	2 (14.3%)
ɛ	11	9 (81.8%)	1 (9.09%)	1 (9.09%)
œ	7	2 (28.6%)	5 (71.4%)	-
ɯː	7	2 (28.6%)	5 (71.4%)	-
u	14	4 (28.6%)	8 (57.1%)	2 (14.3%)
uː	14	4 (28.6%)	10 (71.4%)	-
ɯɑ	8	8 (100%)	-	-
uɒ	19	8 (42.1%)	8 (42.1%)	3 (15.8%)
ɑ	13	9 (69.2%)	-	4 (30.8%)

The results presented in (5) suggest that the most differences between my initial transcriptions and both external transcribers' transcriptions lie in the four vowels: /e/, /ɛ/, /ɯɑ/ and /ɑ/. Specifically, the vowel /e/ was transcribed as either the short or long /i/ seven times by the external transcribers; /ɛ/ was perceived as both long and short /i/ nine times; the diphthong /ɯɑ/ was transcribed as the short or long /ɯ/ six times; and finally, the vowel /ɑ/ was perceived as /ɛ/ five times, and as /ɯ/ three times.

As the final stage of the transcriptions, my former academic supervisor Dr. Anne-Michelle Tessier, a native English speaker who is trained in transcription, verified my transcriptions of the stressed and unstressed instances of /e/ and /i/, the vowel /ɑ/ and the diphthongs /ɯɑ/ and /uɒ/ in the sound files. Sound files of 15 words containing the specified vowels were provided. For each vowel, a verification question or comment was addressed, including the previous transcriptions and the syllable number where the vowels occurred. The former supervisor provided comments and transcriptions on 12 vowels out of the total of 15. It was shown that the transcriptions of the vowels /ɑ/ and /e/ needed to be attended in the final revision transcriptions. Both external transcribers and the former academic supervisor perceived the vowel initially transcribed as /ɑ/ as /ɛ/. An initial transcription of the vowel as /e/ was often perceived as the higher vowel /i/ by the native English speakers. Also, verifications of the former academic supervisor confirmed, that my initial transcriptions of the diphthongs /ɯɑ/ and /uɒ/ were sufficiently accurate, i.e. correct identification of vowels as diphthongs was attested. The former supervisor's comments suggested that my initial transcriptions of the vowel as /ɑ/ needed revising, including the unstressed vowel /e/ that she perceived as the higher vowel /i/. In addition, a consistent transcription of the diphthong /ɯɑ/ as /ɛː/ by the external transcribers was declined by the former supervisor; she confirmed that the vowel started with a back unrounded vowel. Thus, in the final transcriptions I prioritized the transcribed vowels /e/, /ɛ/, /ɯɑ/, and /ɑ/ along with a general thorough revision of the initial transcriptions.