Production of Russian /i/ and /ɨ/ by Russian-English Bilingual Children: Effects of Language Experience

Evgeniya Maryutina, Suzanne V.H. van der Feest, and Valerie L. Shafer

1. Introduction

Bilingual adults can produce separate vowel categories in both of their languages, although it has been shown that the quality of their vowel productions can be highly affected by their exact experiences and age of acquisition of their different languages (e.g., Flege, Schirru, & MacKay, 2003; Guin, 2003; MacLeod, Stoel-Gammon, & Wassnik, 2009). Bilingual children can also produce separate vowel categories in both of their languages, and the quality of their productions can be similar to monolinguals'; however, it has been argued that bilingual children's vowel production development may take longer in languages with larger phonetic inventories (e.g., Gildersleeve-Neumann & Peña, 2009; Gildersleeve-Neumann & Wright, 2010; Kehoe, 2002; Lee & Iverson, 2012). In this study, we further investigate vowel productions of bilingual children. We analyze productions of Russian vowels /i/ and /ɨ/ by Russian-English bilingual children as compared to productions by monolingual Russian-learning children.

The Russian vowel system inventory is relatively small and consists of five vowels: /i/, /a/, /o/, /u/ and /ɛ/ (Halle, 2011; Jones & Ward, 1969). Some phonologists argue that there is an additional sixth vowel /ɨ/ in Russian (e.g., Kodzasov & Krivnova, 2010) whereas others suggest that /ɨ/ is an allophone of /i/ (e.g., Byun, Hong, & Ahn, 2018), as we will discuss below. Despite the small number of vocalic phonemes, a striking feature of the Russian vowel system is the large number of allophones for each vowel, the occurrence of which is determined by the phonetic context such as word-level stress, as well as preceding consonants (Jones & Ward, 1969). These environments are determined by the consonants which in Russian are divided into hard and soft ('palatalized') (Matusevich, 1976). For example, the vowel /a/ as in 'мать' /mat^{j}/ *mother* is realized as /ja/ when preceded by a soft consonant, as in мять /m^{j}at^{j}/ *crush*.

* Evgeniya Maryutina (corresponding author), The Graduate Center, City University of New York (CUNY), Ph.D. Program in Speech-Language-Hearing Sciences, emaryutina@gradcenter.cuny.edu; Suzanne V.H. van der Feest, The Graduate Center, City University of New York, Ph.D. Program in Speech-Language-Hearing Sciences and M.A. / Ph.D. Program in Linguistics, svanderfeest@gc.cuny.edu; Valerie L. Shafer, The Graduate Center, City University of New York, Ph.D. Program in Speech-Language-Hearing Sciences and M.A. / Ph.D. Program Linguistics, vshafer@gc.cuny.edu.

Proceedings of the 46th annual Boston University Conference on Language Development, ed. Ying Gong and Felix Kpogo, 511-523. Somerville, MA: Cascadilla Press.

In this study we investigate the production of Russian vowels /i/ and /ɨ/ by Russian-English bilingual children by comparing the productions of these vowels with productions of monolingual speakers. These two vowels present an interesting case, because the limited distribution and occurrence of /ɨ/ has led to debate regarding its phonemic status; the limited distribution may potentially make /i/-/ɨ/ an especially difficult contrast to acquire for bilingual children because they receive less Russian language input than monolingual Russian children. The vowel /ɨ/ is a high, central, unrounded vowel (Jones & Ward, 1969), and its phonetic realization is highly dependent on the preceding consonant: it is never preceded by a soft consonant. The typical spectral dynamics of the Russian vowel /ɨ/ are characterized by a gradual increase of an initially low F2 value (around 1600-1800 Hz for an average adult male), eventually rising to an F2 value equivalent to /i/ (Derkach, Gumetskyi, Gura & Chaban, 1983). The high, front, unrounded vowel /i/ has a comparatively high starting F2 value (~2500 Hz) which stays stable throughout the vowel.

Whether / ɨ / should be considered a separate vowel or an allophone of /i/ has been a long-term debate (Byun, Hong, & Ahn, 2018). The "Moscow Phonological School" view considers /ɨ/ to be an allophone of /i/ based on three main arguments: (1) only /i/ but not /ɨ/ can occur word-initially and independently (e.g., the preposition 'и' /i/ *and*); (2) /ɨ/ never occurs after soft consonants; and (3) /ɨ/ and /i/ vowels alternate in phonological derivation. In cases where the vowels do seem to occur in contrastive distribution, the claim is that the difference lies not truly in the vowel, but in the hard versus soft consonants preceding the vowel (e.g. in 'мило' /ˈmʼila/ *cute* and 'мыло' / ˈmila/ *soap* and not /ˈmila/ - /ˈmɨla/; under this view, these vowels can only occur in complementary distribution (Baudouin de Courtenay, 1917; Matusevich, 1976).

The opposing view (of the "Saint Petersburg Phonological School") considers /ɨ/ an independent phoneme, albeit with limited distribution, based on four main arguments (see Byun, Hong, & Ahn, 2018; Shcherba, 1957; (1) although infrequent, words beginning with /ɨ/ are possible (e.g., the name of the Russian village 'Ындин' *Yindin*, or the verb 'ыкать' *ykat* 'to pronounce the sound /ɨ/'); (2) /ɨ/ is in true contrastive distribution with other vowels and serves as a semantically differentiating unit (e.g., 'bak' /bak/ *barrel*, 'bok' /bok/ *side*, 'byk' /bɨk/ *bull)*; (3) historically, /ɨ/ was an independent phoneme that later became associated with /i/, but a complete merger of the two vowels never happened (unlike in other languages such as Czech); and (4) native Russian speakers treat /ɨ/ as an independent entity and can pronounce it in isolation as opposed to other allophones that speakers do not attempt to pronounce without a preceding consonant.

Studies on the acquisition of this vowel contrast are rare, however, observations of children and mothers' reports indicate that Russian-speaking children in monolingual environments start producing /ɨ/ accurately later than other vowels, at around three years of age (Gvozdev, 1949; Zharkova, 2005). We ask the following questions: (1) Do Russian bilingual children show evidence of the formation of separate categories for /ɨ/ and /i/? Bilingual children have more

limited input in Russian and more variability in their phonological input due to the presence of more than one language, which may impact learning these vowels. (2) How do bilingual children's productions compare to those of monolingual Russian-learning children? This comparison can provide important insights into the acquisition of a difficult vowel contrast by bilingual children. (3) In addition, we ask how the age of first exposure to Russian and ongoing daily language use affects the quality of vowel productions.

We hypothesize that children's early exposure and continued experience with Russian should enable older Russian-learning bilingual children to acquire and produce both vowels; however, we predict that the quality of the vowel productions may not be the same as those of monolinguals, similar to what has been found for bilingual children acquiring languages with larger vowel inventories (e.g. Kehoe, 2002). We also hypothesize that amount of Russian versus English input will modulate production of the vowels.

To test these hypotheses, we remotely collected speech production data for acoustic analyses from eleven 8- to 13-year-old Russian-English bilingual children living in New York City, and two 10-year-old native Russian speakers living in Siberia, Russia. The data from the Russian monolinguals was collected as a baseline, because to our knowledge there is no previous study where Russian children's productions of /ɨ/ and /i/ were acoustically analyzed. Children in this study participated in two tasks: a Picture-naming task and a Repetition task. The vowels produced in these tasks were extracted and acoustically analyzed, as reported below.

2. Method

2.1. Participants

A total of 13 children participated in this study. Participants were 11 Russian-English bilingual children (4 female) between the ages of 8-13 years (mean age: 10 years). All bilingual participants were living in the New York City area and born in the United States (n=11) or London (n=1). All were exposed daily to both English and Russian from birth (n=5) or before the age of five (n=7). Parents of the bilingual participants were asked to fill out a Language Background Questionnaire via Qualtrics to provide detailed information about their child's experience with both languages. The questionnaire consisted of 90 questions in total. Questions were grouped into 14 categories; General Information (n=8); Parent Information (n=10); Early Russian Exposure (n=3); Home Language (n=14); Other Caregivers (n=8); Extended Family Language (n=4); Social / Peer language (n=3); Current active language use / Production (n=7); Hear (n=4); Formal Education & Russian Classes (n=13); Literacy (n=4); Media (n=8); Leisure Activities (n=4); Travel to Russian Language Countries (n=4)) Parents had to provide detailed information on the age of first exposure to both languages, frequency and context of use on a daily basis for each language, competence in different skills such as reading and writing in both languages, and the amount of language they hear and produce daily. Upon analysis of the questionnaire, one

additional bilingual participant was excluded from the study since one of the caregiver's main language was Spanish, and English turned out to be the third language in the household. An additional two monolingual Russian-learning 10-year-olds (1 female) participated. Both were living in Siberia, Russia. None of the children in the study had reported speech, language, or hearing issues. More details about the participants' characteristics compiled from the General Information, Parent Information, Early Russian Exposure, and Russian Classes questions of the Language Background Questionnaire are illustrated in Table 1.

Table 1 – Bilingual Participants Main Characteristics

Parti-cipant#, gender	Age in years	Russian First Exposure	English First Exposure	Russian speaking parent	Years of Russian classes; weekly frequency	Other languages
B1, F	9	from birth	from birth	1	8; 2 x 1h	Spanish, Hebrew
B2, M	8	from birth	at 3 years	2	0; (2h total)	
B3, F	12	from birth	from birth	1	10; 2 x 1h	Mandarin
B4, M	9	from birth	at 3 years	2	9; 2 x 1h	
B5, M	9	from birth	at 3 years	2	9; 2 x 1h	
B7, F	9	from birth	from birth	1	6; 1 x 1h	Mandarin
B8, M	11	from birth	at 2 years	2	2; 1 x 45m	Spanish
B9, M	10	from birth	at 2,5 years	2	5; 2 x 1h	
B10, F	10	from birth	from birth	2	5; 2 x 1h	Spanish
B11, M	13	from birth	at 4 years	2	never	Spanish
B12, M	12	from birth	from birth	2	never	

2.2. Stimuli

The stimuli selected for the study were 40 mono-, bi-, and trisyllabic real Russian words that contained the target vowels /i/ and /ɨ/. Ten words per vowel were used in the Picture-naming task, and 10 additional words per vowel were used in the Repetition task (a total of 20 unique words per task). In addition, an equal number of Russian words containing different vowels were used for each

task as fillers (an additional 20 unique words per task). All target words were names of high-frequency items such as names of animals, food items, and everyday objects or actions. The majority of the 80 words were nouns, with a few exceptions: numerals (1), adjectives (5), and verbs (3).

In all words, the target vowels /i/ and /ɨ/ occurred only in stressed position, since Russian vowels are subject to reduction in unstressed positions. The target vowel /ɨ/ always occurred in the first stressed syllable of a mono- or bi-syllabic target word. The target vowel /i/ also mostly occurred in the first stressed syllable of a mono- or bi-syllabic target word, with the exception of ('kroko'dil' *crocodile* and 'apel'sin' *orange)* where it occurred in the third stressed syllable of a trisyllabic word. Since /ɨ/ is never used word-initially, no vowel-initial target words were included in the experiments.

2.3. Apparatus and Procedure

The experiment was conducted online via Zoom and consisted of two tasks: (1) a Picture-naming and (2) a Repetition task. Children performed the tasks on their personal desktop computers or laptops. Parents of the participants were asked in advance to record the participants' speech during the experiment on a mobile device. All participants used the VoiceMemos application on either an iPhone or iPad. Parents were instructed to position their device flat on the table approximately 20-25 inches from the child. Children were instructed to sit facing the computer screen. Parents were allowed to be in the same room with the participant but were instructed not to talk and not to interfere with the experiment.

At the beginning of each task, children were given detailed instructions by the experimenter via Zoom, first in English to ensure their understanding of the instructions and then in Russian to encourage the children to shift to a Russian language mode (Grosjean, 2020). Each task began with three practice trials to ensure participants understood the task. The items in the practice trials were not used in the experiments. The first task for every participant was the Picture-naming task, during which children were instructed to name images they saw on the screen in Russian. In total, each task consisted of 40 items: 10 words for each of the two target vowels and 20 fillers. Target words and fillers were presented in a pre-set semi-randomized mixed order. All items were repeated twice, once in the first and once in the second half of the task, so that a total of 40 tokens were collected for the target vowels. The order of presentation was changed in the second round of presentation and was the same for all participants. During the presentation of experimental items, the tokens containing target vowels followed by fillers or occasionally two different words with the same target vowel presented one after another followed by two fillers; target vowels alternated in the order of presentation. This first task typically lasted about 10 minutes.

Next, children were given the option to take a short break before continuing with the Repetition task. Prior to the Repetition task, they were again given detailed instructions first in English, then in Russian. During this second task, children saw an image on the screen and heard the (native Russian speaker)

experimenter say a sentence via Zoom, “Ya mogu skazat [target], [target]” (*I can say [target], [target]*) containing the name of the image repeated twice in a row (e.g.: “Ya mogu sazat syr, syr” *I can say cheese, cheese)*. The participants were instructed to repeat the entire sentence including the repetition of the target word after the experimenter. In total, there were 20 target words per vowel in the Repetition task (the 10 words used in the Picture-naming task plus 10 additional words). Each word was again repeated twice so that 80 tokens were collected per target vowel in this task. The repetition task lasted roughly 20 minutes.

2.4. Data Analyses

In total, 120 tokens were collected (60 per vowel) for each of the 13 participants upon completion of the experiment, provided children successfully named all images during the Picture-naming task.

The onset and offset of the vowel were identified by the presence of stable formant traces in the spectrogram. Once the onset and offset were identified, the boundaries were added to a text tier in Praat. The boundaries were manually checked by a trained Russian-speaking listener (the first author) and adjusted if needed. Vowel duration, F1, F2, and fundamental frequency (F0) values were obtained at 10%, 20%, 50%, 70%, and 80% of the duration for each vowel. The formant settings were individually adjusted for every participant. The Formant Ceiling was increased to 6000 - 9000 (Hz) (occasionally up to 10 000 Hz). The Pitch range was set to 500 Hz. The window length used for analysis was 0.005s and the dynamic range was set up at 30(dB). The default temporal resolution used was 1000 Time steps with 250 Hz Frequency steps.

3. Results

A total of 1447 tokens were collected: 20 words X 2 repetitions X 13 participants in Picture-naming task and 40 words X 2 repetitions X 13 participants in Repetition task. However, out of 1560 possible productions, 113 items total among all the participants were the items children failed to name in the first task. Of these, 1357 were acoustically analyzed: 90 tokens total from all participants combined were excluded due to poor quality of recordings, creaky voice, or excessive background noise.

Upon completion of the acoustic analyses, we first visually analyzed the productions for each individual participant. We observed that the main difference between the vowels was reflected in the second formant and identified three main patterns, which are illustrated in Figure 1. An example of a monolingual participant is illustrated in Figure 1, top-left panel a. There were four children whose productions were similar to monolinguals, producing /i/ with higher F2, and /ɨ/ with F2 that started lower and gradually raised (Figure 1, top right panel b). There were four children whose productions were slightly different from monolinguals, but who still showed different formant values for both vowels and distinct vowel qualities. However, their F2 values for /ɨ/ were slightly higher than

the ones of the monolinguals (Figure 1, bottom left panel c). Finally, there were three children whose production patterns were different from monolinguals. These children showed high F2 values for /i/ and a trend towards assimilating the two vowels (Figure 1, bottom right panel d).

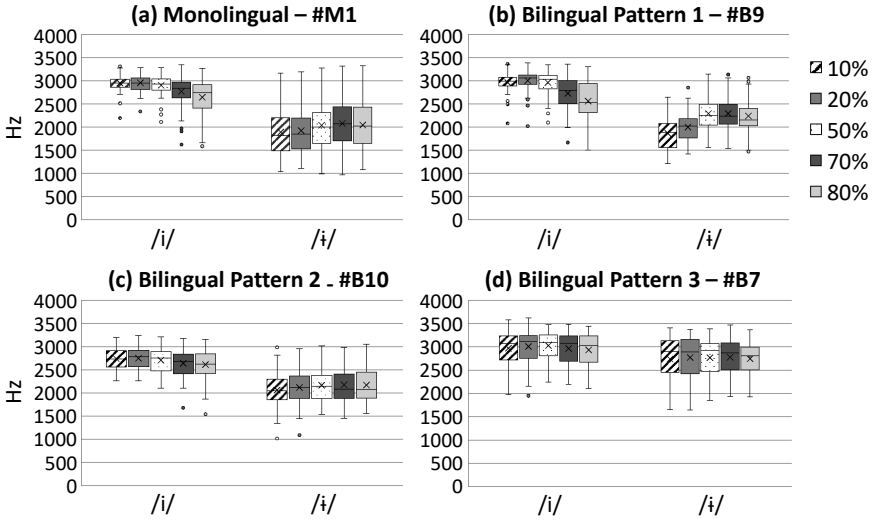

Figure 1 - F2 Formant values (Hz). Boxplots depicting distributions of F2 formants for /i/ and /ɨ/ with whiskers from 1.5 times the interquartile range below and above the first and third quartiles for (panel a) a Russian participant, (panel b) a bilingual participant whose production patterns were similar to monolingual participants, (panel c) a bilingual participant whose production patterns are slightly different from monolinguals, (panel d) a bilingual participant whose production patterns differ from monolinguals. Distributions are plotted at five-time points in the vowel. Dots represent outliers.

The vowel values were converted from Hertz to an auditory scale in Bark, to reduce the variation within the vowel tokens among different speakers (Traunmuller & Hartmut,1997). Mean F1 and F2 values were obtained for each participant, and mean values and standard deviations in Hz and Bark were computed for both groups of participants. We then plotted the mean vowels for both formants (Figure 2). The plot illustrates that /i/ is more fronted for most of the bilingual participants than for monolinguals, and that for the majority of the participants the vowels are clearly separated in the vowel space. For three of the participants, /i/ and /ɨ/ are not well-separated; these are the same participants that were classified as not producing a clear contrast above (illustrated in Figure 1, panel c).

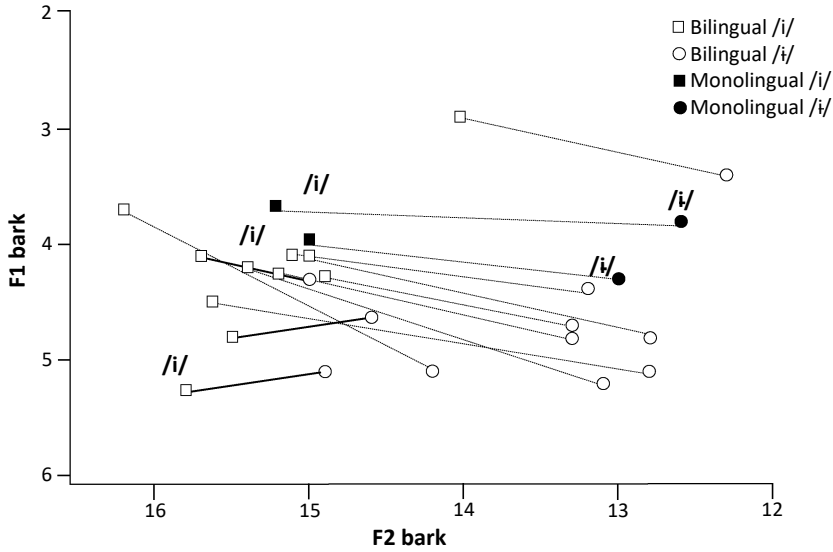

Figure 2 - Individual mean F1 and F2 values (Bark) for target vowels /i/ and /ɨ/ produced by bilingual and monolingual children. Individual values for each participant are connected by lines.

The vowel productions of the bilinguals versus monolinguals were investigated in a planned comparisons repeated measures three-way 2 x 2 x 2 ANOVA with group (bilingual, monolingual) as a between-subjects factor and vowel (/i/, /ɨ/) and formant (F1, F2) as within-subjects factors. There was a significant main effect of formant ($F(1,11) = 1606.5$, $p = <.0001$), as well as a significant interaction between vowel and formant ($F(1,11) = 12.1$, $p = .001$). (Specifically, the two vowels showed greater separation for F2). There were no other significant main effects (vowel, $F(1,11) = 2.89$, $p = 0.09$; group, $F(1,11) = 1.52$, $p = 0.2$) and no other significant interactions (group * vowel, $F(1,11) = 1.19$, $p = 0.2$; group * formant, $F(1,11) = 0.04$, $p = 0.8$; group * vowel * formant $F(1,11) = 0.48$, $p = .4$).

Next, a single sample two-tailed *t*-test was conducted to compare the F1 and F2 values of the two vowels produced by the bilingual children, using the values of the Russian monolinguals to represent the population mean. The F1 values for /ɨ/ were significantly higher for bilinguals ($M = 4.6$ bark, $SD = 0.5$) than the monolingual norm ($t(10) = 4$, $p = 0.02$). The F2 values for /ɨ/ were significantly higher for bilingual group as well ($M = 13.5$ bark, $SD = 0.9$) than the monolingual norm ($t(10) = 2.8$, $p = 0.01$). For /i/, there was no significant difference from the monolingual norm for either the F1 values ($t(10) = 1.9$, $p = 0.07$), nor the F2 value ($t(10) = 1.1$, $p = 0.2$).

To understand the potential origins of the individual differences in vowel productions among bilingual participants, the responses on the Language Background Questionnaire were analyzed. For the analysis, responses to all 90

questions on the questionnaire were tabulated as follows: for yes/no questions, a numerical value of 1/0 was assigned. For questions using a 5-point Likert scale, each answer was assigned a minimum value of 0 and a maximum value of 5. Answers on open-ended and multiple-choice questions were assigned a numerical code 0-4. A maximum score was calculated for each language (173 for English and 212 for Russian) as well as for each participant individually, and a percentage of use of each language for each participant was calculated from the total score (individual score divided by the overall score). Based on the visual inspection of Figure 3, two general patterns were identified: (1) participants who have a relatively high Russian experience (Participants #B4, B5, B8, B9, B10) and (2) participants with low Russian experience (Participants #B1, B2, B3, B7, B11, B12).

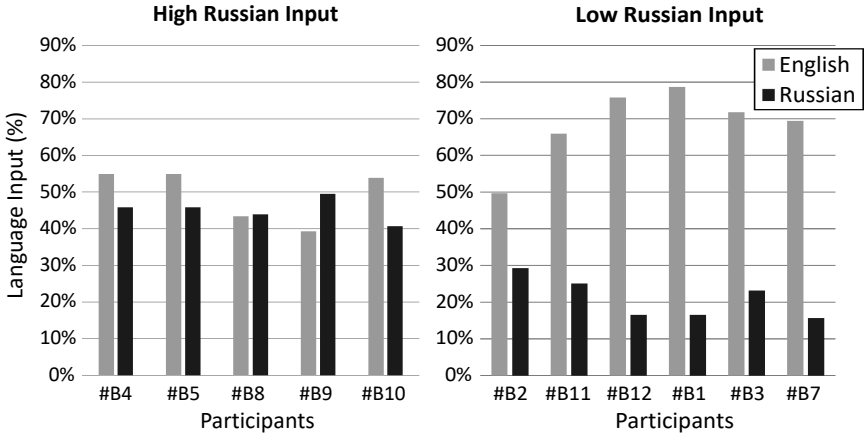

Figure 3 - Language experience in English and Russian based on the questionnaire responses. Each bar represents the percentage of total current input for each participant in English and Russian.

To directly compare the formant values between the two groups of bilinguals identified as having low versus high Russian experience, a repeated measures 2 x 2 x 2 ANOVA was conducted with Russian Experience (low, high) as between-subjects factor and vowel (/i/, /ɨ/) and formant (F1, F2) as within-subjects factors. A significant main effect of formant was found ($F(1,9) = 2562.79$, $p = <.0001$), as well as a significant main effect of vowel, ($F(1,9) = 9.77$, $p = .003$), a significant interaction between vowel and formant, ($F(1,9) = 30.95$, $p = <.0001$), and a marginally significant interaction between Russian Experience and formant, ($F(1,9) = 3.3$, $p = .007$). There was no significant main effect of Russian Experience, $F(1,9) = 1.51$, $p = 0.2$, and no other significant interactions (vowel * Russian experience $F(1,9) = 0.6$, $p = 0.4$; vowel * formant * Russian Experience $F(1,9) = 0.81$, $p = 0.3$) The interaction between Russian Experience and formant that approached significance was related to the low input group producing higher F2 values.

Next, to further investigate differences between the two bilingual groups, a unpaired two-sample two-tailed *t*-test was conducted to compare the F1 and F2 values of the two vowels produced by bilingual children with low versus high Russian Experience. No significant difference was observed between the two groups for F1 values in /i/, ($t(9) = 0.2$, $p = 0.8$), nor for /ɨ/ ($t(9) = 0.4$, $p = 0.6$). For F2 values, there was a marginally significant difference for /ɨ/, ($t(9) = 1.8$, $p = 0.09$) between the group with low ($M = 14$, $SD = 1$) versus high Russian experience ($M = 13$, $SD = 0.2$), but no significant difference between the F2 values of the groups for /i/, ($t(9) = 0.7$, $p = 0.4$).

Finally, the values for the two groups of bilinguals with low versus high Russian experience were each compared with the monolinguals. F1 values for vowel /i/ were significantly higher for the group with high Russian experience ($M = 4.2$, $SD = 0.16$) than the monolingual norm ($t(4) = 5.3$, $p = 0.005$). F1 values for /ɨ/ were also higher for the group with high Russian experience ($M = 4.7$, $SD = 0.2$) than the monolingual norm ($t(4) = 6.3$, $p = 0.003$). No significant difference was observed for F1 values between groups with low Russian experience and monolinguals neither for /i/ ($t(5) = 0.9$, $p = 0.4$), nor for /ɨ/ ($t(5) = 2$, $p = 0.1$). The F2 values of /ɨ/ were significantly higher for the group with low Russian experience ($M = 14$, $SD = 1$) than the Russian norm ($t(5) = 2.7$, $p = 0.04$), but no significant difference in F2 values for /i/ between the groups was found ($t(5) = 1$, $p = 0.3$). There was no difference between monolinguals and the group with high Russian experience for F2 values of /i/ ($t(4) = 0.4$, $p = 0.6$), nor for /ɨ/, ($t(4) = 2$, $p = 0.07$).

In summary, our results show that the overall patterns of production of the two high Russian vowels /i/ and /ɨ/ by bilingual children are similar to monolinguals' patterns. However, there is a degree of variability in the production of the vowel /ɨ/ among the bilinguals: children demonstrate different patterns of production of this vowel as illustrated in Figure 1 where we see that some children produce /ɨ/ with higher and some with relatively lower F2. We argue that this is related to the amount of language experience children receive on the daily basis. Statistical analyses confirmed that the bilingual group produces /ɨ/ with higher F1 and F2 values than the Russian monolingual value, but no difference in formant values was found between the groups for the production of /i/. Furthermore, bilinguals with low Russian experience produce /ɨ/ with higher F2 values than the high input bilingual group, and bilinguals with high Russian experience produce both vowels with higher F1 values than monolinguals.

4. General Discussion

This study examined the productions of two Russian high vowels, front /i/ and mid /ɨ/, by Russian-English bilingual and Russian monolingual children. The main goals of the study were to investigate whether bilingual children form separate categories for these two vowels; how their formant values compare to those of Russian monolinguals; and the effect of the bilinguals' daily language experience on their phonetic realizations of the two target vowels. Overall, the

results showed no significant differences between the bilingual and monolingual groups in their production of /i/. The F2 values were relatively high for both groups with a relatively low F1, the pattern that is typical for Russian /i/. However, a difference was observed between the bilingual and monolingual groups in their productions of both F1 and F2 formants for the vowel /ɨ/. The values for both formants tended to be higher for bilingual participants compared to the monolingual controls. In addition, the examination of individual patterns of production revealed a high degree of variability in the production of this vowel among bilingual participants.

One interesting finding that emerged in this study was that the group with low Russian experience tended to produce higher values for F2 for vowel /ɨ/ than the monolingual speakers. No such difference was observed between the group with high Russian experience and monolinguals. These preliminary findings indicate that there is a correlation between the quality of the vowel productions (i.e., matching the Russian monolingual's vowels and maintaining contrastiveness) and the amount of Russian language experience in bilinguals. Note that all bilingual participants were exposed to Russian since birth, but that the groups differed in the way the language was used on a daily basis. Primarily, some children had more opportunity to practice Russian by virtue of communicating with their parents, siblings, or other family members, or by attending additional Russian classes. However, some children had only one Russian speaking parent (the mother), and most of the time communicated with their parents in English only. We therefore argue that in order to account for differences in productions of young bilingual speakers, not only age of exposure but also the quantity of the input and daily use of both languages should be considered a crucial factor.

When formant values for the vowels were compared between the groups with High and Low Input and monolinguals, an unexpected discovery was the higher F1 values for both vowels by the group with higher Russian input compared to those of the monolinguals and the group with the low input. It is unclear where this difference comes from, especially because no difference was observed for the F2 values for the same vowels when the same groups were compared. One possible explanation may be that some bilingual children tended to produce Russian /i/ with values closer to English /i/, and Russian /ɨ/ with values closer to English /ɪ/; both of the English vowels have lower F1. Future research including direct comparisons with English vowels and a larger number of participants is needed to investigate this issue in more detail.

The last question we attempted to answer in this study was whether studying the production of the two vowels could provide a contribution towards the debate regarding the status of the phoneme /ɨ/. We observed that participants with lower Russian experience struggled to produce the vowel /ɨ/ in a similar fashion to monolinguals, compared to participants with more Russian experience. If /ɨ/ indeed is an allophone and is linked to a specific phonetic environment (in this case, occurring only after hard consonants), then it is plausible that the children who struggled with the vowel might not be employing all phonetic cues and contextual information. Another way to approach the question of the status of the

phoneme is to investigate whether children also have mastered the difference between soft and hard consonants. If such comparisons would show that they are able to produce the difference between consonants, but fail to produce the difference between the vowels, then this could be indicative of the fact that /ɨ/ is an allophone and not a separate phoneme since only contrastive sounds are stored in representations (Shea & Curtin, 2011). Future research is needed to further examine the use of contextual factors in implementing phonetic cues by both bilingual and monolingual speakers of Russian.

This study is the first to investigate the acoustic properties of children's production of the Russian /i/ - /ɨ/ contrast, not only by bilingual Russian-English children but also by native monolingual Russian-speaking children. Although much work remains to be done to understand vowel organization in Russian-English bilingual speakers, these results have important implications. Results show that bilingual children are able to produce the Russian vowels contrastively. However, our results also show that less than 30% daily input in Russian can lead to failure to acquire or maintain this phonetic contrast. This study also provides the first attempt to approach the debate regarding the status of the phoneme /ɨ/ by studying the productions and the acquisition of this vowel by bilingual children who have received a relatively limited amount of Russian input. And finally, this dataset sheds light on the connection between daily language experience and sound production, laying the ground for future investigations in these directions.

References

Avanesov, Ruben I., ed. (1956). *Fonetika sovremennogo russkogo literaturnogo jazyka*. Izd. Moskovskogo Universiteta.

Baudouin de Courtenay, Jan. (1917). *Vvedenie v yazykoznanie*. Saint Petersburg: Studencheski iztatelski komitet pri istoriko-filologicheskom fakultete Sankt-Peterburzhskogo universiteta.

Boersma, Paul and Weenink, David (2019). Praat: Doing phonetics by computer [Computer program]. Version 6.1.03.

Byun, Koonhyuk, Hong, Sung-Hoon, & Ahn, Hyung (2018). A quantitative analysis of the phonemic status of the Russian vowel y. *Russian Linguistics*, *42*(3), 375-390.

Derkach, Miron F., Gumetskyi, Roman Y., Gura, Bogdana M., & Chaban, Miroslava E. (1983). *Dynamichekie spektry rechevykh signalov*/ Pod red.MF Derkacha. Lvov.

Flege, James, Schirru, Carlo, & MacKay, Ian R. A. (2003). Interaction between the native and second language phonetic subsystems. *Speech Communication*, *40*(4), 467–491.

Gildersleeve-Neumann, Christina E., Peña, Elizabeth D., Davis, Barbara L., & Kester, Ellen S. (2009). Effects on L1 during early acquisition of L2: Speech changes in Spanish at first English contact. *Bilingualism: Lang & Cognition*, *12*(2), 259–272.

Gildersleeve-Neumann, Christina E., & Wright, Kira L. (2010). English speech acquisition in 3-to 5-year-old children learning Russian and English. *Language, Speech, and Hearing Services in Schools, 41,* 429-444.

Grosjean, Francois (2020). The bilingual's language modes 1. In *The bilingualism reader* (pp. 428-449). Routledge.

Guion, Susan G. (2003). The vowel systems of Quichua-Spanish bilinguals. Age of acquisition effects on the mutual influence of the first and second languages. *Phonetica*, *60*(2), 98–128.

Gvozdev, Alexander N. (1949). *O fonologicheskikh sredstvakh russkogo yazyka. The compilation of articles*. APN RSFSR.

Halle, Morris (2011). *The sound pattern of Russian: A linguistic and acoustical investigation* (Vol. 1). Walter de Gruyter.

Jones, Daniel, & Ward, Dennis (2010b). *The Phonetics of Russian*. Cambridge Univ. Press.

Kehoe, Margaret (2002). Developing vowel systems as a window to bilingual phonology. *International Journal of Bilingualism*, *6*(3), 315–334.

Kodzasov, Sandro V., & Krivnova, Olga F. (2001). *General phonetics*. Rossiĭskiĭ gos. gumanitarnyĭ universitet.

Lee, Sue Ann S, Iverson, Gregory (2012). Stop consonant productions of Korean–English bilingual children. *Bilingualism: Language and Cognition*, *15*, 275–287.

MacLeod, Andrea A. N., Stoel-Gammon, Carol, & Wassink, Alicia B. (2009). Production of high vowels in Canadian English and Canadian French: A comparison of early bilingual and monolingual speakers. *Journal of Phonetics*, *37*(4), 374–387.

Matusevich, Margarita I. (1976). *The modern Russian language*. Phonetics. Moscow.

Scherba, Lev V. (1957). S*ovremennyy russkiy literaturnyy yazyk [Modern Russian literary language]*. Izbrannye raboty po russkomu yazyku [Selected Works on Russian Language]. Moscow, Uchpedgiz Publ, 110-129.

Shea, Christine E., & Curtin, Suzanne (2011). Experience, representations and the production of second language allophones. *Second Language Research*, *27*(2), 229-250.

Zharkova, Natalia (2004). Strategies in the acquisition of segments and syllables in Russian-speaking children. *Developmental paths in phonological acquisition. Special issue of Leiden Papers in Linguistics*.

Proceedings of the 46th annual Boston University Conference on Language Development

edited by Ying Gong
and Felix Kpogo

Cascadilla Press Somerville, MA 2022

ISSN 1080-692X
ISBN 978-1-57473-077-7 (2 volume set, paperback)

Ordering information

To order a copy of the proceedings or to place a standing order, contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA
phone: 1-617-776-2370, sales@cascadilla.com, www.cascadilla.com