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1. Introduction

During the first few years of life, children attune their perception to the speech sound categories of their native language. Attunement to native-language vowels has been shown as early as 6 months of age (e.g., Kuhl et al., 1992). This is considered a prerequisite for the development of the native-language phonological system, which is used for optimizing both word recognition (perception) as well as the articulation of sounds in running speech (production). While we know that the formation of the phonological system is well underway in the first year of life, native-language speech sounds take longer to be mastered in production. For example, while around 3 years of age children's vowel productions enable listeners to access the intended vowel targets, allowing for successful communication, the production of the acoustic-phonetic cues in vowels is not yet adultlike even at age 3. Several factors are considered to be at play here, including the ongoing maturation of the structural articulatory system (or in other words, children's physical growth), the development and fine-tuning of motor and gestural control, and the ongoing development of the phonological system.

In the current study, we present a first investigation of the production of the English /i/ - /ɪ/ - /ɛ/ vowel contrasts by different groups of Spanish-English and

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Russian-English bilingual children. We will also include analyses of the Russian /i/ - /ɨ/ vowel contrast produced by two groups of Russian-English bilingual children. Little research to date has examined vowel productions by bilingual children, and existing studies are typically smaller single-case studies and tend to employ only analyses of broader phonetic or phonological transcriptions (e.g., Jacewicz & Fox, 2014; Kehoe, 2002; Keshavarz & Ingram, 2002) while studies employing detailed acoustic analyses are rare (e.g., Lee & Iverson, 2012). However, such detailed analyses are required to answer the question of what acoustic-phonetic cues are necessary to allow sound contrasts to be formed and stored in the phonological system. More specifically, we need acoustic analyses to learn what the necessary cues are that bilingual children employ to successfully use multiple systems simultaneously. As our test case, here we look at vowel productions in groups of Russian-English and Spanish-English bilingual children in the New York City (NYC) metro area.

New York City forms a rich context for studying bilingual speech development: over 700 languages and dialects are spoken in this densely populated area (e.g., Perlin et al., 2015, http://languagemap.nyc). This includes communities that are relatively homogeneous, with dominant languages such as Spanish (the main language in 20% of households) or Russian (the 4th most common language spoken in the area). In these communities, some children may hear English in bilingual households, and others may be introduced to significant amounts of English only in preschool or kindergarten. Multiple varieties of Spanish are used in the NYC area, and the English of the different bilingual Spanish-English groups tends to be highly identifiable for native listeners, characterized for example by a staccato-type rhythm and acoustic-phonetic features influenced by Spanish (e.g., more prevoicing of voiced stops) and African American English (e.g., stopping of dental fricatives) (e.g., Newman, 2014; Otheguy & Zentella, 2012). Much less is known about the influence of Russian on the English spoken by bilingual NYC communities where Russian is widely spoken, such as large communities in Brooklyn which have been established much more recently (after ~1990) (e.g., Kleyn & Vayshenker, 2012) than the Spanish-dominant communities.

When such bilingual communities are studied, their English tends to be characterized as “foreign-accented” English (e.g., Flege et al., 1995; Thompson, 1991). However, we argue here that the English spoken in these communities should instead be studied as a different variety of American English, with (bidirectional) influence between English and the other dominant language(s) in those communities. Considering the English spoken by these bilingual groups as a form of dialectal variation is important for various reasons. The most obvious of these may be the avoidance of a generally negative “deficit” approach towards for instance Spanish-influenced English, leading to negative attitudes associated with speakers of this variant. Furthermore, in the vast majority of public schools and other formal settings, “General” or “Mainstream” American English (G/MAE) is used, and mastery is assumed and expected. However, systematic differences in the languages and language variants in children’s input may lead to different phonetic-phonological categories and systems, differences in the acoustic-phonetic or phonological cues in productions of words, and differences in recognition of words in the mainstream language variant. Finally, in addition to more negative attitudes and attempts to have children focus on the acquisition of the mainstream over the home language variant (with negative attitudes potentially leading to stigmatization and / or social isolation), bilingual children are also at higher risk for under- and overdiagnosis of speech and / or language delays and disorders (e.g., Bedore & Peña, 2008; Goldstein & Gildersleeve-Neumann, 2007; Grimm & Schulz, 2014).

Here, we investigate production of English vowels by Russian-English and Spanish-English bilingual children in the NYC area. We ask whether the dominant community language (L1, in our test case Russian or Spanish) influences the production of the mainstream language (L2, English) lax vowels /ɪ/ and /ɛ/, and the tense vowel /i/. This is an interesting test case because the lax vowels /ɪ/ and /ɛ/ may be problematic for different bilinguals with English as their non-dominant (L2) language; we also added measurements of the tense vowel /i/ as a reference point, because all three languages (English, Russian and Spanish) have this vowel in their sound inventories - illustrated in Table 1 - while only English has the /ɪ/ -/ɛ/ vowels, as well. (See e.g., Goldstein, 2007 for a description of Spanish; Halle, 2011 for a description of Russian; Byun et al., 2018 for the debate on the phonemic status of Russian /ɨ/.)

Table 1. Vowel inventories

Language	Tense vowels	Lax vowels
Spanish	/i, e, a, u, o/	
Russian	/i, ɨ, e, a, u, o/ (+ /ɨ/)	*(more limited set of reduced vowels in unstressed position only)*
American English	/i, e, ɑ, u, o/	/ɛ ɪ æ ʌ ɔ/ (+ /ʊ/) (+ front mid diphthongized /eɪ/)

Previous studies have shown that early Spanish-English bilinguals have relatively good discrimination of the /ɪ/ - /ɛ/ vowels, but L1-Spanish-L2-English adult learners show poor discrimination and identification (e.g., Hisagi et al., 2015). There is little data on Russian-English bilinguals, but late L1-Russian-L2-English adult learners have been shown to categorize both English /ɪ/ and /ɛ/ as most similar to Russian /e/ (Gilichinskaya & Strange, 2010; Kondaurova & Francis, 2004), and the only study looking at the acoustics of early Russian-English bilingual children's vowel productions showed that they produce the Russian /i/ with lower F2 values than the typical English /i/, which may indicate that these bilingual children employ a special strategy to differentiate the vowels in their two languages (Maryutina et al., 2022).

In this study, we ask whether (1) the more limited amount of English and more variability in the phonological input due to the presence of Russian or

Spanish impact the acoustic-phonetic characteristics of Russian-English and Spanish-English bilingual children's English /ɪ/ - /ɛ/ vowels, and in addition, we ask (2) how the age of first exposure to English and ongoing daily language use in children's different languages affect the quality of vowel productions. Based on previous findings, we hypothesize that more English input *over time* will lead to better productions of the target vowels /ɪ/ - /ɛ/. That is, we predict that younger bilingual children (4- to 5-year-olds) may show differences in their productions of these vowels dependent on the amount of English input they have encountered, and that older children (8- to 10-year-olds) will show better and more uniform mastery of these vowels. This older group has had a minimum of about 3 years of consistent English exposure in school - independent of the exact balance between English and the dominant home / community language (e.g., Paradis et al., 2001; 2010; Vidal, 2016). (Note that 'better' here refers to more similar to similar-aged monolinguals; and 'mastery' here means that native English speakers are able to tell the vowels apart and that children consistently produced them contrastively.) Furthermore, previous work found that less than 30% of ongoing daily input in Russian led Russian-English bilingual 8- to 12-year-olds to differentiate the Russian /i/ - /ɨ/ less accurately in their word productions, with /ɨ/ formants shifting closer to the General/Mainstream American English (G/MAE) /ɪ/ vowel (Maryutina et al., 2022). We therefore hypothesize that the *amount of daily input* also modulates the production of vowel contrasts - not limited to English vowels but including vowels in the children's dominant home/community language, as well.

To test these hypotheses and begin to answer our research questions, we acoustically analyzed speech production data from two Spanish-English and two Russian-English bilingual cohorts in the NYC area. Data included in the current analyses consisted of English productions of /i/ - /ɪ/ - /ɛ/ vowels from the two Spanish-English and one of the Russian-English cohorts, as well as Russian productions of /i/ - /ɨ/ vowels from both Russian-English cohorts. The Russian data were included to specifically start addressing the second main question regarding the potential influence of English on the home language of bilingual children in the NYC region. The characteristics of the four groups (whose data were collected as part of different larger projects) as well as the methods for the vowel analyses are reported in the next section.

2. Method

2.1. Participants

The data analyzed for this study were originally collected as part of three different research cohorts in the NYC area that were recruited to study different linguistic markers in the language of preschool- and elementary-school-aged children. The *Shafer cohort* consisted of Spanish-English bilingual children from a broader range of mid-to-high SES backgrounds (recruited through searches in specific zip codes in the NYC area) and came from mainly English-dominant (but bilingual) communities (see Datta et al., 2020). The *Barrière cohort* included both

Russian-English children recorded in preschool settings, as well as Spanish-English children (mostly from Mexican-Spanish households) recorded in Head Start preschool settings. The Russian-English children in this cohort tended to come from slightly higher SES backgrounds and Russian dominant communities (see Shimoonov et al., 2019), whereas the Spanish-English children came from low SES backgrounds and Spanish-dominant communities (see Barrière et al., 2017). The *Maryutina cohort* consisted of generally high SES background Russian-English bilingual children who grew up in English-dominant communities (see Maryutina et al., 2022). All participants were typically developing children with no history of hearing issues or speech-language, developmental or neurological disorders or delays (see the papers cited for more screening details of each cohort).

Data from a total of 37 participants from four groups was included in this study: (1) 12 Spanish-English 3- to 10-year-olds with a higher SES background (7 female), from English-dominant families (*Shafer cohort*); (2) 9 Spanish-English bilingual 3- to 5-year-olds with a low SES background (4 female), from Spanish-dominant families (*Barrière cohort*); (3) 5 Russian-English 3- to 5-year-olds with a low- to medium SES background (3 female), from Russian-dominant families (*Barrière cohort*); and (4) 11 Russian-English 8- to 12-year-olds with a high SES background (4 female), mainly from English-dominant families (*Maryutina cohort*). From all children in the Shafer and both groups in the Barrière cohorts, English production data were collected; in addition, Russian production data were collected from the children in the Russian-English group in the Barrière cohort and from the children in the Maryutina cohort.

Parents of all participants filled out a Language Background Questionnaire to provide detailed information about their child’s experience with the different languages of their environment (for more details, see Datta et al., 2020 (*Shafer cohort*); Barrière et al., 2017; Shimoonov et al. 2019 (*Barrière cohort*) and Maryutina et al., 2022 (*Maryutina cohort*)). In addition, all children in the Shafer cohort were given the Clinical Evaluation of Language Fundamentals (CELF) test and Peabody Picture Vocabulary Test (PPVT) - both tests were administered in English (Semel et al., 2004; Dunn & Dunn, 1997), as well as the Spanish (Wiig et al., 2006; Dunn & Dunn, 1986). The children in the Barrière cohort were given the Brigance (Brigance, 2005a) or Ages & Stages Questionnaires (ASQ) developmental screening measures (Bricker & Squires, 1999), as well as the Diagnostic Evaluation of Language Variation (DELV) measure (Seymour, Roeper & de Villiers, 2005).

2.2. Apparatus and Procedure

For the Shafer cohort, children’s word productions were elicited from 40 pictures (e.g., “pig”, “bed”), or produced in a natural language sample. Productions were recorded in person using a SONY camcorder and a Lavalier wireless microphone. For the Barrière cohort, word productions with the target vowels recorded during a retelling of the *Frog Where Are You* story (Mayer, 1969) and from the DELV tasks were included. In addition, elicitations of Russian words (based on an adaptation of the DELV, see Shimoonov et al., 2019) were included if they contained (one of) the Russian target vowels. Recordings were made with an Olympus digital recording device. Recordings of Russian word productions by the Maryutina cohort were obtained online via zoom during the Covid-19 pandemic and consisted of two tasks: (1) a Picture-naming and (2) a Repetition task. The caregivers of all participants used the Voice Memos application on either an iPhone or iPad to record their child during the tasks (see Maryutina et al., 2022 for more details on the original tasks and procedure).

2.3. Data Analyses

In total, for the 26 children in the three groups who provided English production samples (Spanish-English, *Shafer cohort*; Spanish-English, *Barrière cohort*; Russian-English, *Barrière cohort*) a minimum of 5 different word types for each target vowel /ɪ/, /ɛ/, /i/ were identified for analyses. For the 11 children in the fourth group, who provided Russian production samples (Russian-English, *Maryutina cohort*) words were identified, transcribed and transcriptions were verified by two or more trained listeners (the authors). All acoustic analyses of the data were conducted in Praat (Boersma & Weenink, 2022). The onset and offset of the vowels 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, which were then manually checked by a second transcriber (real adjustments were rarely made, but when there was disagreement the first and last author double-checked the measurements and made the final decision on the boundary). Vowel duration, F1, F2, and fundamental frequency (F0) values were obtained for each word containing one of the target vowels. Measurements were conducted manually and were taken from the midpoint of the vowel (cf. Whalen et al., 2022). (The higher F0 (compared to adults adults), particularly from the youngest children, makes it more difficult to accurately identify F1 and F2 – in the current study, samples with an F0 above 400Hz were not included for this reason) The formant ceiling was increased to 6000Hz (and for the Maryutina data, occasionally up to 10,000Hz). The pitch range was set to 500Hz. The window length used for analysis was 0.005s and the dynamic range was set up at 30(dB). The default temporal resolution was 1000 Time and 250Hz Frequency steps.

3. Results

3.1. English vowels

A total of 2443 vowel tokens were included in our analyses; 518 English tokens from the Shafer Spanish-English cohort, 280 English tokens from the Barrière Spanish-English cohort, 198 English and 90 Russian tokens from the Barrière Russian-English cohort, and 1357 Russian tokens from the Russian-English Maryutina cohort (note that the Maryutina et al., 2022 study was specifically designed to collect words with the relevant vowels).

Figure 1 plots the average first and second formant values of the three different vowels produced by the children in the two groups of Spanish-English bilingual children. The panel on the left shows the data from the higher SES group (*Shafer cohort)* and includes one monolingual child's data which was collected for the same project (Datta et al., 2020) as a reference of where we expect the English vowel formants to be. We find that the mean F1-F2 values for this higher SES cohort are generally at expected frequencies for children of this age range, with only one 4-year-old (highlighted with arrows on the figure) showing some overlap in /i/, /ɪ/ and /ɛ/ values productions. In contrast, the low SES group on the right (*Barrière cohort)* showed somewhat greater overlap of F2 for adjacent vowels, although F1 values were distinct, similar to the Higher SES group. (two examples of children's overlapping values are highlighted with arrows).

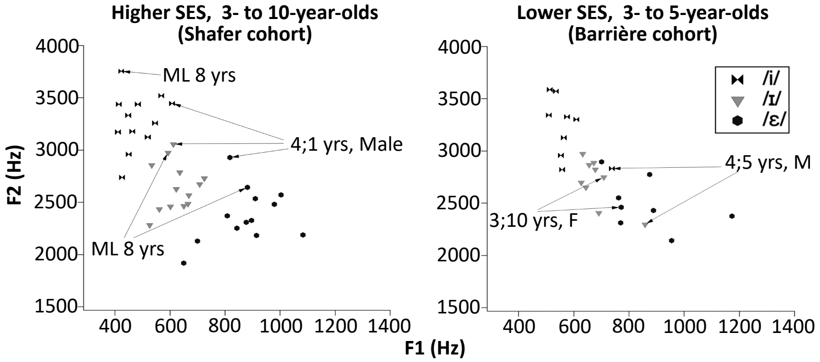

Figure 1. Spanish-English bilingual children's English /i/-/ɪ/-/ɛ/ vowel productions, average F1 (x-axis) versus F2 (y-axis), in Hz. Left panel: 3- to 10-year-olds, higher SES Shafer Cohort (n=12, ML=monolingual reference). Right panel: 3- to 5-year-olds, lower SES Barrière Cohort (n=9).

To further investigate these general trends, we looked in more detail at the individual data from the children in the different cohorts. First, we divided the 12 children in the higher SES Shafer cohort into three different age groups: 3- to 5-year-olds; 6- to 7-year-olds; and 8- to 10-year-olds. The data, per age group, is plotted in Figure 2, columns a,b,c. In this figure, we also separately plotted children's first formants (F1, bottom panels) versus second formants (F2, top panels). When looking at the individual differences in this way, we see that only the oldest children are clearly separating all three different vowels by F1, and that there is uniformity between individual children's productions of F1 only in the oldest age group (there are more individual differences between the productions of the younger age groups). (Note that the added data of the monolingual control in the oldest age group illustrates that the F2 values of even the oldest bilingual children are still lower than those of the monolingual, for all three vowels).

The 9 Spanish-English bilingual children in the low-SES Barrière cohort were all in the same 3- to 5-year-old age group. Recall that all children in this cohort were considered Spanish-dominant bilinguals according to their language background questionnaires; Spanish being the dominant language of their community and in their homes. In Figure 2, the participants in this cohort are split into two groups: those with lower versus higher English fluency (categorized unanimously based on their language sample by two trained native-English transcribers (G.M. and V.S.)[1]). These two groups of Spanish-dominant children (columns d,e) can be compared with the English-dominant children from the Shafer cohort of the same age (column a). When we look at the F1 (bottom panels) versus F2 (top panels) in these groups, we see that the productions from the Spanish-dominant children with higher English fluency (middle panels) are more comparable to those of the youngest English-dominant group (right panels), but that as a group, they still do not differentiate the three vowels as well, especially when we look at the F1 in their productions. (Note that there was one child with a missing datapoint for /ɛ/ in the low-fluency group; this child had the most limited English skills and kept using Spanish almost exclusively).

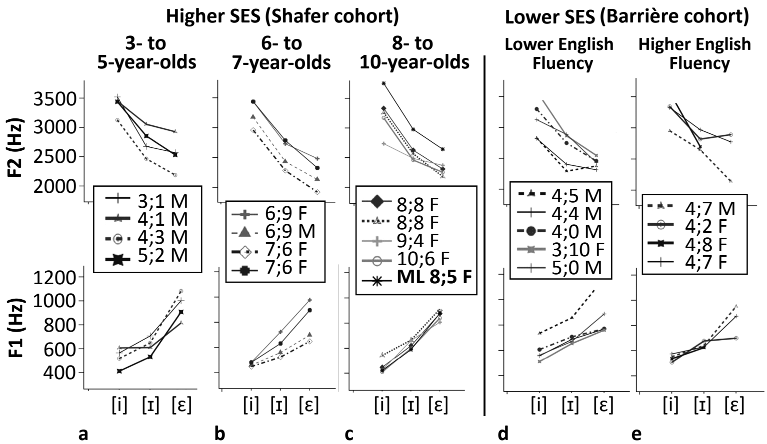

Figure 2. Spanish-English bilingual children's English /i/-/ɪ/-/ɛ/ vowel productions, average F1 (bottom panels) versus F2 (top panels), per subject, in Hz. Data is divided by age group (columns a,b,c: Shafer cohort) and by English fluency (columns d,e: Barrière Cohort).

Next, we analyzed the English /ɪ/, /ɛ/, /i/ vowels from the low-SES Barrière cohort of Russian-English bilingual children, for whom English as well as Russian

[1] The children in the lower fluency group frequently used Spanish in their English narratives and show less English vocabulary knowledge. Future planned analyses will include a detailed assessment of all children's language background questionnaires and the development of a fluency scoring system for all participants in this study.

word productions were collected. The left-most panels in Figure 3 (column a) illustrate F1 and F2 values from the 3- to 5-year-olds in this group. These children are differentiating the /ɪ/ - /ɛ/ vowels based on F2, and largely by F1 as well; /ɪ/ - /i/ is also mostly differentiated by F2, but only about half of the children in this group differentiate /ɪ/ - /i/ at all based on F1. In the center and right panels of Figure 3 (column b,c) we illustrate differentiation for both the Russian-English children as well as the Spanish-English children combined in a different way: Here, we plotted the /i/ - /ɪ/ versus the /i/ - /ɛ/ contrasts (comparing /ɪ/ and /ɛ/ in turn with the reference vowel /i/); the bottom panels showing F1, the top panels F2. The dotted diagonal represents a perfect match. Any individual child (datapoint) that is very close to the diagonal is not really differentiating based on the pictured formant between the two vowels plotted against each other. These graphs illustrate that the Russian-English participants more than the Spanish-English participants rely on F2 for differentiation; and we see that overall, more Spanish-English participants are closer to the diagonal (as we saw in Figure 2, these are mainly participants from the younger and / or Barrière cohort).

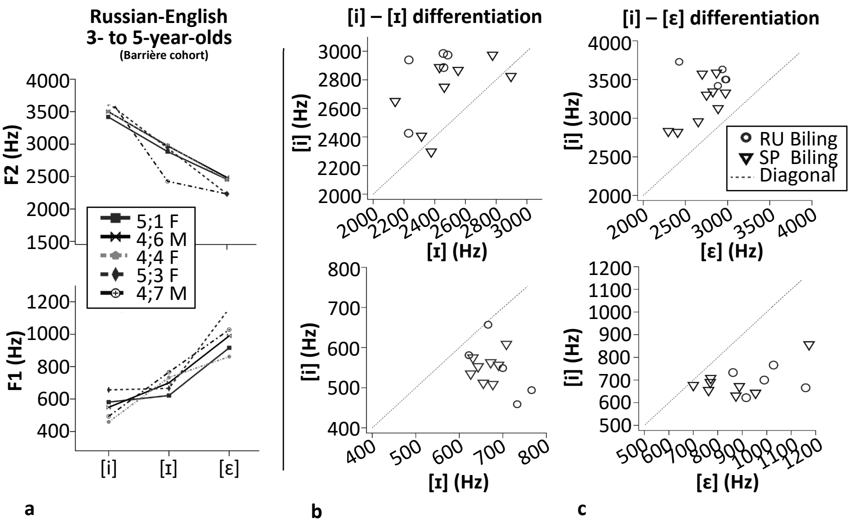

Figure 3. Russian-English and Spanish-English bilingual children's English /i/-/ɪ/-/ɛ/ vowel productions. Left panels (a) show Russian-English bilinguals' (Barrière Cohort) average formants (F1, bottom panel, F2, top panel), per subject, in Hz. Center (b) and right (c) panels show differentiation by first versus second formant for vowel pairs /i/-/ɪ/ (column b) and /i/-/ɛ/ (column c), from all Russian-English (RU Biling) and Spanish English (SP Biling) participants. Diagonal lines illustrate a perfect match = no differentiation based on the plotted formant between vowels in a pair.

3.2. Russian vowels

The next step in our analyses was to analyze the Russian vowels produced by the Russian-English bilinguals in the Barrière cohort (who came from slightly higher SES backgrounds than the Spanish-English bilinguals in that cohort, but from lower backgrounds than the Maryutina cohort) and compare them to productions of Russian vowels by the (high SES) children in the Maryutina cohort (recall that for these children, only Russian productions were collected, cf. Maryutina et al., 2022). We focused on acoustic analyses of the two Russian high vowels, front /i/ and mid /ɨ/. The data from Maryutina et al. (2022) is illustrated in Figure 4, left panels. Here, we see a high degree of variability in the average productions of the /ɨ/ vowel between bilingual participants, as compared to the two Russian monolingual children of the same age who were included in the study as the referents. There were no such large differences between participants' average productions of the Russian /i/, which is also part of the American English vowel inventory. In a detailed analysis of the participants' language backgrounds, Marytina et al. (2022) concluded that even though all children in their cohort were exposed to Russian from birth, those children with lower ongoing Russian experience – roughly less than 30% daily input, and typically with one rather than two Russian-speaking parents – tended to produce higher F2 values for the /ɨ/ vowel and showed weaker differentiation of the vowels /ɨ/-/i/ compared to monolingual Russian-speaking children.

The top-left panel of Figure 4, above the Maryutina data, shows the Russian data from the 3- to 5-year-old Russian-English children in the Barrière cohort. These children came from lower SES but more Russian-dominant environments (compared to the Maryutina cohort). While we have less precise measures of the exact amount of daily Russian input for these 3- to 5-year-olds, we see that these younger children achieve the high central vowel distinction /ɨ/-/i/: they consistently produced a higher F2 for /i/ than /ɨ/. Interestingly, In the right panels of Figure 5 the data of both Russian-English groups are combined, and these panels illustrate differentiation in same way as Figure 4: productions very close to or on the diagonal lines mean that there was no differentiation by F1 or F2 for a given participant.

It is important to note here that the children in the Maryutina cohort were all exposed to Russian from birth and all had Russian-speaking mothers, with most (all but three) of the children coming from households with two Russian-speaking parents (i.e., these children were all exposed on a daily basis to Russian throughout their lives). These results therefore imply that SES is not the factor that leads to better differentiation here, but rather it is the amount of *ongoing* daily input in a language that is crucial for the successful formation of vowel contrasts in production by young bilingual speakers. We will come back to this point in the Discussion section.

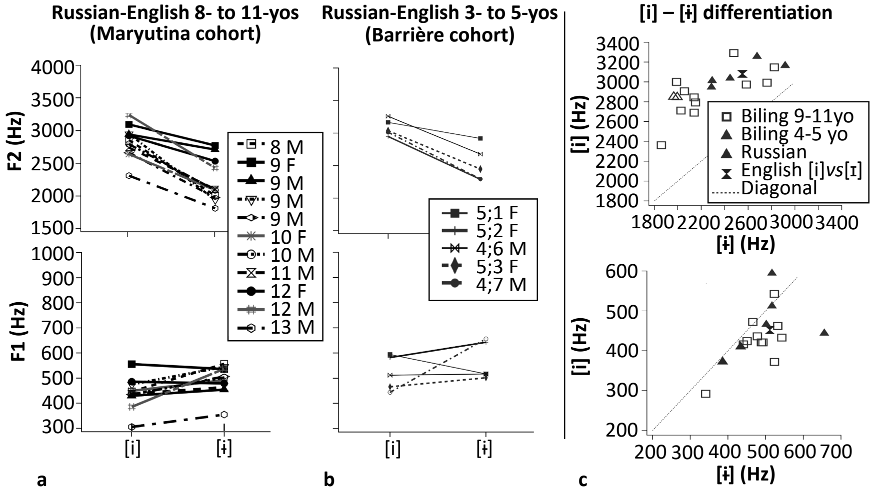

Figure 4. Russian-English bilingual children's Russian /i/-/ɨ/ vowel productions (F1, bottom panels, F2, top panels). Left panels (a, Maryutina cohort) and center panels (b, Barrière Cohort) show average formants, per subject, in Hz. Right panels (c) show differentiation by F1 versus F2 for all Russian-English participants combined (9-11-year-olds, Maryutina cohort; 3- to 5-year-olds, Barrière cohort). Average values from monolingual Russian subjects as well as a monolingual English subject are included as referents. Diagonal lines illustrate a perfect match = no differentiation based on the plotted formant between vowels in a pair.

4. General Discussion

In the earlier stages of English acquisition (i.e., the younger age groups in our study) the Russian-English, but especially the Spanish-English bilingual children did not consistently differentiate the English /ɪ/ - /ɛ/ and /i/ - /ɪ/ vowels (Figures 1, 2 and 3). We found that older children with more English experience, as well as the younger children in the Spanish-English group with more English-dominant language backgrounds (*Shafer cohort*), showed better differentiation of the English vowels compared to the Spanish-dominant group (*Barrière cohort*). It is possible that less differentiation in production of these vowel contrasts is (in part) due to different, overlapping, lexical-phonological representations (e.g., the word "next" might be stored with /ɪ/). Future studies looking at the perception of vowel contrasts in similar groups of bilingual children (e.g., acoustic measures, neural processing, and word recognition) will be able to shine more light on this.

The older Spanish-English children in the Barrière cohort, who showed less differentiation, not only came from more Spanish-dominant, but also from lower SES backgrounds compared to the children in the Shafer cohort. The younger Russian-English children in the Barrière cohort, who also showed better differentiation of the English vowels, came from more Russian-dominant language environments. (As mentioned above, they came from higher SES backgrounds than the Spanish-English Barrière cohort children, but from lower SES backgrounds than both the Shafer and especially the Maryutina cohorts). While we cannot directly disentangle the input and SES factors for the Spanish-English children in this study (because the more English-dominant groups were also the groups with higher SES backgrounds), the data from the two groups of Russian-English bilinguals indicate that the crucial factor for successful production of vowel contrasts is not SES, but the amount of *ongoing daily input* in the given language. If higher SES leads in general to better differentiation of vowel contrasts in young bilingual's production, we would have expected the Shafer Spanish-English and Maryutina Russian-English cohorts to outperform both Barrière cohorts, which is not what we found. Furthermore, there does not seem to be a clear relationship between age (total language experience over time) and vowel differentiation. We therefore argue that our findings indicate that the exact amount of (ongoing) input is crucial for the successful acquisition of sound contrasts in bilingual children's languages. Planned future work, including more detailed (statistical) analyses of the input and SES factors in the current dataset; expansion of these analyses across more vowels and languages; analyses of within-word variability; and analyses of more children's data are needed to further evaluate these claims.

Our main finding is that bilingual children – even those growing up from a very young age with two languages in a multilingual community - show different acoustic-phonetic characteristics in their vowel productions when compared to the monolingual "target" values. We need to gain a better understanding of whether this is due to the nature or the amount of input these children are getting, and what the consequences of these differences are. There may be important clinical and pedagogical implications: clinicians and educators who are evaluating bilingual children should be aware of any systematic variations in speech productions. For instance, when phonemic awareness is being taught in an American school setting, there may be references to English sound categories that overlap for certain groups of bilingual children. Additionally, theoretical implications are that differences in abstract lexical-phonological representations of bilingual children may lead to differences in word recognition, as well as word production - which ultimately may lead to language change in both smaller and larger multilingual language communities. In these communities, we may be watching the birth of new language variants in real time.

References

Barrière, Isabelle, Kresh, Sarah, Aharodnik, Katsiaryna, Legendre, Géraldine, & Nazzi, Thierry (2019). The comprehension of 3rd person singular-s by NYC English-speaking preschoolers. In: *Three streams of generative language acquisition research: Selected papers from the 7th Meeting of Generative Approaches to Language Acquisition* (Vol. 63, pp. 7-34). John Benjamins Publishing.

Bedore, Lisa M., & Peña, Elizabeth D. (2008). Assessment of bilingual children for identification of language impairment: Current findings and implications for practice. *Int. J. Biling. Educ.,* 11, 1–30. doi: 10.2167/beb392.0.

Boersma, Paul, & Weenink, David (2022). Praat: Doing phonetics by computer [Computer program]. Version 6.2.17.

Brigance, Albert H. (2005a). *Brigance Early Preschool Screen*. North Billerica, MA: Curriculum Associates.

Bricker, Diane, & Squires, Jane (1999). *Ages & Stages Questionnaires, ASQ: A parent-completed child-monitoring system* (2nd ed.). Baltimore: Brookes.

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.

Datta, Hia, Hestvik, Arild, Vidal, Nancy, Tessel, Carol, Hisagi, Miwako, Wróblewski, Marcin, & Shafer, Valerie L. (2020). Automaticity of speech processing in early bilingual adults and children. *Bilingualism: Language and Cognition*, *23*(2), 429-445.

Dunn, Lloyd M., & Dunn, Leota M. (1986) Test de Vocabulario en Imagenes Peabody (TVIP). Circle Pines, MN: American Guidance Service.

Dunn, Lloyd M., & Dunn, Leota M. (1997) Peabody Picture Vocabulary Test (3rd ed.). Circle Pines, MN: American Guidance Service.

Flege, James E., Munro, Murray J., & MacKay, Ian R. (1995). Factors affecting strength of perceived foreign accent in a second language. *The Journal of the Acoustical Society of America*, *97*(5), 3125-3134.

Gilichinskaya, Yana D., & Strange, Winifred (2010). Perceptual assimilation of American English vowels by inexperienced Russian listeners. *The Journal of the Acoustical Society of America*, *128*(2), EL80-EL85.

Goldstein, Brian A. (2007). Spanish speech acquisition. In S. McLeod (Ed.), *The international guide to speech acquisition* (pp. 539-553). Clifton Park, NY: Thomson Delmar Learning.

Goldstein, Brian A., & Gildersleeve-Neumann, Christina. (2007). Typical phonological acquisition in bilinguals. *Perspectives on Communication Disorders and Sciences in Culturally and Linguistically Diverse (CLD) Populations*, *14*(2), 11-16.

Grimm, Angela, & Schulz, Petra (2014). Specific language impairment and early second language acquisition: The risk of over-and underdiagnosis. *Child Indicators Research*, *7*(4), 821-841.

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

Hisagi, Miwako, Garrido-Nag, Karen, Datta, Hia, & Shafer, V L. (2015). ERP indices of vowel processing in Spanish–English bilinguals. *Bilingualism: Language and Cognition*, *18*(2), 271-289.

Jacewicz, Ewa, & Fox, Robert A. (2014). The effects of indexical and phonetic variation on vowel perception in typically developing 9-to 12-year-old children. *Journal of Speech, Language, and Hearing Research*, *57*(2), 389-405.

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

Keshavarz, M. Hossein, & Ingram, David. (2002). The early phonological development of a Farsi-English bilingual child. *International Journal of Bilingualism, 6*(3), 255-269.

Kleyn, Tatyana, & Vayshenker, Beth (2012). Russian Bilingual Education across Public, Private and Community Spheres. In Ofelia García, Zeena Zakharia, & Bahar Otcu (Eds.). (2012), *Bilingual community education and multilingualism: Beyond heritage languages in a global city* (Vol. 89, pp. 259-271). Multilingual Matters.

Kondaurova, Maroa V., & Francis, Alexander L. (2004). Perception of the English tense/lax vowel contrast by native speakers of Russian. *The Journal of the Acoustical Society of America*, *116*(4), 2572-2573.

Kuhl, Patricia K., Williams, Karen A., Lacerda, Francisco, Stevens, Kenneth N., & Lindblom, Björn (1992). Linguistic experience alters phonetic perception in infants by 6 months of age. *Science*, *255*(5044), 606-608.

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

Maryutina, Evgeniya, Van der Feest, Suzanne V.H., & Shafer, Valerie S. (In press, 2022). 'Production of Russian /I/ and /y/ by Russian-English Bilingual Children: effects of Language Experience.' *Proceedings of the 46th Boston University Conference on Language Development.* Cascadilla Press, Somerville, MA.

Mayer, Mercer (1969). *Frog, where are you?* New York, Dial Press.

Newman, Michael (2014). *New York City English*. De Gruyter Mouton.

Otheguy, Ricardo & Zentella, Ana Celia (2012) *Spanish in New York: Language contact, dialect leveling and structural continuity.* Oxford, UK: Oxford University Press.

Paradis, Johanne (2001). Do bilingual two-year-olds have separate phonological systems? *International Journal of Bilingualism, 5*(1), 19-38.

Paradis, Johanne, Emmerzael, Kristyn, & Duncan, Tamara S. (2010). Assessment of English language learners: Using parent report on first language development. *Journal of communication disorders*, *43*(6), 474-497.

Perlin, Ross, Kaufman, Daniel, Lampel, Jason, Daurio, Maya, Turin, Mark, & Craig, Sienna, eds. (2015). *Languages of New York* (digital version), mpa. New York: Endangered Language Alliance. (Available online at http://languagemap.nyc, Accessed on 2021-04-15)

Semel, Eleanor, Wiig, Elisabeth H., & Secord, Wayne A. (2004) Clinical evaluation of language fun- damentals (4th ed.). Toronto, Canada: The Psychological Corporation/A Harcourt Assessment Company.

Seymour, Harry N., Roeper, Thomas, & de Villiers, Jill G. (2005). DELV-NR (Diagnostic Evaluation of Language Variation) Norm-Referenced Test. San Antonio, TX: he Psychological Corporation.

Shimoonov, Daniella, Barrière, Isabelle, Aharodnik, Katsyarina, Koulaguina, Elena, Fracasse, Jessica, Karp, Chana, & Yunusova, Nargiza (2019) *The Effect of First Language and Amount of Exposure on Bilingual Hebrew-English and Russian-English-Speaking Preschoolers Receptive Language Skills.* Poster, New York State Speech Language Hearing Association.

Thompson, Irene (1991). Foreign accents revisited: The English pronunciation of Russian immigrants. *Language learning, 41*(2), 177-204.

Vidal, Nancy S. (2016). *Neurophysiological correlates of English vowels/I/and/E/in monolingual and bilingual 4 and 5-year-old children*. Doctoral Dissertation, The Graduate Center, City University of New York.

Whalen, Douglas H., DiCanio, Christian, & Dockum, Rikker (2022). Phonetic documentation in three collections: Topics and evolution. *Journal of the International Phonetic Association, 52*(1), 95-121.

Wiig, Elisabeth H., Semel, Eleanor, & Secord, Wayne A. (2006) Clinical Evaluation of Language Fundamentals-Spanish. The Psychological Corporation/A Harcourt Assessment Company.

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