Vilniaus universiteto leidykla

Contents lists available at Vilnius University Press

Jaunųjų mokslininkų darbai
2024, vol. 54, pp. 36–45

eISSN 1648-8776
DOI: https://doi.org/10.15388/JMD.2024.54.4

The Effect of Duolingo on l2 Learners' Pronunciation: Vowel Analysis through Minimal Pairs

Duolingo programėlės poveikis antrosios kalbos besimokančiųjų tarimui: balsių tarimo analizė minimalių porų kontekste

Giedrė Balčytytė

Vilniaus universiteto Filosofijos fakultetas
giedre.balcytyte@flf.vu.lt
https://ror.org/03nadee84

Viktorija Skerstonaitė

Vilniaus universiteto Anglistikos programos magistrantė
viktorija.skerstonaite@flf.stud.vu.lt

Summary. The present paper focuses on the acoustic analysis of Russian speakers' English vowel production before and after using the Duolingo application. The study aims to investigate phonetic acquisition of English vowels, particularly in the context of minimal pairs. The method chosen to achieve this objective is experimental analysis using phonetic acoustic variables – formant frequencies (F1 and F2) and vowel duration which were evaluated through spectrograms. Ten Russian-speaking volunteers participated in the experiment and were treated pre-test and post-tests. The results observed in this experiment show that Duolingo application contributed to Russian speakers' production of tense/lax English vowel pairs /u/-/ʊ/ and /i/-/ɪ/ with F1 and F2 frequency values closer to those of British English, but no improvements were seen with the open front vowel /æ/. The duration of vowels did not see significant improvements apart from the vowel pair /u/-/ʊ/.

Keywords: Duolingo, phonetic analysis, vowel pronunciation, minimal pairs, Russian speakers.

Santrauka. Straipsnyje pagrindinis dėmesys skiriamas besimokančiųjų rusakalbių anglų kalbos balsių tarimo akustinei analizei prieš ir po naudojimosi *Duolingo* programėle. Tyrimo tikslas – ištirti *Duolingo* programėlės poveikį taisyklingam anglų kalbos balsių tarimui minimalių porų kontekste. Metodas, pasirinktas šiam tikslui pasiekti, yra eksperimentinė analizė, naudojant fonetinius akustinius kintamuosius – formantų dažnius (F1 ir F2) ir balsių trukmę, kuri buvo įvertinta spektrogramomis. Dešimt rusakalbių savanorių, suskirstytų į eksperimentinę ir kontrolinę grupes, atliko minimalių balsių porų tarimo testus prieš ir po eksperimento. Remiantis tyrimo rezultatais, *Duolingo* programėlės naudojimas labai pagerino rusakalbių balsių porų /u/-/ʊ/ ir /i/-/ɪ/ tarimą – F1 ir F2 dažnių reikšmės po mokymo(si) tapo artimesnės anglų kalbos normoms. Tačiau ryškių skirtumų tariant atvirąjį priešakinį balsį /æ/ nepastebėta, o balsių trukmės analizė reikšmingų pokyčių, išskyrus porą /u/-/ʊ/, neparodė.

Pagrindiniai žodžiai: *Duolingo*, fonetinė analizė, balsių tarimas, minimalios poros, rusakalbiai.

Received: 2024-06-19. **Accepted:** 2024-12-04

Introduction

Relevance of the topic. When learning a foreign language, acquiring intelligible pronunciation is essential. However, achieving proficiency in this skill involves significant challenges due to the complex interplay of phonetic, phonological, and sociolinguistic factors, one of which is the influence of the phonological system of learners' first language (L1) (Flege, 1995; Best & Tyler, 2007). This influence significantly shapes the learners' perception, making it difficult to accurately perceive and produce foreign language phonology. The L1 interference theory explains this phenomenon by positing that the phonological system of a learner's L1 exerts a profound influence on the acquisition of the learner's second language (L2) phonology (Flege, 1995). This influence is especially evident when comparing highly phonetic languages like Russian, which have a consistent sound-to-letter correspondence, with non-phonetic languages like English, where such correspondence is less predictable. One of the most salient distinctions between Russian and English is the structure of their vowel systems, which in turn is one of the most complex aspects to master.

Phonetic training is essential for overcoming the phonological interference that arises from L1 influence on L2 pronunciation. Pronunciation learning activities have long been an integral component of foreign language learning curricula, designed to enhance learners' phonetic accuracy and phonological awareness, as well as to address the challenges imposed by the phonological system of their L1. A variety of methodologies have been employed to teach pronunciation, including traditional classroom instruction, the use of phonetic drills, immersive language experiences, and computer-assisted pronunciation training (CAPT). In today's age of technological advancement, the integration of CAPT and other technologies into instruction and autonomous learning is indispensable. One such advancement is Mobile-Assisted Language Learning (MALL), which utilizes mobile technology to enhance language acquisition and provide flexible learning opportunities. Numerous language learning applications have been designed and are effectively employed by users to enhance various foreign language skills. However, these applications often allocate limited attention to developing pronunciation skills. One of the most prominent applications is Duolingo, which is extensively adopted for teaching vocabulary acquisition, grammatical structures, reading comprehension, and listening skills. However, Duolingo has only recently incorporated features specifically aimed at pronunciation training. Despite its widespread adoption and efficacy in other linguistic domains, the focus on pronunciation development within Duolingo and similar applications remains relatively underrepresented. Correspondingly, research on the impact of these apps on pronunciation is limited. While many studies highlight the positive learning outcomes from (MALL), most research has concentrated on vocabulary and grammar (Loewen et al., 2019; Irawan et al., 2020). Some studies have noted the lack of dialogue practice and the unnatural quality of conversations taught by these apps, which could impede the development of speaking skills (Sakalauskė & Leonavičiūtė, 2022). Loewen et al. (2019) analysed Duolingo and found that while there were gains in L2 learning, participants scored lowest in speaking

skills, likely due to the lack of authentic speaking and pronunciation tasks as well as dominating grammar-translation and audiolingual-type activities employed by Duolingo.

***The aim of the research*.** The aim of this article is to analyze Duolingo's impact on Russian-speaking English learners' vowel pronunciation through the analysis of minimal pairs. To achieve this aim, the following research objectives have been established:

1. To analyze the differences in Russian and English vowel systems and determine common English vowel pronunciation difficulties experienced by Russian speakers.
2. To investigate the impact of MALL in phonetic training.
3. To study changes in Russian-speaking learners vowel pronunciation, after administering Duolingo treatment, through the acoustic analysis of minimal pairs contrasts.

To obtain meaningful results, a hypothesis was formulated, proposing that the pronunciation accuracy of Russian-speaking English learners will be positively influenced by Duolingo's language learning platform, specifically when measured through minimal pair analysis.

Brief analysis of differences between Russian and English vowel systems

The Russian language is formed of only five vowel phonemes /i/, /u/, /e/, /o/, /a/, which can be found in accented syllables. The five vowel phonemes are not categorized based on length, instead they are susceptible to a significant allophony. For this reason, linguists, such as Jones (1969) and Halle (1971) name ten vowels in the Russian vowel system – five soft vowels and five hard vowels. According to Swan (2011) vowel allophones in Russian occur depending on whether they are positioned next to a hard or a soft consonant and the position relative to the stressed syllable, e.g. allophones that differ in the minimal pair of *мать* /ˈmatʲ/ (mother) and *мять*.

Another instance of L1 interference for Russian speakers of English arises from the differing patterns of vowel reduction. In Russian, similar to English, vowel reduction occurs in unstressed syllables. However, unlike in English, where reduced vowels are usually qualitatively replaced by weak phonemes /ə/ and sometimes /ɪ/ (Wells, 1982), Russian reduction is much more complicated. Avanesov and Sidorov (1970) describe two degrees of reduction in Russian. The first degree, also referred to a moderate reduction, happens in the syllable just before the stressed syllable and the second-degree reduction, which takes place in all other unstressed positions. For example, the only vowels which can undergo first degree reduction are /o/ and /a/, and if the preceding consonant is non-palatalized, these vowels undergo the reduction process with an end result of /a/. In other words, the phonetic contrast between /o/ and /a/ is neutralized. Vowels /a/, /o/, /e/ appearing before palatalized consonant undergo even stronger neutralization, and an outcome of this reduction is always /iᵊ/, which is a substantially more centralized vowel /i/. In the second-degree reduction all vowels are realized as /ə/.

The British English vowel system is considerably more complex, comprising twenty vowel phonemes: twelve monophthongs and eight diphthongs, with vowels further catego-

rized by various features, such as tongue height and advancement, lip rounding, whether the vowels are lax or tense as well as short and long. The set of short vowels includes /ɪ/, /e/, /æ/, /ʌ/, /ʊ/, /ɒ/; long vowels are: /iː/, /ɑː/, /ɔː/, /uː/, /ɜː/; and eight diphthongs include: /eɪ/, /aɪ/, /ɔɪ/, /aʊ/, /əʊ/, /ɪə/, /eə/, /ʊə/ (Ladefoged, 2006). Phonetically, short vowels in British English are not only shorter than their long vowel counterparts, but also more centralized in the vowel space and for this reason short vowels sometimes might be called lax, and long vowels are called tense. Additionally, vowel length can vary based on their distribution and the way they are used allophonically. An example is the English open front unrounded vowel /æ/, which is phonologically a lax vowel since it cannot occur at the end of a word. However, various phonetic characteristics, such as its length, which is longer than any other short vowel, and its lack of centralization, allow /æ/ to be considered a tense vowel and therefore a long vowel (Wang and van Heuven, 2006). The duration of this vowel varies significantly depending on whether the syllable is stressed and whether the following consonants are voiced (fortis) or voiceless (lenis).

The tense and lax vowel contrast in English presents a significant challenge for Russian learners (Panasyuk, & Gorlovsky, 2019) because this distinctive feature of the English phonemic system is absent in the Russian language. An outstanding study has been done by Panasyuk, & Gorlovsky (2019), who have found that difficulties can be clearly seen in monosyllabic consonant-vowel-consonant (CVC) words, when tense vowels are shortened by the fortis consonant /biːt/, and lax vowels are lengthened before the lenis consonant / bɪd/. The data collected in this research showed that Russian listeners responded mainly to the durational characteristics of the vowels and paid less attention to the quality.

Another challenge for L2 speakers is phonotactic constraints, which involve the permissible combinations of sounds within a language and play a significant role in L2 acquisition. In Russian, specific vowel clusters or sequences are prohibited due to stringent phonotactic rules related to palatalization and vowel reduction. For example, the high front unrounded vowels /i/ and /ɨ/ have distinct distribution patterns depending on the preceding consonant's palatalization. /i/ typically follows palatalized (soft) consonants, whereas /ɨ/ follows non-palatalized (hard) consonants, as seen in words like *лит* /lit/ and *мыт* /mit/, respectively (Rubach, 2000; Padgett, 2003). Another example could involve vowel sequences like /iːɒ/ in *neon* /ˈniːɒn/ and /eɪɒ/ in *chaos* /ˈkeɪɒs/ which are problematic because Russian phonotactics typically do not allow adjacent vowels within a sequence. Ghabanchi (2017) discussed the allophonic use of /æ/ by Russian learners, who are likely to replace it with /e/, as in the word *bet*. Interestingly, the sound /æ/ can be found in the Russian language but only as an allophonic variant. The back vowel /a/ becomes /æ/ only between two soft consonants, such as in the word *пять* /pʲætʲ/. In English, palatalization is specific to certain consonants only and is not rendered phonemic. Consequently, Russian speakers might encounter difficulties pronouncing words like *cat* /kæt/ since /k/ is not palatalized in English.

Vowel acoustic distance in Russian and English

Formants are crucial in distinguishing vowels from each other and providing an insight into the acoustic characteristics of speech sounds. Ladefoged (2006) claims that each vowel has three formants. The major acoustic representation of the auditory property of the vowel height, therein high, mid-high, mid, mid-low, low, is the first frequency of the formant, or in other words the first formant (F1). The second formant (F2) combines three traditional vowel features: highness, backness and roundness, and according to him can be described as brightness. In simplified terms, high front unrounded vowels portray the highest value of brightness and high back rounded vowels have the lowest value. Studies which have focused on frequencies as a contrasting feature in vowels, have found some average means, which can be applied loosely to a language. For example, English formant values for /e/ and /æ/ are exceptionally similar to one another (at least in some English dialects) and are closest to values of Russian /e/. Hence it is less likely, that L2 vowels that are similar to one another in both F1 and F2 values will be acquired as two separate vowel categories. Ivanova (2016) mentions that the greatest challenge for the perception and production of L2 vowels is in creating new phonetic categories similar to or extending over the existing categories. Comparing Russian and English languages, it was found that the most challenging pairs of vowels for Russian Speakers speaking English as L2, are /i/ and /ɪ/, /u/ and /ʊ/, /e/ and /æ/, /ɑ/ and /ʌ/, since features and contrasts of these pairs are not present in Russian. Makarova (2011) indicates the overreliance on vowel duration in Russian speakers, with the greatest degree of dependance seen in the vowel pair /e/ and /æ/, followed by /i:/ and /ɪ/ as well as /u:/ and /ʊ/ respectively. Researcher claims that phonetic perception is better when speaker's concentration is on the contrasts, and lexicon involvement is less required.

Phonetic training through Mobile Assisted Language Learning (MALL)

Modern world relies heavily on technologies to aid in every aspect of human's life, including language learning. The term Mobile Assisted Language Learning, or MALL, originated in Chinnery's (2006) paper, who claimed that mobile devices can be used as an effective pedagogical tool for language learning and teaching. Arvanitis & Krystalli (2021) state that MALL is used not only to encourage the use of the target language, promote learning, and enhance the motivation, but also to give more opportunities for students to develop various communication skills, including comprehension and production of a spoken language. In Zhen & Hashim (2022) study, they claimed that MALL contributed to the instructional approach in English speaking skills, while also increasing learner's motivation and self-confidence, which are often associated with communication skills, when using non-native language. When it comes to pronunciation, however, MALL training is notably limited. Surprisingly, in the same study, Arvanitis and Krystalli (2021) found that out of 340 studies conducted between 2010 and 2020, only 20 focused on pronunciation, indicating that the pronunciation aspects of learning apps are still under-researched.

Duolingo, being one of the most popular language learning applications, has demonstrated positive effects on various aspects of English learning, including vocabulary acquisition, grammatical competence, reading comprehension, and listening skills. However, the app seems to provide a rather limited attention to speaking and pronunciation. Moreover, the conversations presented in the app often sound unnatural, which may lead to learners forming sentences that sound awkward or incorrect to native speakers (Sakalauskė & Leonavičiūtė, 2022). A study by Loewen et al. (2019) found that although Duolingo facilitated tangible gains in second language (L2) learning, participants scored lowest in speaking skills.

Similarly, very limited research can be found on the effects of Duolingo in Russian speakers learning English. Mospan (2018) organized a survey-based study, where Russian speaking students from universities in Poland and Ukraine reviewed various mobile applications for learning English. Duolingo was chosen as the most used one. When asked if they believed that using apps, such as Duolingo, contributed to improving their language skills, 77.5% of the participants answered positively. Kemalova et al. (2021) conducted a six-month long study, where they provided pre and post-tests to sixty Russian speaking students after studying English language on Duolingo. Students' average scores improved after using Duolingo, and it was concluded, that Duolingo with "its repetitions of sentence structure has contributed to better understanding lexis, grammar and syntax as a whole" (Kemalova et al., 2021, p. 636).

Data and methods

The present study was conducted at an IT company in Vilnius, where ten employees were selected for participation. The design for the experiment used was quasi-experiment with non-equivalent pre-test and post-test control group design (Peláez-Sánchez & Velásquez Durán, 2023). The participants were divided into two groups: a control group (CG) and an experimental group (EG). Both groups attended English language lessons at a B2 level (CEFR, 2020) twice a week during the experiment. Data collection was performed in two stages. Initially, pre-tests were administered individually to each participant in both groups. Participants were asked to read sentences with target pronunciation items aloud without prior preparation. Both groups were treated a pre-test and a post-test after four weeks. CG had regular classes through the timeline of study. Conversely, EG used the Duolingo app daily for 15 minutes, focusing on both general and phonetic training. The recordings were then processed using the WebMAUS web application to perform automatic phonemic segmentation, aligning speech recordings with their corresponding text transcriptions. This data was subsequently analyzed using Praat speech analysis software.

The rationale for selecting specific target language vowels is grounded in the challenges faced by Russian speakers in distinguishing certain English vowel sounds. Minimal pairs were chosen as the primary tool for learning phonemic contrasts in vowels and consonants. As discussed above, Russian speakers often struggle with the vowel sound /æ/, which they tend to substitute with /e/. Therefore, minimal pairs of /æ/ and /e/, as well as /ʌ/ and

/æ/, were selected to determine whether the confusion occurs only in close proximity or more generally. Additionally, the contrast between lax and tense vowels presents another difficulty for Russian speakers; hence, minimal pairs of /i/ and /ɪ/, along with /u/ and /ʊ/, were included in the test. As vowel length in English can vary based on their distribution and the way they are used allophonically, the exact length of the allophones was measured instead of clear-cut long vs. short phoneme distinction. The phonological model used for data analysis followed the methodology of Escudero and Williams (2014), employing phonetic acoustic variables such as formant values (F1 and F2) and vowel duration, detected and measured using a spectrogram.

Results and discussion

Pre-test results of the experiment align with the common errors produced by Russian speakers. Both: CG and EG vowel production showed minimal acoustic distances between tense and lax vowel pairs /i/ - /ɪ/ and /u/ - /ʊ/. F1 for the vowel /i/ was between 285Hz-305Hz on average, while F1 for the vowel /ɪ/ - 290-315Hz in both groups. This shows that while producing both /i/ and /ɪ/ tongue vertical position was similarly high. Similarly, vowel sound pair /u/ and /ʊ/ did not differentiate in F1, with /u/ ranging between 340Hz and 360Hz and /ʊ/ between 360Hz and 390Hz, while F2 was in a range of 798Hz and 820Hz for /u/ and 840Hz-900Hz for /ʊ/. This shows that both /u/ and /ʊ/ were produced in the back of the mouth, even though /ʊ/ is a near-back vowel, meaning that it should differentiate from /u/ in the horizontal position of the tongue.

Vowel /æ/ can be distinguished from sound /e/ more so by backness than height of the tongue position. Traditionally, F1 for these sounds is similar frequenting at around 580Hz-588Hz, yet /æ/ is produced more in the front, than /e/. Pre-test results show that F2 for these vowel sounds was very close ranging between 1594Hz and 1757Hz for /æ/, while /e/ saw ranges of 1737Hz and 1777Hz. Russian speakers producing /æ/ sound more in the back found themselves pronouncing it more like /e/ (see Figure 1 with vertical axis representing F1 measurements, which corresponds to tongue height, and horizontal axis representing F2 measurements, which corresponds to tongue advancement.)

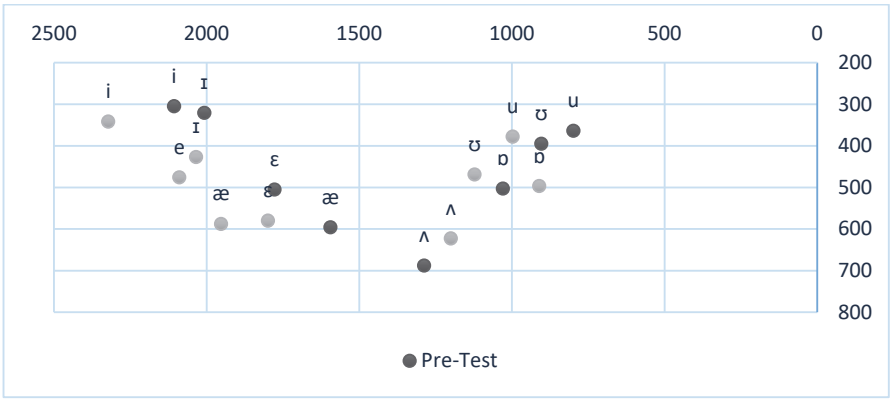

Figure 1. **Pre-test vowel quality of EG and CG**

After using Duolingo for a month, noticeable differences emerged in the EG pronunciation. For example, the F1 value for /i/ was 283Hz and for /ɪ/ it was around 350Hz. The pair /u/ and/ʊ/ saw F1 frequencies of approximately 385Hz and 435Hz, respectively. The backness for /u/ and /ʊ/ also improved, with F2 values of 847Hz for /u/ and 1053Hz for /ʊ/. These changes were not observed in the CG. However, /æ/ did not show significant improvement, remaining close to /e/. The CG showed less significant changes in vowel duration, with pre-test and post-test ratios remaining similar (see Figure 2).

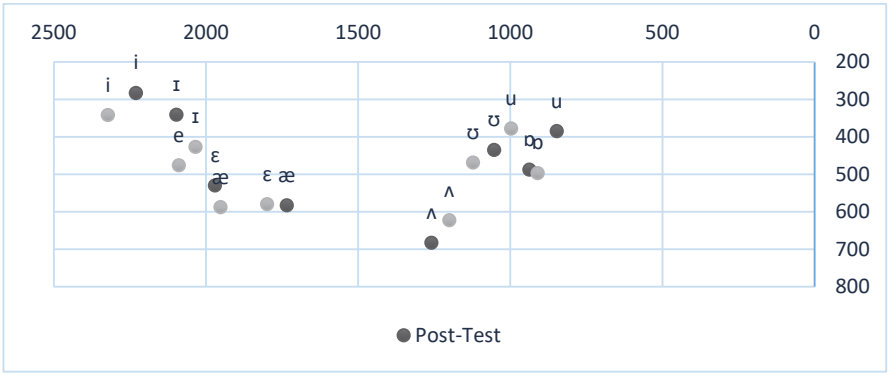

Figure 2. **Post-test vowel quality of EG and CG**

Vowel duration analysis further highlighted the difficulties Russian speakers face in distinguishing long and short vowels. As noted before there is no distinction between short and long vowels in the Russian language, therefore minimal differences were expected between pairs such as /i/ and /ɪ/, and /u/ and /ʊ/. As it can be seen in Figure 3, EG's average vowel durations changed after treatment, except /æ/ that remained the same duration.

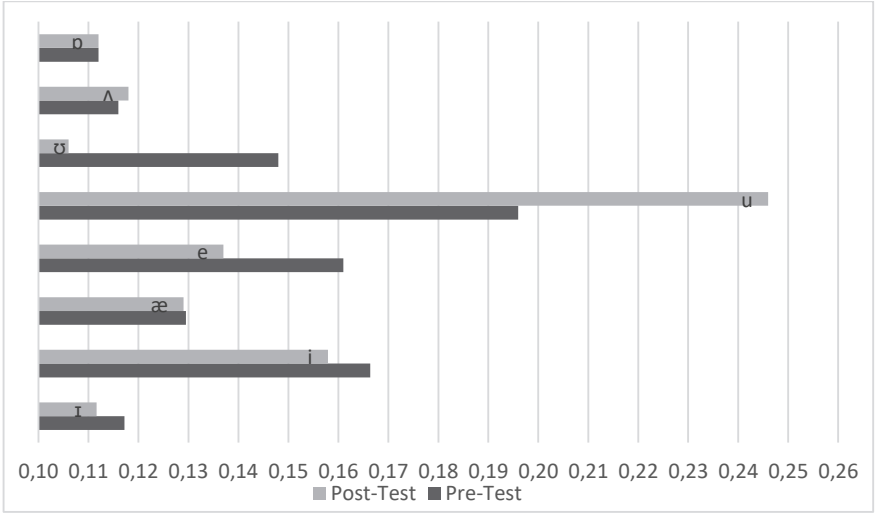

Figure 3. **EG vowel duration pre and post-test**

Conclusions

The findings of this experiment support the hypothesis that Duolingo positively impacts the pronunciation accuracy of Russian learners of English, at least in the vicinity of tense/lax vowels. This was observed in the improvement of formant frequencies of vowels /i/ and /ɪ/ as well as /u/ and /ʊ/. These changes suggest that MALL, when integrated with focused phonetic training, can effectively enhance the perceptual and production accuracy of vowel contrasts that are relevant to the L2 learner's native phonological system. However, the likelihood of phonetic categories formation of L2 speech sounds depends not only on the perceived cross-language phonetic distance but also on the state of development of L1 phonetic categories. The persistence of difficulties in pronouncing the /æ/ sound - absent in the Russian phonological system - highlights the challenge of acquiring phonemes that do not correspond to those in the learner's first language. This underscores the need for further research to identify and implement more targeted and adaptable methods in MALL applications, particularly those that address the distinct phonetic hurdles faced by learners of varying linguistic backgrounds. Additionally, future studies should explore the effectiveness of incorporating more nuanced and interactive pronunciation tasks, including those that involve speech production in natural conversational contexts, to further enrich the learning experience and improve pronunciation outcomes.

References

Arvanitis, P., & Krystalli, P. (2021). Mobile Assisted Language Learning: A decade of research. *International Journal of Mobile and Blended Learning*, *13*(1), 1–19.

Avanesov, R. I., & Sidorov, V. (1970). *Standard Pronunciation and Phonetic Norms in Russian Language*. Moscow: Nauka.

Best, C., & Tyler, M. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In O. Bohn & M. Munro (Eds.), *Language Experience in Second Language Speech Learning: In Honor of James Emil Flege* (pp. 13–34). Amsterdam: John Benjamins.

Chinnery, G. M. (2006). Going to the MALL: Mobile Assisted Language Learning. *Language Learning & Technology*, *10*(1), 9–16.

Escudero, P., & Williams, D. (2014). Learning to perceive and recognize a second language: the L2LP model revised. *Frontiers in Psychology*, *5*, 28–39.

Flege, J. E. (1995). Second-language speech learning: Theory, findings, and problems. In W. Strange (Ed.), *Speech Perception and Linguistic Experience* (pp. 233–277). Timonium, MD: York Press Inc.

Ghabanchi, Z. (2017). The allophonic use of /æ/ by Russian learners of English. *International Journal of Linguistics, Literature and Translation*, *4*(2), 23–34.

Halle, M. (1971). *The Sound Pattern of Russian: A Linguistic and Acoustical Investigation*. The Hague: Mouton.

Irawan, A., Wilson, A., & Sutrisno, S. (2020). The implementation of Duolingo Mobile Application in English Vocabulary Learning. *Scope: Journal of English Language Teaching*, *5*(1), 8–20.

Ivanova, T. (2016). Challenges in the perception and production of L2 vowels by Russian speakers. *Journal of Second Language Pronunciation*, *2*(2), 253–273.

Jones, D. (1969). *An Outline of English Phonetics.* Cambridge: Cambridge University Press.

Kemalova, E., Syretdinova, R., & Makhmutova, A. (2021). The impact of Duolingo on the English language proficiency of Russian students. *Education and Information Technologies*, *26*(5), 631–639.

Ladefoged, P. (2006). *A Course in Phonetics*. Boston: Thomson Wadsworth.

Loewen, S., Crowther, D., Isbell, D. R., Kim, K. M., Maloney, J., Miller, Z. F., & Rawal, H. (2019). Mobile-assisted language learning: A Duolingo case study. *ReCALL*, *31*(3), 293–311.

Makarova, V. (2011). Vowel duration and its impact on English pronunciation by Russian speakers. *Journal of Phonetics*, *39*(3), 237–245.

Mospan, N. (2018). Students' perceptions of mobile apps for English language learning: A survey-based study. *International Journal of Mobile and Blended Learning*, *10*(3), 47–65.

Padgett, J. (2003). Contrast and Post-Velar Fronting in Russian. *Natural Language & Linguistic Theory, 21*(1), 39–87.

Panasyuk, V., & Gorlovsky, P. (2019). Analysis of the perception of English vowels by Russian learners. *Language and Speech*, *62*(2), 231–247.

Rubach, J. (2000). Backness switch in Polish. *Phonology, 17*(1), 39–64.

Sakalauskė, A., & Leonavičiūtė, V. (2022). Strategic analysis of Duolingo language learning platform. *Mokslas – Lietuvos ateitis*, *14*(1), 1–9.

Swan, M. (2011). *Learner English: A Teacher's Guide to Interference and Other Problems*. Cambridge: Cambridge University Press.

Wells, J. C. (1982). *Accents of English*. Cambridge: Cambridge University Press.

Zhen, W., & Hashim, H. (2022). Mobile Assisted Language Learning (MALL): A study on its impact on English speaking skills. *Journal of Educational Technology & Society*, *25*(2), 123–137.