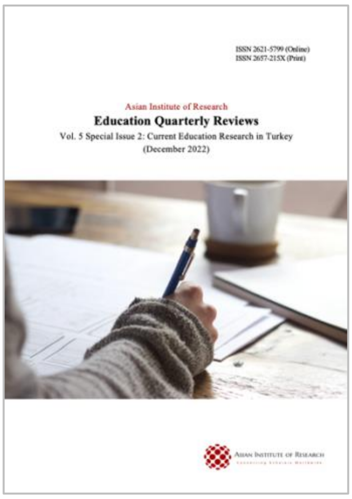


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# The Effect of Turkish Pronunciation Training on Brain: An fMRI Study

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**Abstract**
This study aimed to develop the pronunciation skills of students who learned Turkish as a foreign language and determine the extent of the instruction given for that purpose by observing its cognitive effects. It was designed as an in-class action research and carried out with nine students speaking different languages. Of those, five were bilinguals: Four were native speakers of their native tribal language and French, and one was a native speaker of Kazakh and Russian. The remaining four students were native speakers of Arabic. The fMRI findings at the beginning and the end of the study showed that phonological and reading motor processes were better for bilingual learners who were native tribal speakers and learned French and Mongolian as their country's official language, compared with native Arabic monolingual learners. Based on the analysis, it can be stated that an increase in foreign language sound awareness of learners results in the acquisition of more accurate pronunciation skills.

**Keywords:** Teaching Turkish as a Foreign Language, Pronunciation, Speech Centers in the Brain, Speaking Instruction, Broca's Area, Functional Magnetic Resonance Imaging (fMRI)

## 1. Introduction

Speaking, which is a complex motor skill (Levelt, 1989), develops easily and spontaneously in the process of native language acquisition (Hu et al., 2012, p.1). In the acquisition process, the vocal organs and two cortical centers in the brain are actively involved. These centers form the physical and cognitive aspects that play a crucial role in the development of the speaking skill. The cortical centers located around the Sylvian fissure in the left hemisphere of the brain are referred to as the Broca's and Wernicke's areas (Troike-Saville, 2012, p.72). Of these, the Wernicke's area functions as the sound format repository, and the Broca's area acts as the processor that receives the necessary phonological information from this repository (Heim & Friederici, 2003). Phonology is used predominantly in the Broca's area (Tanrıdağ, 2009, p.158). Although the cognitive processes responsible for language production and comprehension take place in the left hemisphere (Troike-Saville, 2012, p.73), the speaking skill utilizes the simultaneous functioning of the right and left hemispheres of the brain. The ability of an individual to realize the speaking skill in a correct and meaningful way depends on both physical and cognitive development and maturity. In the development of this ability, the role of pronunciation acquires prominence, especially for correct and effective speech in a foreign language.

Significant individual differences occur in late-onset (around 10 years) bilinguals who learn a foreign language (Reiterer, et al., 2011, p.1). A study found that individuals who started learning a foreign language at an early age generally achieved a higher level of proficiency than those who started at a later age (Hyltenstam & Abrahamsson, 2003). Although the acquisition of a foreign language is possible after childhood, some problems impede the process (Lenneberg, 1967, p. 176). One of those problems is pronunciation as it can easily hinder intelligibility. Therefore, the teaching of pronunciation in foreign language instruction necessitates a multidimensional and stimulus-rich educational process.

In learning the sound system of a foreign language, the learner's mother tongue is of paramount importance. The number of the mother tongue sounds or the absence of exact equivalents of the target language sounds can prevent learners from producing the target language sounds accurately (Karatay & Tekin, 2019a). One of the most common causes of pronunciation problems has to do with perception, which refers to the learners' perceiving the sounds of the target language through the phonological filter of their mother tongue. In other words, the learners may not hear the sounds in the way a native speaker does (Derwing, 2008). When target language sounds are not perceived and produced correctly, "accent" occurs in the learners' spoken production of the target language. Different explanations have been provided for the emergence of a foreign accent in speech. The first is the replacement of a foreign language sound with a native language sound. The second is ignoring sounds that do not exist in the native language, and the last is maintaining mother tongue sounds while speaking the foreign language (Flege, 1995). In other words, learners can transfer their mother tongue features to the target language.

Therefore, using an efficient model of pronunciation would ensure that the target language sounds are identified and distinguished. Such an instructional model would include a large array of activities that would introduce learners to the segmental and suprasegmental features of the target language and provide ample opportunities for practice.

A model of pronunciation teaching that would introduce and provide ample practice opportunities of the target language segmental and suprasegmental features should be multi-directional and include multi-stimulus providing activities. There are studies that focus on the pronunciation problems of students who learn Turkish as a foreign language. These studies can be grouped as descriptive and experimental. Descriptive studies focus on segmentals (Adalar Subaşı, 2010; Beydilli Kaya, 2019; Biçer, Çoban & Bakır, 2014; Demir & Güleç, 2015; Doğan, 2007; Gürbüz & Güleç, 2016; İnan & Öztürk, 2015; Kahraman 2018; Karababa Candaş, 2009; Kaplan, 2018; Kurt, 2017; Kurt & Demir, 2016; Moralı, 2018; Nurlu & Özkan, 2016; Özmen, Güven & Dürer, 2017; Şengül, 2014) and suprasegmentals (Alshirah, 2013; Çelebi & Kibar Furtun, 2014; Şenyiğit & Okur, 2019; Sis & Ateş, 2018; Tüm, 2014; Uğur & Azizoğlu, 2016). Experimental studies focus on the teaching of segmental and suprasegmental units of pronunciation (Çerçi, 2014; Erdem et al., 2015; Erten Dalak & Mercan, 2017; İlgün, 2015; Karatay, Güngör, & Özalan, 2019; Özkaya, 2012; Yılmaz & Şeref, 2015). An overall evaluation of these studies would show that the focus is more on segmentals and that the experimental studies are limited in number.

Unlike the previous studies that focused on either the segmental or suprasegmental features of Turkish, this study adopts a holistic approach that allows it to simultaneously focus on those features and aims to develop the linguistic and imitation abilities of learners of Turkish as a foreign language in a communicative context. In the adopted approach, individual sounds are presented dually in isolation and in multiple utterance contexts because teaching the pronunciation of a sound in those contexts may result in permanence in learning the target language sounds. Teaching the Turkish sound system through this approach and determining the cognitive effects of learning sounds in the Broca's area through fMRI imaging may provide useful information for teachers who are involved or interested in pronunciation teaching effectively.

This study was initiated to seek answers to the following research questions:
1. Is pronunciation training given in accord with the holistic approach effective in improving the pronunciation errors of learners?
2. Does such pronunciation training lead to changes in the involved areas of the brain?

## 2. Research Design and Method

This study was designed as in-class action research. In action research studies, the interested parties “define the problems to be examined, cogenerate relevant knowledge about them, learn, and execute social research techniques, take actions, and interpret the results of actions based on what they have learned.” (Greenwood & Levin, 2007, p.3). Thus, ways to improve existing practices through the incorporation of new ideas are investigated, necessary actions for improvement are taken and the effects of those actions are assessed (Calhoun, 2002). In this study, suitable approaches, methods, and techniques that improve pronunciation skills were determined and used to improve the pronunciation problems of international students learning Turkish.

Three approaches are used in pronunciation teaching. These are the Analytical-Grammatical, Intuitive-Imitative, and Holistic approaches. Of these, the holistic approach, which addresses both the analytical linguistic ability and the communicative skill and focuses on segmental and suprasegmental units at the same time, was used in this study. In the devised action plan, sound awareness activities, correct pronunciation of the sounds, and spelling activities with words were done at the beginning of the A1 level. At the A2 level, activities for teaching sounds in words and sentences and pronunciation activities that showed students how to express emotions were done. At the B1 level, word and sentence stress, pronunciations of those units, and drama and role-play activities were practiced in addition to the teaching of sounds in words. Thus, the holistic learning approach was implemented by providing training in both segmental and suprasegmental units. The training was implemented for a weekly total of two hours for fifteen weeks. The length of provided training was 3 weeks at the A1 level. The training period was 6 weeks for each of the A2 and the B1 levels. The implementation process was planned as follows:

### *2.1. Implementation Process*

2.1.1. Examination of current practices**:** The examination of the textbooks used in instruction showed that the activities geared toward developing pronunciation skills were limited.

2.1.2. Identifying the pronunciation problems of learners**:** At the A1 level, a text in Turkish was read aloud by each student and recorded. The recordings were analyzed and the pronunciation errors the learners had made were identified. After the pronunciation problems were identified, *f*MRI images of the learners (the first test) were taken to determine the areas involved in their brains during their pronunciations of Turkish sounds.

2.1.3. Identifying activities to improve pronunciation errors**:** In line with the holistic approach, it was decided that 20 interesting activities out of the 44 activities previously determined by the researchers would be used (Karatay & Tekin, 2019a, 2019b).

2.1.4. Implementation: "Listen to the Sound of Turkish", "How Many Times Have You Heard the Sound?" and "Feel the Sound" activities were implemented respectively at the A1 level for three weeks. At the A2 level, the "Feel the Sound", "Distinguish What You Are Listening to", "Coloring", "Mini Dictation", "What Sounds Can You Make?", "Silent Dictation", "Bingo", "Reading Out Loud", "Pay Attention to the News!" and "Sound Scoring" activities were implemented.

2.1.5. Assessment, evaluation, and reflection**:** The learners were recorded once again at the end of the A2 level which was the first proficiency level of the study, and the analyses of the recordings showed improvement in the learners’ pronunciations of the majority of the problematic sounds. It was also observed that some sounds had not been corrected. Following this phase of the study, the implementation plan was continued**.**

2.1.6. Revising and implementing the revised plan*:* The "Ear to Ear", "Mini Dictation", "The Smallest Couple", "Tongue Twisters", "Reading Out Loud", "Rhythmic Speaking", "Emotional States of Language", "Which Word?", "Creating Meaning in Pronunciation", and "Stress in Sentence" activities were implemented at the B1 level for the suprasegmental features of Turkish while the teaching of segmental sound units continued.

2.1.7. Evaluating the action research plan and sharing the findings**:** At the end of the B1 level, it was observed that the mispronunciations of most of the problematic sounds had been corrected. The changes and cognitive developments in the learners’ brains caused by the improvement in pronunciation skills were described for each learner and in terms of the learners' mother tongues.

*2.2. Study Group*

The study group consisted of 9 volunteer students who were learning Turkish as a foreign language at the Bolu Abant İzzet Baysal University Turkish Education Application and Research Center (TÖMER) in the 2018-2019 academic year. The students were selected, using the purposive sampling method, from among the students who were experiencing pronunciation problems. The sample consisted of 7 males and 2 females who were 18-20 years of age. Arabic was the mother tongue of 4 students; 4 students were native speakers of French, and there was 1 student who was a native speaker of Mongolian/Kazakh.

*2.3. Data Collection*

The data consisted of the audio recordings and the *f*MRI images of the participants and were collected through document analysis. The audio recordings were made three times at the end of the A1, A2, and B1 levels. The *f*MRI images were taken twice at the end of the A1 and B1 levels. At the A1and B1 levels, all students were asked to read aloud a level-appropriate Turkish text for 10 minutes in the MR device, and their pronunciations were recorded to detect the specific sound errors they made individually. The students' brain images were also taken simultaneously to help account for the errors they made in the production of the sounds in the texts. The audio recordings were transcribed and subsequently analyzed for pronunciation errors. The *f*MRI images of the participants were taken at the A1 level and B1 level to determine whether and to what extent differences occurred in their brains as a result of the instruction given.

A 1.5 magnetic resonance device (Symphony; Siemens Medical Systems, Erlangen, Germany) with a superficial coil for the head and neck was used to obtain the fMRI data. The functional imaging was obtained by blood oxygen level-dependent sensitive gradient echo-planar imaging sequence to observe the response of the blood flow in the brain of each participant during the 1st (A1 level) and 2nd (B1 level) tests. For anatomical imaging, a fast acquisition gradient echo sequence prepared by high-resolution three-dimensional magnetization was taken from each participant.

*2.4. Analysis of Data*

The data obtained through the students' voice recordings were analyzed by doing content analysis. The fMRI data were uploaded to the radiology workstation and analyzed by an expert radiologist using the BOLD software. To report the results of the analyses, the nine participants were coded and numbered as "P1-P9". The errors in the students' voice recordings were classified into two categories as vowel errors and consonant errors. The improvements for each level were identified and presented in graphs. Examples of pronunciation errors in words are given in Appendix 1.

## 3. Findings

*First research question:* To seek answers to this question, the pronunciation errors that were determined based on the analysis of the transcribed recordings of the students' reading texts at the end of the A1, A2, and B1 levels were used.

The findings will be presented in three groups based on the native languages of the participants by levels. Thus, first, the phonetic errors of the students whose native language was Arabic will be given. This will be followed by the phonetic errors of the students who were native speakers of French. Finally, the errors made by the student who was a native speaker of Mongolian/Kazakh will be presented.

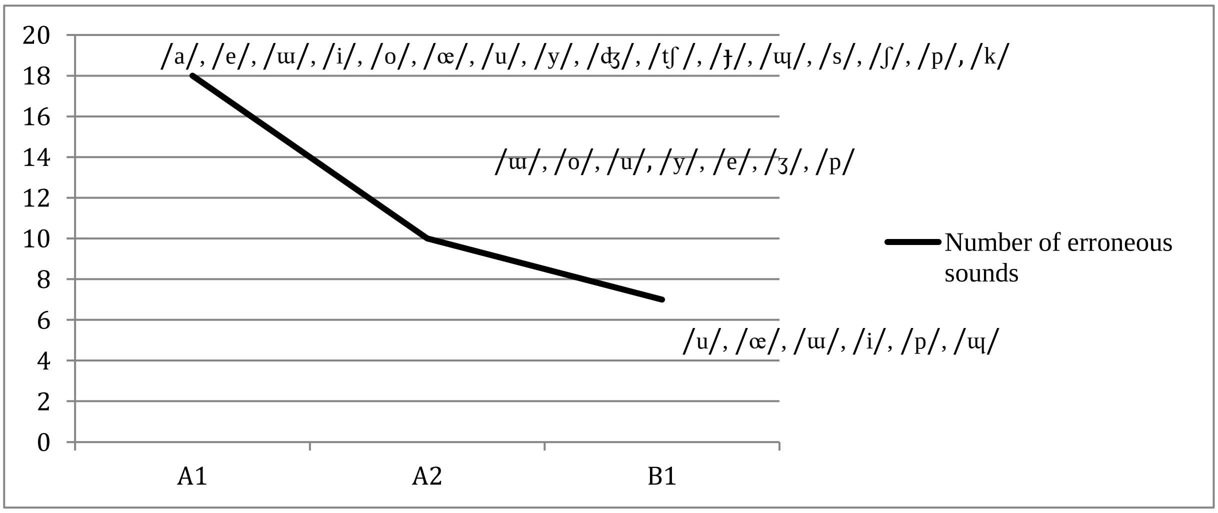
3.1.1. Pronunciation Errors Made by The Arabic Native Speaker Students by Proficiency Levels

P1, who was an Egyptian female student, could not pronounce the vowels /a/, /e/, /ɯ/, /i/, /o/, /œ/, and /y/ and the consonants /ʤ/, /tʃ/, /ʃ/, /p/, and /k/ correctly. The vowel sounds /o/, /e/, and /ɯ/ were incorrect at the A2 level. At the B1 level, only the vowel /ɯ/ and the consonant /p/ were incorrectly pronounced.

P2, who was a Palestinian female student, could not pronounce the vowels /a/, /e/, /i/, /o/, /œ/, /u/, /y/, and /ɯ/ and the consonants /ɟ/, /ʤ/, /p/, /s/, and /ɰ/ at the A1 level correctly. The student could not pronounce the vowels /ɯ/ and /u/ and the consonant /p/ correctly at the A2 level. At the B1 level, only the vowel /i/ was incorrectly pronounced.

P3, who was a Palestinian male student, could not pronounce the vowels /i/, /e/, and /ɰ/ at the A1 level. At the A2 level, the vowel /u/ was pronounced incorrectly. The consonant /ɰ/ was the only incorrectly pronounced sound at the B1 level.

P4, who was a Yemenite male student, could not pronounce the vowels /e/, /ɯ/, /œ/, /y/, /i/, /u/, and /o/ and the consonants /ʤ/, /p/, /s/, /tʃ/, and /ʃ/ correctly at the A1 level. At the A2 level, the student pronounced the vowels /e/, /ɯ/, and /y/ and the consonant /ʒ/ incorrectly. At the B1 level, the student incorrectly pronounced the vowels /œ/ and /u/ and the consonants /p/ and /ɰ/. Graph 1 below shows the pronunciation errors made by the Arabic native-speaker students by proficiency levels.




Graph 1: Phonetic Errors Made by The Arabic Native Speaker Students by Proficiency Levels

3.1.2. Pronunciation Errors Made by The French Native Speaker Students by Proficiency Levels

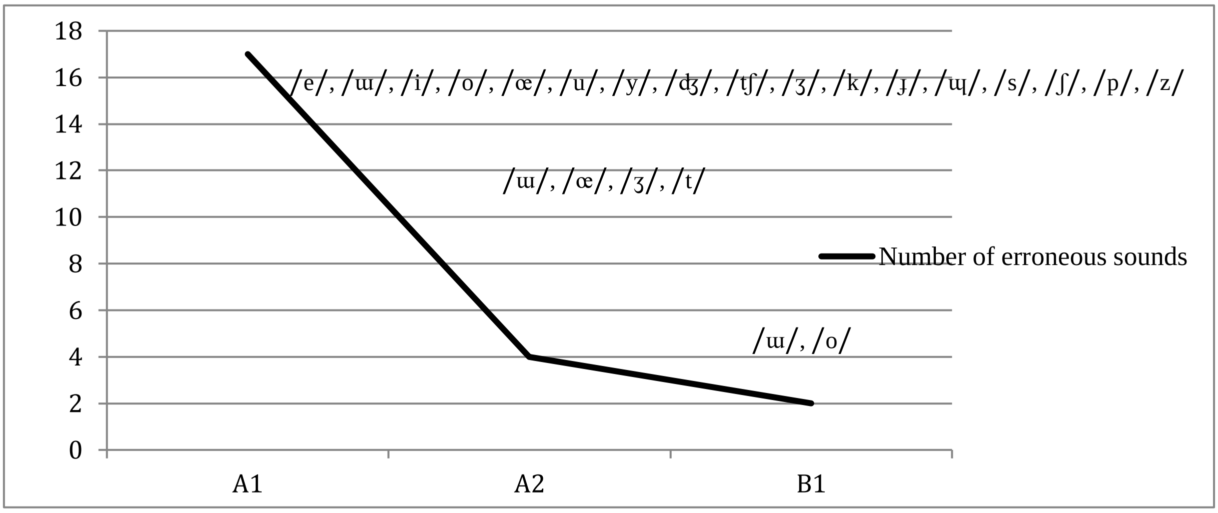
P5, who was a Guinean male student, could not pronounce the vowels /ɯ/, /i/, /e/, /u/, /œ/, /o/, and /y/ correctly at the A1 level. For the consonants /ʤ/, /tʃ/, /s/, /ʒ/, /ɟ/, /p/, and /k/, the student used the replacements sounds /k/, /ʃ/, /z/, /ʤ/, /ʒ/, /b/, and /g/ at the same level. The vowel /ɯ/ and the consonants /t/ and /ʒ/ were incorrectly pronounced at the A2 level by the student. At the B1 level, only the vowel /ɯ/ was pronounced incorrectly.

P6, who was a Nigerian male student, could not pronounce the vowels /ɯ/, /y/, and /e/ and the consonant /tʃ/ correctly at the A1 level. The student did not mispronounce any sound at other levels.

P7, who was a Burundian male student, could not pronounce the vowels /ɯ/, /œ/, and /y/ and the consonants /ʤ/, /s/, /tʃ/, and /ɰ/ at the A1 level. Only the vowel /ɯ/ was incorrect at the A2 level. At the B1 level, the sounds that were incorrectly pronounced were /ɯ/ and /œ/.

P8, who was a Chadian male student, could not pronounce the vowels /e/, /œ/, /ɯ/, /y/, and /u/ and the consonants /z/, /ʤ/, /tʃ/, /ʃ/, /ɟ/, /s/, and /ɰ/ at the A1 level. Only the vowel /œ/ was incorrect at the A2 level. The student did not make any pronunciation errors at the B1 level.

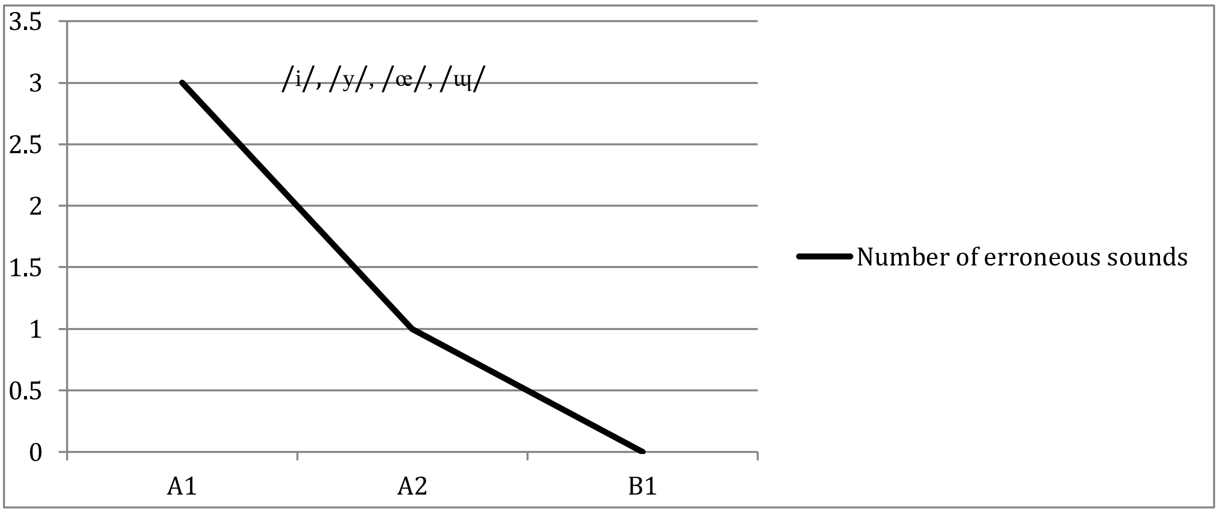
Graph 2 below shows the pronunciation errors made by French native-speaker students by proficiency levels.




Graph 2: Phonetic errors made by the French native speaker students by proficiency levels

3.1.3. Pronunciation Errors Made by The Mongol/Kazakh Native Speaker Student by Proficiency Levels

P9, the only Mongolian male student, could not pronounce the vowels /i/, /y/, and /œ/ and the consonant /ɥ/ at the A1 level. The student did not make any pronunciation errors at the subsequent levels. Graph 3 below shows the pronunciation errors made by the Mongolian/Kazakh native-speaker student by proficiency levels.




Graph 3: Phonetic errors made by the Mongolian / Kazakh native speaker student by proficiency levels

*Second research question:* To answer this question, two *f*MRI images were taken. The first image was taken at the end of the A1 level before the implementation of the devised action plan. The second image was taken at the end of the B1 level after the implementation process.

3.2.1. The 1st and 2nd fMRI Images of the Arabic Native Speaker Students

In the first *f*MRI image of P1 [Figure 1, P1 1st Test] mild involvement was detected both in the bilateral medial frontal and left FEF areas of the brain. In the second image [Figure 2, P1 2nd Test], brain involvement was observed in the bilateral FEF, bilateral superior frontal, bilateral occipital, and bilateral cerebellar areas.

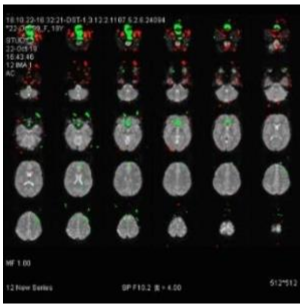


Figure 1. P1 1st Test

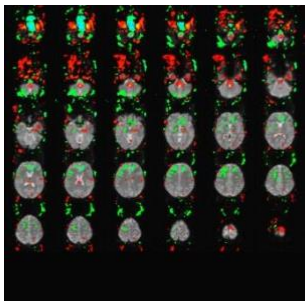


Figure 2. P1 2nd Test

In the first *f*MRI image of P2 [Figure 3, P2 1st Test], involvement was detected in the bilateral superior frontal and right FEF areas of the brain. In the second image [Figure 4, P2 2nd Test], brain involvement was observed in the bilateral superior frontal, bilateral medial frontal, bilateral FEF, bilateral Broca's, cingulum, bilateral occipital, and bilateral cerebellar areas.

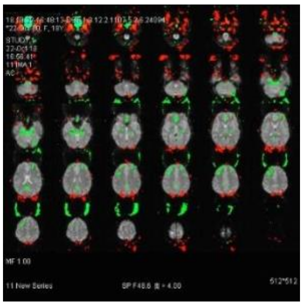


Figure 3. P2 1st Test

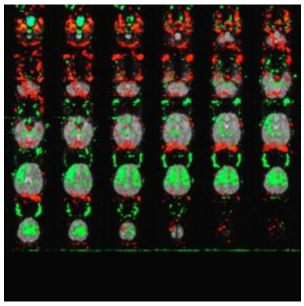


Figure 4. P2 2nd Test

In the first *f*MRI image of P3 [Figure 5, P3 1st Test], mild involvement was detected in the right FEF area of the brain. In the second image [Figure 6, P3 2nd Test], brain involvement was observed in the bilateral superior frontal, bilateral medial frontal, bilateral FEF, bilateral Broca's, cingulum, bilateral occipital, and bilateral cerebellar areas.

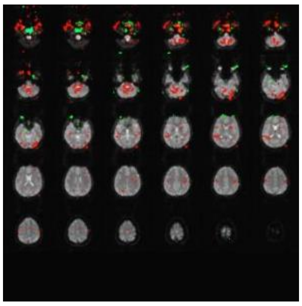


Figure 5. P3 1st Test

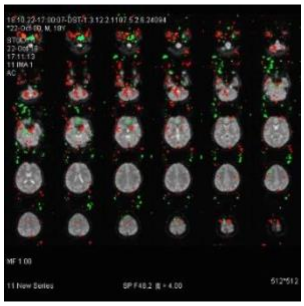


Figure 6. P3 2nd Test

In the first *f*MRI image of P4 [Figure 7, P4 1st Test], brain involvement was detected in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, bilateral Broca's (right dominant), cingulum, bilateral superior temporal, and bilateral occipital areas. In the second image [Figure 8, P4 2nd Test], brain involvement was observed in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, right Broca's, bilateral superior temporal, bilateral occipital, cingulum, and bilateral cerebellar (mild) areas.

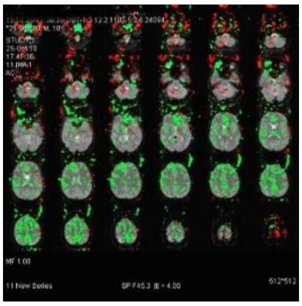


Figure 7. P4 1st Test

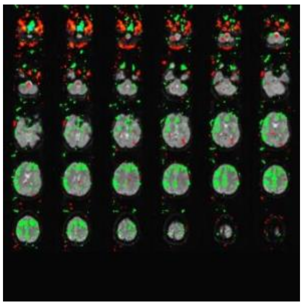


Figure 8. P4 2nd Test

3.2.2. The 1st and 2nd fMRI Images of the French Native Speaker Students

In the first *f*MRI image of P5 [Figure 9, P5 1st Test], involvement was detected in the bilateral superior frontal, bilateral FEF, and right Broca's (mild) areas of the brain. In the second image [Figure 10, P5 2nd Test], brain involvement was observed in the left superior frontal, bilateral FEF, right Broca's, bilateral occipital, and bilateral cerebellar areas.

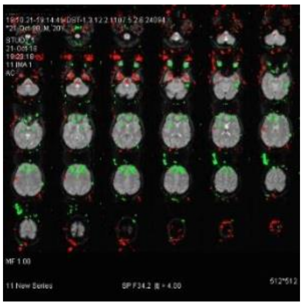


Figure 9. P5 1st Test

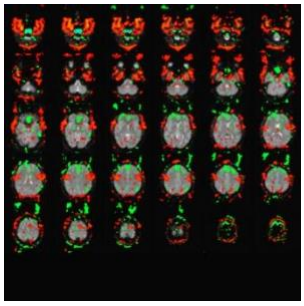


Figure 10. P5 2nd Test

In the first *f*MRI image of P6 [Figure 11, P6 1st Test], mild brain involvement was detected both in the bilateral superior frontal and the bilateral FEF areas. In the second image [Figure 12, P6 2nd Test], brain involvement was observed in the bilateral superior frontal, bilateral FEF, right Broca's, bilateral occipital, and bilateral cerebellar areas.

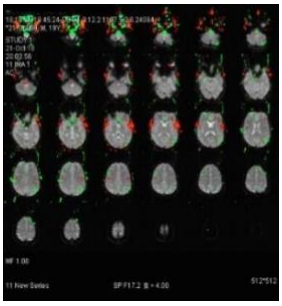


Figure 11. P6 1st Test

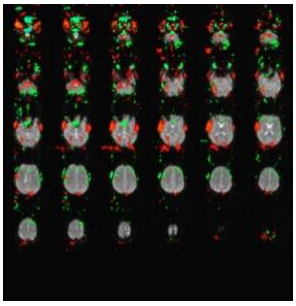


Figure 12. P6 2nd Test

In the first fMRI image of P7 [Figure 13, P7 1st Test], involvement was detected in the bilateral medial frontal, bilateral superior frontal, bilateral, FEF, and right Broca's (mild) areas of the brain. In the second image [Figure 14, P7 2nd Test], brain involvement was observed in the bilateral medial frontal, bilateral FEF, bilateral Broca's, bilateral occipital, and bilateral cerebellar areas.

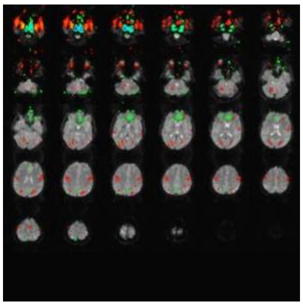


Figure 13. P7 1st Test

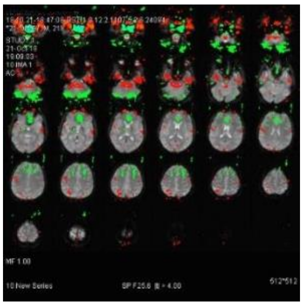


Figure. 14 P7 2nd Test

In the first *f*MRI image of P8 [Figure 15, P8 1st Test], involvement was detected in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, and left Broca's areas of the brain. In the second image [Figure 16, P8 2nd Test], brain involvement was observed in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, left Broca's, bilateral occipital, and bilateral cerebellar areas.

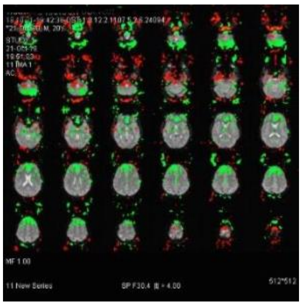


Figure 15. P8 1st Test

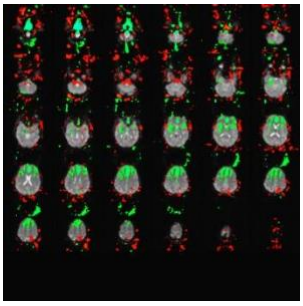


Figure 16. P8 2nd Test

3.2.3. The 1st and 2nd fMRI Images of the Mongolian/Kazakh Native Speaker Student

In the first fMRI image of P9 [Figure 17, P9 1st Test], involvement was detected in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, left Broca's, cingulum, bilateral superior temporal (mild), and bilateral occipital areas of the brain. In the second image [Figure 18, P9 2nd Test], brain involvement was observed in the bilateral medial frontal, bilateral superior frontal, bilateral FEF, bilateral Broca's, bilateral occipital, and bilateral cerebellar areas.

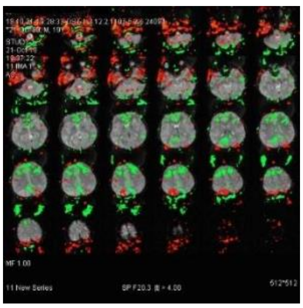


Figure 17. P9 1st Test

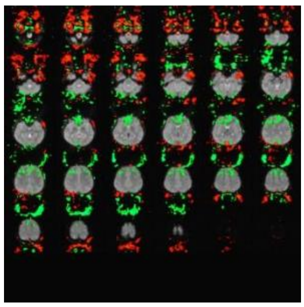


Figure 18. P9 2nd Test

## 4. Results

The analyses showed that at the A1 level, Arabic native-speaker students could not pronounce 16 different sounds correctly. Those sounds were /a/, /e/, /ɯ/, /i/, /o/, /œ/, /u/, /y/, /ʤ/, /tʃ /, /ɟ/, /s/, /ʃ/, /p/, /k/ and /ɰ/. At the A2 level, 7 sounds were incorrectly pronounced. Those sounds were /ɯ/, /o/, /u/, /y/, /e/, /ʒ/ and /p/. At the B1 level, the number of incorrectly pronounced sounds was 6. Those sounds were /u/, /œ/, /ɯ/, /i/, /p/ and /ɰ/.

At the A1 level, French native-speaker students could not pronounce 17 sounds correctly. Those sounds were /e/, /ɯ/, /i/, /o/, /œ/, /u/, /y/, /ʤ/, /tʃ/, /ʒ/, /k/, /ɟ/, /s/, /ʃ/, /p/, /z/, and /ɰ/. At the A2 level, 4 sounds were incorrectly pronounced. They were /ɯ/, /œ/, /ʒ/, and /t/. At the B1 level, the students mispronounced only two sounds which were /ɯ/ and /o/. The Mongolian student did not make any pronunciation errors at the subsequent levels.

The fMRI signal in the frontal lobes and the Broca's area was generally more marked in the first fMRI images of the students who were native speakers of French compared with the students whose mother tongue was Arabic. Among the Arabic native-speaker students, only one student (P4) was found to have a higher fMRI signal than the students whose mother tongue was French. In that student, a signal was observed in the bilateral superior temporal, cingulum, and bilateral occipital areas which was not observed in the French native-speaker students.

All second fMRI images showed increased signals in the cerebellar region due to neurovascular connections. The increase is less in P4 than in the other students, whose first fMRI image showed the highest signal. This is because he was not able to attend the activities regularly. Therefore, the pronunciation mistakes he made during the read-alouds and in speaking persisted. In the first fMRI images, a signal in the occipital region was observed only in two students (P4, P9), while in the second test, all students showed a signal increase in the same region. In the second images, the most significant signal increase was seen in P1, P2, P3, and P6.

## 5. Discussion

In this study, the pronunciation mistakes made by the Arabic native speakers in the Turkish vowel sounds of /o/, /œ/, /u/, and /y/ are due to the limited number of vowels in Arabic (Adalar Subaşı, 2010; Demirci, 2015; Doğan, 2007; Karatay et al., 2019; Şengül, 2014). Also, the absence of the Turkish consonant sounds /p/, /g/, /ɰ/, /ʒ/, /tʃ/, and /v/ in Arabic caused those sounds to be pronounced incorrectly (Demirci, 2015; Doğan, 2007). It was found in the previous studies (Adalar Subaşı, 2010; Akkaya & Gün, 2016; Alshirah, 2013; Beydilli Kaya, 2019; Biçer, 2017; Demirci, 2015; Erdem et al., 2015; Erten Dalak & Mercan, 2017; İnan & Öztürk, 2015; Kaplan, 2018; Kara, 2010; Moralı, 2018; Okatan, 2012; Şengül, 2014; Tuzlukaya, 2019; Ünal, Taşkaya & Ersoy, 2018; Yılmaz & Şeref, 2015) that Arabic native speaker students employed negative transfer when there were sounds that were missing in their own language or when they had difficulty perceiving or distinguishing new sounds, by replacing those sounds with similar sounds in their language. Such problems, however, can be reduced by using activities such as listening and distinguishing (Çerci, 2014; Er, Biçer & Bozkırlı, 2012; Özmen, Güven & Dürer, 2017) which were used in this study. Thanks to these activities, the phonetic errors made by the students began to decrease when the students reached the A2 level.

Throughout the study process, it was observed that the phonetic errors made by Arabic native-speaker students were more persistent. The significant increases observed in each of the brain images of those students also indicated that they had no previous knowledge of the Turkish sound system at the A1 level and thus experienced more difficulties in terms of pronunciation than other students. The eye movement signals related to the motor process of reading in the frontal lobes and Broca's area were less common in Arabic students than in other students. The reason for this may be explained through the differences between Turkish and Arabic in terms of the alphabet and reading direction which is from left to right in Turkish and from right to left in Arabic.

During the reading process, the difference in the reading direction in Arabic causes the perceptual distance to extend more to the left (Jordan et al., 2014). The differences in eye movements and reading motor processes in students whose mother tongue was Arabic and the lack of a signal in brain involvement areas also supported these findings. At the A2 level gains were observed in terms of word recognition, letter recognition, motor processes in reading, eye movements, and following writing signals in the brain as the students' knowledge of phonological encoding and pronunciation skills increased.

Except for the pronunciation of some fossilized sounds, the sound errors made by French native-speaker students decreased. These students also achieved the most successful results in terms of pronunciation, motor processes of reading, and frontal eye movements. This may be explained first by the fact that French native-speaker students were learning their third language while Arabic native-speaker students were learning their second language which gave them leverage in terms of language learning experience and strategies. Secondly, French native-speaker students had the advantage of learning another language that used the same alphabet and direction of reading which shortened the time of eye movement and led to faster reading (Rayner, 1978).

In student P9, whose mother tongue was Mongolian/Kazakh, phonetic errors completely disappeared at the end of the A1 level. These results may be explained by the existence of similarities between the syntax and morphological and phonetic features of Mongolian/Kazakh and Turkish (Albayrak, 2010; Biçer, Çoban & Bakır, 2014) as similarities and common features between Turkish and its dialects also facilitate language learning (Baytok, 2018; Biçer & Alan, 2019). This participant's higher Turkish readiness and similar pronunciation skills compared with those of other students had activated the occipital region in his first brain image and openly revealed the relationship between the occipital region and pronunciation.

Signal increases were observed in the occipital region in all students who in general started to understand what they read as a result of improvement in their knowledge of Turkish pronunciation. Thus, it may be said that occipital involvement in the brain is associated with reading and cerebellar involvement is associated with a decrease in pronunciation errors. The finding that one of the students (P4) continued to have pronunciation errors during speaking because of lesser cerebellar involvement compared with other students also supports this.

Increasing learners' sound awareness along with speaking skills leads to a decrease in phonetic errors and contributes to the development of the motor processes of reading, tracking writing, and eye movements. The pronunciation skill should be one of the primary goals from the beginning of language learning because it is the key to accurate listening comprehension and speaking skills.

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