T.C.
MERSİN UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ENGLISH LINGUISTICS

SECOND LANGUAGE ARTICULATIONS OF NATIVE TURKISH SPEAKERS LEARNING ENGLISH AS A FOREIGN LANGUAGE IN THE 14-19 AGE GROUP: SHARED AND DISTINCT FEATURES

Master's Thesis

Prepared by
Cevdet ÜSTÜN

Advisor
Asst. Prof. Dr. Özlem KURTOĞLU ZORLU

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Prepared by
Cevdet ÜSTÜN
ORCID No: 0000-0002-9866-6315

Advisor
Asst. Prof. Dr. Özlem KURTOĞLU ZORLU
ORCID No: 0000-0002-1853-9843

AUGUST-2024, MERSİN

ÖZET

SECOND LANGUAGE ARTICULATIONS OF NATIVE TURKISH SPEAKERS LEARNING ENGLISH AS A FOREIGN LANGUAGE IN THE 14-19 AGE GROUP: SHARED AND DISTINCT FEATURES

Aksanlılık, "söz konusu dilin yerel çeşitliliği ile ikinci dil konuşucusunun konuşma üretimi arasındaki farkın derecesi" olarak betimlenmektedir ve bir dinleyicinin, anadili konuşucusu normundan farklı olan ikinci dildeki konuşmayı ne ölçüde yargıladığını anlatır. Bu çalışmanın amacı, 14-19 yaş arası Türkçe anadil konuşucu ve İngilizce L2 (ikinci dil) (İng. Language 2) öğrenicilerinin ana dillerinde ve hedef dilde yer alan ünlüleri sesletimlerini "ünlü özellikleri" (İng. vowel features) ve "ünlü niteliği" (İng. vowel quality) açısından incelemek ve "Uygunluk Kuramı" (İng. Optimality Theory) (Prince ve Smolensky, 2004) bağlamında değerlendirmektir. Uygunluk Kuramı, algısal ve üretimsel süreçte L2 ses sistemi üzerinde anadil etkisinin anlaşılmasına katkı sağlamaktadır. Bununla birlikte, katılımcıların performans değerlerinin ölçülerek, sözü edilen söyleyiş farklılıklarının spektrografik analizler ve sayısal değerler üzerinden, ünlü özelliği ve niteliği bağlamında anadile yakınlık ve uzaklık durumlarının ortaya konması hedeflenmiştir. Bu derece farklılıklarının, hangi ünlülerde belirginleştiğini saptamanın, araştırmanın dayandığı varsayımları test etmeyi ve araştırma sorularına cevap bulmayı sağlaması beklenmektedir. Katılımcılar Kahramanmaraş il merkezinde, Milli Eğitim Bakanlığı'na bağlı liselerde öğrenim gören, Türkçe anadil konuşucusu, İngilizce L2 öğrenicisi, 14-19 yaş grubu 20 öğrencidir. Katılımcılara "en küçük çift"ler (İng. minimal pair) şeklinde belirlenmiş sözcükleri içeren ve karışık bir şekilde sıralanmış 56 Türkçe, 132 İngilizce tümceyi sesli bir şekilde okumaları istenmiş, sesletimler kaydedilmiştir. Katılımcılardan elde edilen ses kayıtları Praat (Boersma & Weenink, 2020) kullanılarak çözümlenmiştir. Ünlülerin bölümlemesi yapıldıktan sonra, ortalama F1 ve F2 değerleri hesaplanmış, dağılımlar ve haritalar nicel yöntemle RStudio (RStudio Team, 2019) kullanılarak, phonR (McCloy, 2016) yardımıyla oluşturulmuştur.

Anahtar Kelimeler: Ünlü, Aksan, Anlaşılabilirlik, Ünlü Nitelikleri, Formant, Akustik Sesbilim.

Danışman: Dr. Öğr. Üyesi Özlem KURTOĞLU ZORLU, İngiliz Dilbilimi Bölümü, Mersin Üniversitesi, Mersin.

ABSTRACT

Second Language Articulations of Native Turkish Speakers Learning English as a Foreign Language in the 14-19 Age Group: Shared and Distinct Features

Accentedness is described as "a rating of the degree of difference between an L2 speaker's productions and the local variety of the language in question" and describes the extent to which a listener judges second language speech that differs from the native speaker norm. The aim of this study is to examine the vowels of Turkish native speakers and English L2 learners between the ages of 14-19, in their native language (L1) and in the target language, in terms of "vowel features" and "vowel quality" to evaluate it in the context of Optimality Theory (Prince & Smolensky, 2004). Optimality Theory contributes to the understanding of the L1 effect on the L2 sound system in the perceptual and generative process. In addition, by measuring the performance values of the participants, it is aimed to reveal the proximities and distances to the native language in the context of vowel features and vowel quality, through spectrographic analyses and numerical data. It is expected that determining in which vowels these degree differences are evident will enable to test the hypotheses on which the research is based and to find answers to the research questions. Participants are 20 students in the 14-19 age group, who are Turkish native speakers and English L2 learners, studying at secondary schools bound to the Ministry of National Education in Kahramanmaraş city centre. Participants were asked to read aloud 56 Turkish and 132 English sentences containing words designated as "minimal pairs" and arranged in a mixed order, and the pronunciations were recorded. Audio recordings obtained from the participants were analysed using Praat (Boersma & Weenink, 2020). After segmentation of vowels, average F1 and F2 values were calculated, distributions and maps were created with the help of phonR (McCloy, 2016) using quantitative method using RStudio (RStudio Team, 2019).

Keywords: Vowel, Accent, Intelligibility, Vowel Features, Formant, Acoustic Phonetics.

Advisor: Asst. Prof. Dr. Özlem KURTOĞLU ZORLU, Department of English Linguistics, University of Mersin, Mersin.

ACKNOWLEDGEMENTS

The story dates back a long time (almost 25 years); first started as an interest, then turned into love, and then into a passion… First of all, I must express my happiness that my linguistic observations have turned into an academic study. I would like to express my gratitude to respectable academicians of Mersin University English Linguistics Department who gave me the opportunity to work, guided me in the right way and supported me in difficult times, my advisor Asst. Prof. Dr. Özlem KURTOĞLU ZORLU, our valuable lecturers Prof. Dr. Aygül UÇAR, Prof. Dr. Pınar İBE AKCAN, Assoc. Prof. Dr. Filiz ÇETİNTAŞ YILDIRIM and also to Asst. Prof. Dr. Demet GÜL who used to be my advisor at the beginning of this study. I would also like to thank my family for being right in the centre of my heart and my life, my wife Feride Ferda ÜSTÜN, my daughter Aslı Zeynep ÜSTÜN and my son Mehmet Barış ÜSTÜN, who supported me unconditionally throughout this process. I thank God for existence and presence of Assoc. Prof. Dr. Beyhan YETER, Prof. Dr. Cemal ÇAKIR, Asst. Prof. Dr. Günfer MENDOZA VASQUEZ, Asst. Prof. Dr. Neslihan ÖZKAN, Yusuf Tarık GÜNAYDIN, İbrahim KANADIKIRIK, Hasan Zahid YURDAGÜL and İbrahim DAŞKIRAN, and I wish them a healthy and long life. I commemorate my dear teacher, the deceased Necdet ÖZKILAVUZ, who passed away during the preparation of this thesis, and my dear brother, the deceased Ferhat AĞCA, who passed away in the 6 February 2023 earthquake in Kahramanmaraş. I would also like to thank my friends Alper ÜNAL, Harika Bahar DOĞAN and Merve TOSUN, whom I had the great honour of meeting during our postgraduate study. I hope that my work will be beneficial to humanity and to people…

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ABBREVIATIONS and SYMBOLS

Abbreviation / Symbol	Definition
BC	Before Christ
L1	Language 1 - chronologically the first language that a child learns
L2	Language 2 - a language acquired by a person in addition to his mother tongue / native language
F0	Formant 0
F1	Formant 1
F2	Formant 2
IPA	International Phonetic Alphabet
UG	Universal Grammar Theory
LP	Linguistic Perception Model
OT	Optimality Theory
GL	Generative Linguistics
GEN	Generator
EVAL	Evaluator
CON	Constraint
C1/cand1	Candidate 1
C2/cand2	Candidate 2
C3/cand3	Candidate 3
AusEWS	Western Sydney Australian English
ms	Millisecond
Hz	Hertz
kHz	Kilohertz
Mhz	Megahertz
Ave	Average
TNC	Turkish National Corpus
dB	Decibel
°C	Degree Celsius
P1, P2, P3, …	Participant 1, Participant 2, Participant 3, …
M	Male
F	Female
SSB	Standard Southern British
SSBE	Standard Southern British English
RP	Received Pronunciation
TE	Turkish-accented English
AE	American English
CVC	Consonant – Vowel – Consonant

INTRODUCTION

Social studies and research are carried out in a wide range of fields – from the interactions of individuals to global social processes. It can be claimed that the interaction and communication between people exist in the point of origin for those studies. The formation and development of civilizations has been possible with collective ideas and actions of humankind throughout millenniums. Obviously, "language" is in the core of social interactions which meets the need for effective and strong communication. 'The one thing in which we are especially superior to beasts is that we speak to each other.' Cicero said in 55 BC.

Linguistic studies contribute better understanding of systematic structure of human language as well as universal language attributes with a scientific approach. Revealing scientific realities in the light of findings in the form of significant similarities/differences between the attributes and systematics of languages, linguistics examines languages from various aspects and objectives through theories and approaches that have developed over time. By processing the data obtained in the field, the studies enable the cumulative augmentation and development of scientific knowledge. With its sub-disciplines, linguistics deals with different dimensions of language such as sound, meaning, form, syntax, and it offers a multidimensional workspace.

The sound structure of the languages is subject to considerable amount of linguistic studies. Each of those studies aims to interpret the typical specifications of the languages' sound systems and adds precious scientific data into the field. The researchers mainly obtain and process linguistic data, evaluate the findings and then share the results with the humanity – which is the overall objective of scientific work. Naturally, each reality revealed brings out the next question to be asked and introduces the next phase of scientific research cycle.

As well as examining the structures of each language, a crucial question attracts linguists' attention: "How do languages affect one another?" Seeking for answer to this question, the studies focus on reliable findings which depend on real linguistic data obtained from the field. In the light of theories, the obtained data are evaluated in order to contribute interpreting the sound systems of languages.

1. ABOUT THE STUDY

In this study, the researcher focused on the articulation issues of second language. Specifically, the research area was designed upon the articulation of vowels of both native language of participants, Turkish, (*Language 1 – L1*) and English as their second language (*Language 2 – L2*). Processing the formant values F1 and F2 in the articulations of the participants, the researcher investigated the effect of native language (L1) vowels on the second language (L2) vowels; then the results were evaluated regarding Optimality Theory (Prince & Smolensky, 2004).

1.1. Aim of the Study

The aim of this study is to examine the vowel pronunciations of Turkish native speakers that are English L2 learners aged 14-19 in their native language as well as in the target language in terms of "vowel features" and "vowel quality", and to evaluate in the context regarding Optimality Theory (Prince & Smolensky, 2004). It is aimed to contribute to a better understanding of the effect of native language on accentedness by discussing the findings obtained from the collected data in the light of the Optimality Theory.

1.2. Significance of the Study

L2 learners' pronunciation of phonemes in the target language unlike native speakers has been subject of many studies. These studies deal with the aforementioned pronunciation differences with the "accentedness" approach and analyse them in the context of causality. A significant majority of the analyses focus on the amount of input that L2 learners receive or are exposed to in the target language, try to reveal the correlation between the amount and duration of input in the process and the students' pronunciation performances. While the findings and discussions confirm the input-performance relationship, it is of great importance to investigate and analyse other factors that affect learners' pronunciation performances, and to understand the factors behind the mentioned pronunciation differences.

Another approach focuses on how the sounds in the target language (phone), especially phonemes are perceived by learners. Together with the amount of input, this approach reveals the effect of the phonological structure in the native language on the perception of L2 phonemes in the perceptual dimension. There are studies showing that L2 phonemes which do not exist in the native language and/or differ significantly from the phonemes in the native language are perceived by the learners as the "closest" phoneme existing in their native language. Here, it is well-known that the phonological structure of the native language is of great importance. Studies on this effect as "phoneme identification" and "phoneme perception" describe it as "Perceptual Magnet Effect" (Kuhl, 1991).

In the light of all current research and analysis, in order to examine the pronunciation performances of the phonological structure in the target language accurately and effectively, it is important to reveal the differences in the L2 pronunciation performances of learners in a concrete and measurable way. Traditionally, a linguistic approach is based on the judgments of individuals –

especially native speakers; however, performing acoustic analysis of these differences, performing measurements, examinations, comparisons and evaluations with numerical values, and revealing the main findings and data that can be referenced in this study area through real linguistic data will provide significant scientific contributions.

In this context, it is essential to examine the pronunciation differences of Turkish native speaker English L2 students – specifically in vowel pronunciations in English – over real linguistic data, to determine performance values in terms of vowel features and vowel quality, to evaluate these values in comparison with the values of English native speakers. The research is based on comparative analyses over these values aiming to reach the results by evaluating the findings. The relatively limited number and scope of the existing studies conducted in this area enhances the significance of this study in terms of the results that this research aims to reveal.

1.3. Research Questions

In this study, answers to the research questions listed below were sought in line with the determined objectives:

Research Question 1: Are vowels of English Language pronounced differently by native Turkish speaker English L2 learners? If so, which vowels are pronounced in qualities of native language (L2) and which vowels are pronounced out of qualities of native language?

Research Question 2: Is it possible to make generalizations about vowel pronunciations by native Turkish speaker English L2 learners in the target language?

Research Question 3: Can Optimality Theory contribute to a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners?

1.4. Hypotheses

The researcher aimed to test the hypotheses in accordance with the research questions:

Hypothesis 1: Some of the vowels of English language are pronounced out of qualities of native language (L2) by Turkish speaker English L2 learners.

Hypothesis 2: It is possible to make generalizations about vowels' pronunciations by native Turkish speaker English L2 learners in the target language.

Hypothesis 3: Optimality Theory can contribute to a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners.

1.5. Limitations of the Study

The limitations of the research are that the research focuses on the possible differences to be sought in the English L2 vowel pronunciations of Turkish native speaker secondary school students,

that the participants live in the city centre of Kahramanmaraş, and especially that the participants are volunteer students to participate in the research.

It is also evaluated as a limitation that the voice recordings were taken from volunteer participants in a structured reading task rather than natural/casual speech in order to require them to pronounce specific words, and that the pronunciations were based only on the reading task.

2. REVIEW OF LITERATURE

2.1. Language and Sound

Language has been at the core of humans' individual and social interactions, meeting the need for strong and effective communication between people for millenniums. Language is defined as "The understanding process between people by words or signs to express what they think and feel" by Turkish Language Association (Türk Dil Kurumu | Sözlük, n.d. https://sozluk.gov.tr/). Ergin stated "Language is a natural tool of communicating between people, an entity that has its own laws and develops only within the limits of those laws, a system of secret agreements whose foundation was laid at unknown times, a social institution structured by sounds" (Ergin, 2009, p. 3). The diversity of definitions naturally reflects the multidimensional structure of language. For instance, "Language is a directly human-specific, very powerful, magical configuration that we use in verbal and written communication, that we find ready and we start acquire when we are born; it is a system of thinking and transferring what is thought" (Aksan, 2006, p. 13). Among existing definitions, Mulder and Hervey's (1975, p. 1) approach highlights the structural complexity of language with the title of their work "Language as a System of Systems".

Linguistics is the scientific study of human language which has been the basic aspect that meets the need for communication throughout millenniums. Linguistic studies contribute better understanding of nature and structure of languages with scientific approach and methodology. Delahunty and Garvey (2010, p. 14) states the motivation for studying languages as the interest in language variation, how languages evolve over time, the history of English, language standardization, how languages are learnt, language disorders, the relationships between language and culture or society, or how computers are programmed to interpret or produce language.

Regarding the multidimensional structure of the language(s), each component of language is dealt with by a specific study field. Phonology and phonetics deals with the sounds of language, syntax with the sentence structure principles, orthography with the spelling system, morphology with the structure of words, pragmatics with the meaning emerged in specific contexts, semantics with the literal meanings of sentences and words, in order to reveal existing systematic mechanisms and processes.

2.1.1. Phonology and Phonetics

Phonetics and phonology are inextricably linked sub-disciplines of linguistics that are concerned with sounds of language with the major objective that to interpret how sounds combine and pattern together. They observe and analyse the sound structures of languages, both specifically and with a universal approach, and define these structures through data and findings. The fact that the main purpose of both disciplines is to define the sound structures of languages often makes the relationship and distinction between them a matter of discussion.

Chomsky and Halle (1968, p. 9) emphasized the phonological elements in their work by revealing the distinction between the two disciplines and defined them as "the system of rules that

applies to a surface structure and assigns to it a certain phonetic representation drawn from the universal class provided by general linguistic theory". Accordingly, it can be said that phonological elements are abstract compared to phonological symbols, and phonological principles that people acquire and control can determine the shape of phonemes, words and sentences.

In the glossary section of their work Delahunty and Garvey (2010, p. 54) gives a brief definition for phonetics as "study of speech sounds as sounds", and for phonology as "study of speech sounds that distinguish meaningful units in a language".

Davenport and Hannahs (2010, p. 3) introduce the phonetics as "the physical description of the actual sounds used in human languages" and phonology as "the way the sounds we use are organised into patterns and systems" while they also regard phonetics as "the surface manifestation of spoken language" and phonology as "the abstract system organising the surface sounds and gestures".

On the definition and distinction of phonetics and phonology, Hamann (2011, p. 202) concludes the need for defining the issues of the two linguistic disciplines in order to characterize the interface: phonetics is concerned with gradient, continuous, physical representations encoding articulatory and auditory details, whereas phonology is concerned with abstract, discrete categories encoding language-specific distinctions in meaning.

According to Ashby (2011, pp. 12-13), phonology is dependent on phonetics, but in a more abstract way; in comparison, phonetics is a very concrete field. She claims that phonetics inputs to phonology, while phonology groups all of the detailed phonetic data about a language's pronunciation into phonemes (more abstract units that cause a change of meaning).

2.1.1.1. Basic Concepts and Terms

2.1.1.1.1. Segment, Phone and Phoneme

In their works "The Segment in Phonetics and Phonology" Raimy and Cairns (2015, p. 1) states that segment is and elusive entity and there has never been agreement on what the segment is or even if it reflects some type of cognitively a real entity, to the extent that the segment has even been formally described at all.

Speech consists of sequences of sounds. Syllables, words, phrases and sentences can be formed by sequencing the sounds in a certain order. When a normal speech act and the sounds produced by this action are analysed, it can be seen that speech generally consists of continuous sounds within words and across word boundaries. Speakers of a language can perceive and make sense of this continuous sequence of sounds by parsing them into words. Although it is relatively more difficult, they can split words into component sounds (Coxhead, 2006, p. 1). These components, which are included in the sound sequence that make up the speech act, are called "segment". In a dictionary of linguistics and phonetics by Crystal, "segment" is defined as "a term used in phonetics and linguistics primarily to refer

to any discrete unit that can be identified, either physically or auditorily, in the stream of speech" (Crystal, 2008, p. 426).

Phonetic or phonological studies concerning details of individual sounds are called "segmental", those concerning larger chunks of speech that span a number of segments, such as whole words of phrases, are called "suprasegmental". Wang et al. (2015, p. 2) states that segments consist of vowels and consonants while suprasegmental features are speech attributes that accompany consonants and vowels but which are not limited to single sounds and often extend over syllables, words, or phrases.

Components of speech sounds, which are differentiated by the approach of completely separating from each other, isolating them in terms of their properties and qualities, and therefore seeking to describe them as "distinctive sound units", are expressed and referred as "phoneme"s. McMahon (2002, p. 16) defines the phonemes as "realisations of an abstract unit which native speakers regard as the same". The distinctive aspect of the phonemes is also highlighted by Ladefoged and Johnson (2011, p. 34): "When two sounds can be used to differentiate words, they are said to belong to different phonemes".

Steriade (2007, p. 139) emphasizes that phonemes contrast with each other: embedded in otherwise identical contexts, a difference between a phoneme pair normally has the potential to convey a meaning difference.

In his dictionary, Crystal provides definitions for phone as "a term used in phonetics to refer to the smallest perceptible discrete segment of sound in a stream of speech" and for phoneme as "the minimal unit in the sound system of a language, according to traditional phonological theories" (Crystal, 2008, p. 361).

2.1.1.1.2. Allophone and Homophone

Defining the allophones as "the variants of the phonemes that occur in detailed phonetic transcriptions", Ladefoged and Johnson (2011, p. 46) claim that they can be described as a result of applying the phonological rules to the underlying phonemes.

Allophones are commonly accepted as a grouping of speech sounds that are phonetically related. The phoneme is rather an abstract unit and is not pronounceable; the allophones – various realizations of phonemes – are pronounceable. In his study, Carr (1993, p. 17) points out the notions of phonemic distinction and allophonic distinction: a phonetic distinction between two or more sounds is phonemic if the two sounds occur in parallel distribution and function contrastively, and allophonic if they occur in complementary distribution and are phonetically similar.

When two words are pronounced identically and the meanings are separated by the spellings, those words are called homophones. In the glossary section of his book, Brown (2014, p. 298) defines the homophones as "two or more words with unrelated meanings, such as pray and prey, that are pronounced the same (/preɪ/) but spelled differently".

2.1.1.1.3. Minimal Pair

If two sounds can occur in the same slot, and the two words differ only with respect to those two sounds, such pair of words are referred as minimal pair (Ball & Rahilly, 1999, p. 408). Therefore, in a minimal pair the two sounds function to distinguish those two words; they are distinct words with distinct meanings. Minimal pairs are specifically used to demonstrate how sound pairs in a language distinguish words from one another.

2.1.1.2. Speech Analysis

Linguistics provide techniques of analysis and descriptions of languages to define speech behaviours as well as the speech features. Regarding the systematic complexity of human language, linguists approach to speech analysis having regard to features principle and resolving speech into ultimate units. Contrastive analysis stands in the centre of the analytic process. As suggested by Engler et al. (1973), basic process for speech analysis consists of eliciting and recording the sample, transcribing the sample, segmenting the sample, and analysing the segments.

During the speech analysis, features foster identification of the speech sounds as well as the sound patterns of languages. Jakobson et al. (1952, pp. 4-11) defines the phonemic pattern as the multiple set claiming that any one language code has a finite set of distinctive features and a finite set of rules for grouping them into phonemes and also for grouping the latter into sequences. The authors also emphasize the contrastive effects to be utilized in acoustic investigations: "As soon as it is realized that the proper criterion of selection is the linguistic relevance (expressed in binary terms), the acoustic problems of the speech sounds find a far more determinate solution. Correspondingly the articulatory stage of speech must be defined in terms of the means utilized to obtain any pair of contrastive effects. For example, as far as language uses an autonomous distinctive opposition of gravity and acuteness, we examine the acoustical correlates of the linguistic values in question and the articulatory prerequisites of these stimuli".

2.1.2. Articulatory Phonetics

In general, articulatory phonetics focuses on how people use their bodies to produce speech sounds. To research many facets of these structures, including their physical shape, function, and regulation as well as their evolution, development, and usage patterns, articulatory phoneticians utilize a variety of tools and approaches. Gick et al. (2019, p. 107) indicates the interaction of articulatory phonetics with other disciplines, concluding that articulatory phonetics engages in a wide range of interactions with other fields, including neuroscience, speech-language pathology, motor control, dentistry, cognitive science, biomedical engineering, developmental psychology, otolaryngology, and, of course, other subfields of phonetics and linguistics.

2.1.2.1. Production of Speech

Speech occurs by arranging the sounds in a certain order. The production and/or performance of speech can be examined in two phases. In the first phase, the role of the lungs and larynx in producing

sound, and in the second stage, the role of the channels – pharynx and oral cavity – that continue from the larynx are examined.

Houkema (2001, p. 12) states that speaking is essentially the by-product of a necessarily bodily process, which is the discharge of air from the lungs after it has served its purpose in respiration. The organs that participate in the generation of speech serve a "secondary" purpose in relation to their primary function, which is entirely unrelated. Most, if not all, of the major speech organs (see Figure 2.1) are only or even mostly devoted with speaking. The lungs' primary function is respiration, while the larynx serves as a barrier to prevent food from entering the respiratory tract which includes the mouth, throat, and nose. The soft palate and uvula ensure that the nasal cavity is closed during swallowing, and the mouth, teeth, and tongue are essential for eating. These organs also contribute to the speech production mechanism.

Abercrombie (1967, p. 20) also highlights the role of organs during the production of speech: "There is no part of a human being which is specific all designed for talking. The parts of the body which produce the sounds of language are incidentally useful for this purpose, but they all have other duties to perform which from the biological point of view are older and more important-duties connected, for instance, with breathing, chewing, swallowing, smelling, and other such activities. These duties are the primary functions of the organs used for speech. 'Physiologically', speech is an overlaid function, or, to be more precise, a group of overlaid functions.".

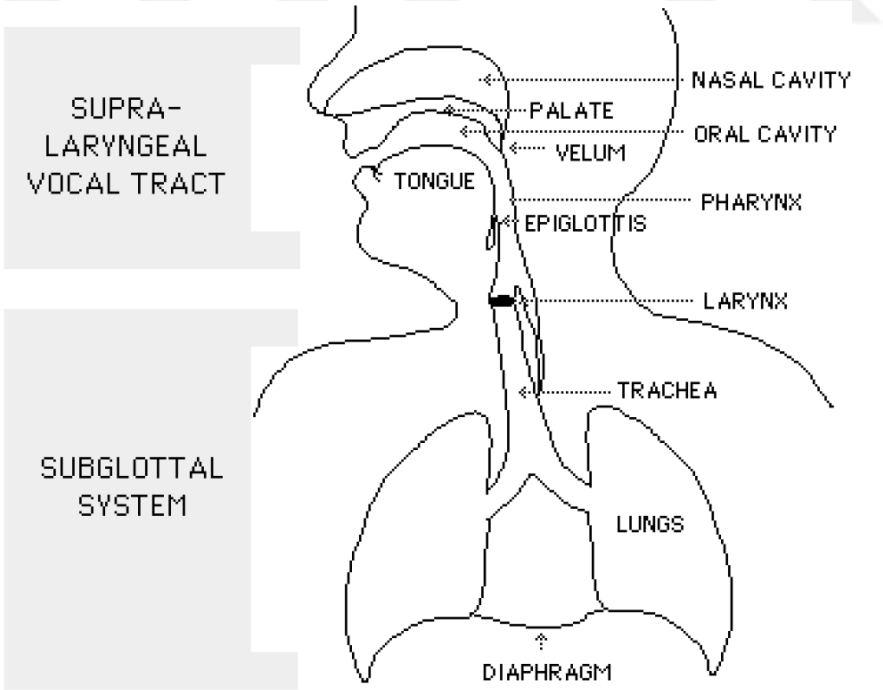


Figure 2.1. Schematic representations of the human speech production system, showing the major organs of speech (Houkema, 2001, p. 12).

The speech sounds are produced by air pressure resulted the vibration in the vocal cords. The air needed for this process is supplied by the lungs with the pressure produced by the diaphragm, the forced air moves off through trachea and pharynx. At the larynx, air pressure is utilized to vibrate the vocal cords and produce the sound for speech. Briefly, as a result of synchronical control and coordination of different parts of the vocal tract, the basic sound (phone) is transformed into speech.

Since speech consists of designated sequence of sounds, the speaker has to move the articulators in formulated plans. Regarding the number of muscles involved, speech production is seen as a significantly complex motor-control process. Radford (2009, p. 113) concludes that the complexity of this process can be realized when we become aware that we can and do adjust the rhythm, volume, and most importantly tone of our voice (intonation) in order to attain many nuances of meaning in our everyday speech.

2.1.2.2. Describing Speech Sounds

The study of phonetics focuses on describing speech. There are numerous motivations for wanting to do this, which corresponds to a wide variety of phoneticians. Some phoneticians are interested in various sounds that appear in different languages, or speech disorders, while others are attempting to teach individuals a specific dialect of English or to figure out how to get computers to understand speech or speak more clearly. Phoneticians need to understand what speakers do while speaking and how speech sounds can be defined for all of these reasons (Ladefoged & Johnson, 2011, p. 2).

Speech can be captured as an auditory signal or an articulatory score. It can either be transcribed in great detail (a narrow transcription) or less detail (broad transcription). In reality, it can be transcribed using only the contrastive qualities of the language being described or by using abstract symbols that represent contrastive units. The finer-grained range of representations are phonetic representations, while the latter style of representation is what is known as a phonemic representation (Mortensen et al., 2020, p. 1).

2.1.2.2.1. Distinctive Features

Speech sounds –specifically the phonemes– are defined or characterized by linguists within different principles and approaches. Each of theoretical approaches developed are subject to discussions and critical examinations.

One popular approach is distinctive feature analysis, which is based on the idea that phonemes should be viewed as combinations of multiple features rather than as isolated and indivisible units (Roach, 2009, p. 102). This approach defines the features to classify the phonemes and the phonemes are evaluated regarding their articulative features. Each feature is given binary values as + or – out of the matters of degree, such as degree of aspiration or degree of fronting vowels etc. Figure 2.2 can be given as an example:

	d	b	g	t	s	z	n
alveolar	+	−	−	+	+	+	+
bilabial	−	+	−	−	−	−	−
velar	−	−	+	−	−	−	−
lenis	+	+	+	−	−	+	(+)*
plosive	+	+	+	+	−	−	−
fricative	−	−	−	−	+	+	−
nasal	−	−	−	−	−	−	+

* Since there is no fortis/lenis contrast among nasals this could be left blank.

Figure 2.2. Distinctive Feature Analysis for Some Phonemes (Roach, 2009, p. 103).

In this binary system, each phoneme has its own combination of feature values. Therefore, if two sounds are represented by the same + and – values, it will be impossible to say that they are different phonemes. And vice versa, if two sounds are not represented by exactly the same + and – values, then it will not be possible to say that they are different phonemes; they are distinct phonemes separated from one another by one or more distinctive feature.

Indicating the fact that each of these oppositions has a unique quality that distinguishes it from the others within a given language, Jacobson et al. (1952, p. 3) claims that the decision between two opposites is referred to as a distinctive feature. Because none of the distinguishing traits can be broken down into smaller linguistic components, they are the ultimate distinctive entities of language. A phoneme is formed by the combination of various features into a single simultaneous bundle.

Chomsky and Halle (1968, p. 65) indicate that all features are strictly binary only in their classificatory function, and only in their phonetic function do they have a physical interpretation. The distinguishing properties play a part in the comprehensive specification of a lexical entry as classificatory devices (along with syntactic and semantic features and idiosyncratic classifications of various sorts that determine the behaviour of a lexical entry with respect to the rules of the grammar).

Gussenhoven and Jacobs (2017, p. 75) concludes that natural classes that can be identified in various languages can be captured by distinctive features. They contain the theoretical premise that distributional generalizations and phonological processes organize the segments to which they apply into groups that share some feature or feature combination. This shows that phonetic processes that may initially affect single segments in one generation become concentrated on a group of segments determined by some feature specification in the following generation.

2.1.2.2.2. Consonants and Consonantal Features

During the production of speech, the lungs expel air while vocal cords produce a sound which is transformed by the resonances of oral, pharyngeal and nasal cavities. Depending on the position of the larynx, velum, tongue, lips and jaw, various forms of these cavities are formed providing different resonance qualities, allowing different vocal sounds (phones) to be produced and interpreted accordingly.

Briefly, consonants are known as the sounds with various types of constriction in different locations in the vocal tract.

Hayes (2009, p. 6) points out the commonsense distinction of consonants and vowels for phonetics and phonology as generally valid; stating that vowels are highly sonorous sounds made with a relatively open vocal tract while consonants involve some kind of constriction(s) in the vocal tract: "They are quieter than vowels, and often are detectable by the ear not so much by their own sound as by the transitional acoustic events that occur at the boundaries of consonants and vowels.".

Mainly, consonants are classified due to three features: voicing, place of articulation and manner of articulation.

Regarding the feature theory, classification of consonants is based on three fundamental features, which are voice, place and manner.

Voice feature: [+/-voice] distinguishes the consonants that are connected to vibrating vocal cords from the ones that are not. [+voi] sounds are produced with the vibration of the vocal cords, while [+voi] sounds are produced with vocal cords at rest.

Place features: [+/-coronal] refers to the place of the segment related to the front of the tongue such as dentals, alveolars and palatals. [+cor] are sounds that the tip of the tongue raised during articulation, [-cor] are the ones those do not involve the tongue tip during articulation.

[+/-anterior] refers to the place of the segment related to the front of the mouth such as dentals, labials and alveolars. [+ant] are sounds that are produced in front of the alveolar ridge, [-ant] are the ones those produced back in the oral cavity.

Manner features: [+/-continuant] refers to continuity or the airflow in the oral cavity. [+cont] are sounds that there is airflow during articulation, [-cont] are the ones the airflow is stopped in the oral cavity.

[+/-nasal] refers to the nasality. [+nas] are sound that are produced with the airflow through the nasal cavity with lowered velum, [-nas] are the ones without the airflow through the nasal cavity.

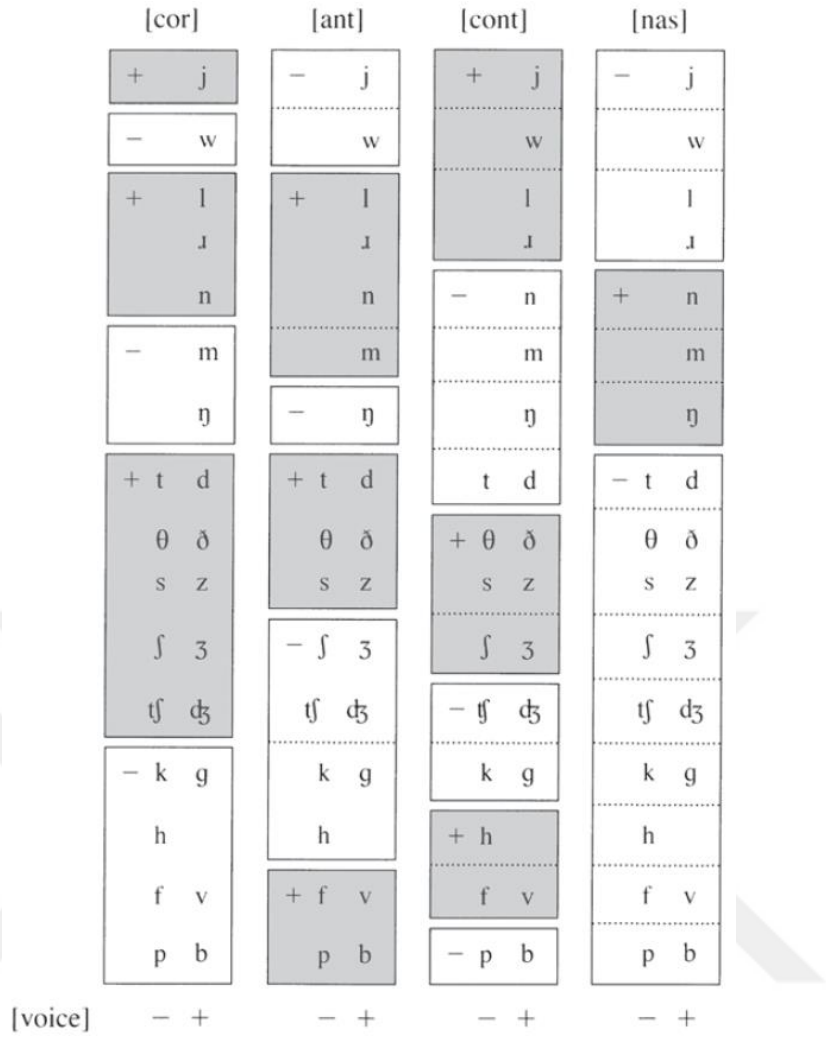
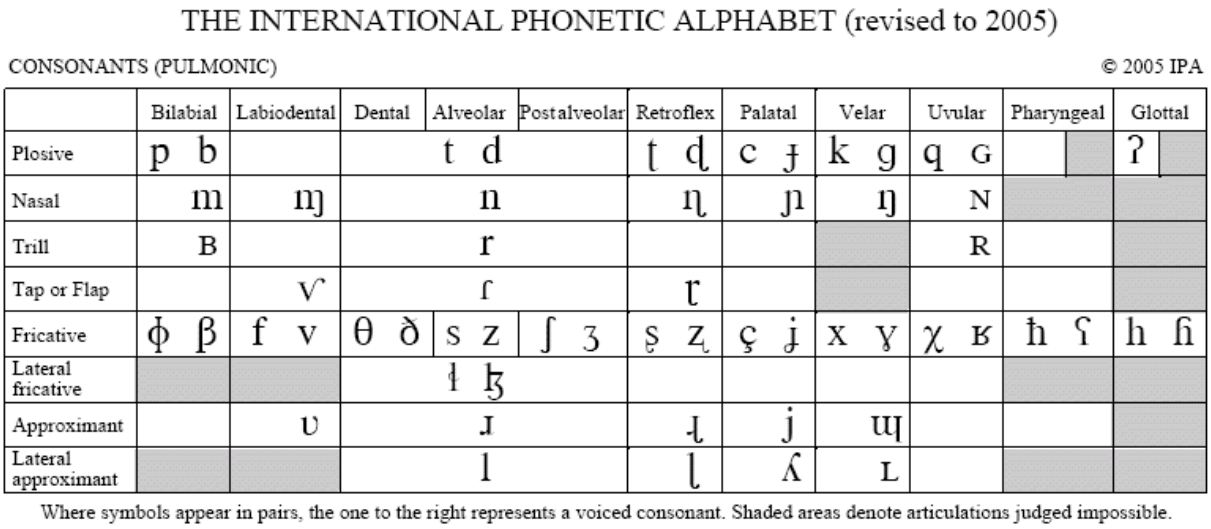


Figure 2.3. Manner Features Examples for Some Phonemes (Davenport & Hannahs, 2010, p. 100)

In International Phonetic Alphabet (IPA), which is mentioned in following sections, consonants are classified and shown in a chart regarding place of articulation and manner of articulation (See Figure 2.4).



THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

CONSONANTS (PULMONIC) © 2005 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Figure 2.4. Chart of Pulmonic Consonants within International Phonetic Alphabet (IPA) (Retrieved on 20.10.2022)

https://www.internationalphoneticassociation.org/content/ipa-pulmonic-consonants

2.1.2.2.3. Vowels and Vowel Features

The most common view is that vowels are the sounds in which the air flow passes from the larynx to the lips without obstruction. As a basic definition of "vowel", Maurer (2016, p. 1) states that if a vocal sound is perceived to belong to a particular linguistic unit (more precisely, a basic linguistic unit, a phoneme), and if the cavity formed by the pharynx and the mouth remains open, then the sound produced is referred to as a vowel sound and its linguistic identity as a vowel quality or simply as a vowel.

Vowels are distinguished from consonants by the absence of "places of articulation," or locations of substantial constriction in the vocal tract. Rather, the entire vocal tract serves as a resonating chamber. Changing the form of this chamber with movements of the tongue, jaw, and lips adds timbre to the basic sound generated by the vocal chords (Hayes, 2009, p. 12).

Regarding the feature theory, classification of vowels is based on three fundamental features, which are height (also open/close), backness, rounding and length. High vowels are distinguished from other sounds as [+/- high] regarding the position of the tongue in the oral cavity. [+ high] vowels are those which the tongue body is raised above its natural or namely neutral position. [- high] vowels are those which the tongue body is not raised. Low vowels are distinguished from other sounds as [+/- low] according to the position of the tongue. The body of tongue is lowered compared with its neutral position in [+ low] vowels, and in [- low] vowels the tongue is positioned without lowering.

Regarding the position of the tongue in the oral space, back vowels are separated from other sounds as [+/- back]. [+ back] vowels are those in which the tongue body is retracted from its natural or, more specifically, neutral position. Vowels with [- back] are those in which the tongue body is not

retracted. Front vowels are separated from other sounds by the position of the tongue as [+/- front]. In [+ front] vowels, the body of the tongue is fronted relative to its neutral position, whereas in [- front] vowels, the tongue is not fronted.

[+/- tense] can be utilized to differentiate between long and short vowels; [tense] is generally not regarded important for consonants. [+ tns] sounds involve significant muscle constriction ('tensing') of the tongue body in comparison to its neutral state. This constriction produces a longer and more peripheral sound, whereas [- tns] sounds produce a shorter and more centralised sound.

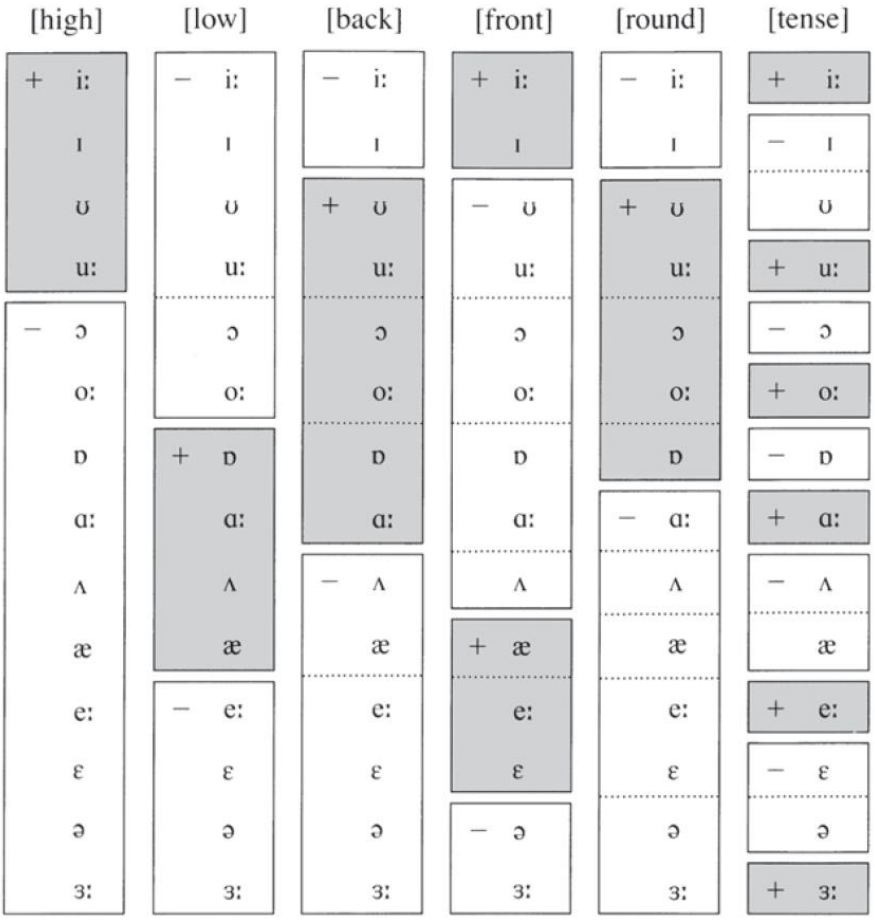


Figure 2.5. Vocalic Features Examples for Some Phonemes (Davenport & Hannahs, 2010, p. 107)

Hayes (2009, p. 83) indicates that relevant to vowel inventories, there are three more features:

• [long]: Classical Latin, for example, featured five contrasting long vowels and five contrasting short vowels. This characteristic also applies to consonants; [+ long] consonants are frequently referred to as geminates.

• [nasal]: This feature is also used in consonants, but it is used to distinguish nasalized vowels from non-nasalized vowels.

• [stress]: This appears to be dubious as a vowel feature.

On the classifying vowels through binary values, Davenport and Hannahs (2010, p. 111) concludes that using features allows us to capture such generalisations in a more informative way; rather than referring to natural classes in terms of the individual segments in the class, we can refer to the features that the segments share, allowing us to make more economical and elegant statements.

In International Phonetic Alphabet (IPA), which is mentioned in following section, vowels are classified and shown in a chart regarding their features (Figure 2.6).

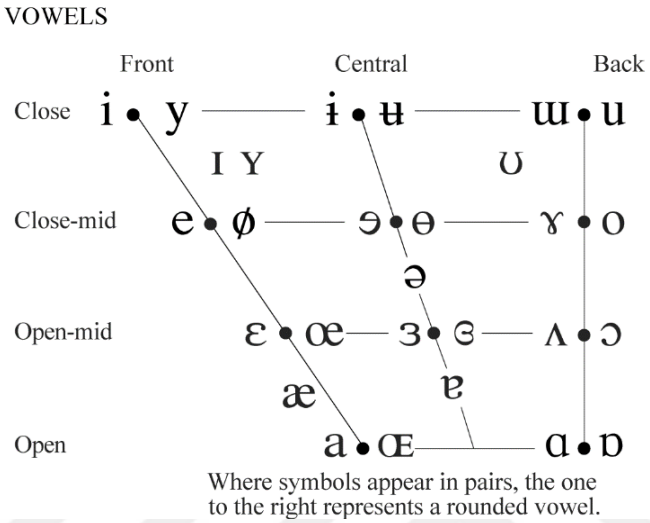


Figure 2.6. Vowel Chart within International Phonetic Alphabet (IPA) (Retrieved on 20.10.2022) https://www.internationalphoneticassociation.org/content/ipa-vowels

2.1.2.2.4. The IPA Chart

Traditionally, phonetic symbols are used to represent the pronunciation of words; any such representation is a phonetic transcription. The International Phonetic Association proposed the symbols that are used in this book (IPA). An individual speech sound, or segment, is represented by a phonetic symbol, which is specified independently of any language. Phonetic symbols may be complemented with diacritics, indications that describe specific pronunciation characteristics and are displayed above, below, or superscripted alongside the phonetic symbol (Gussenhoven & Jacobs, 2017, p. 17).

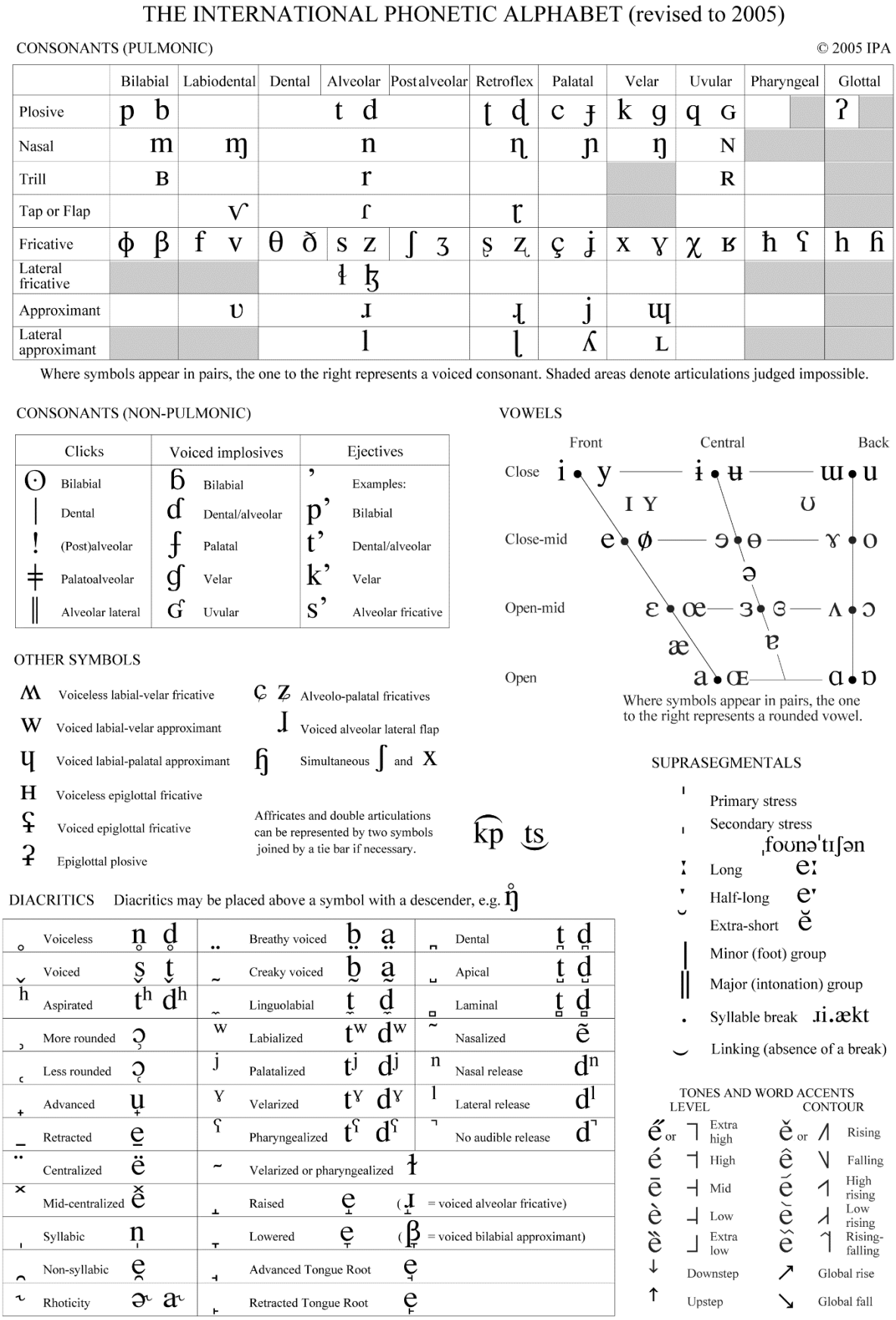


Figure 2.7. International Phonetic Alphabet (The IPA Chart) (Retrieved on 20.10.2022) https://www.internationalphoneticassociation.org/sites/default/files/IPA2005_3000px.png

2.1.3. Auditory Phonetics

Auditory phonetics is a distinct field of phonetics which investigates the perception of the speech sounds by the listener. Studies of auditory phonetics mainly focus on how the sounds are transmitted from the ear to the brain and how they are processed – and naturally on speech perception. Ball and Rahilly (1999, pp. 141-144) define auditory phonetics as the study of listening to, identifying, and differentiating sounds. It is the branch of phonetics that teaches listeners to concentrate on particular speech sounds, enables us to distinguish sounds that we are hearing, and enables us to hear differences between sounds.

2.1.3.1. Segmental Aspects

As Coxhead stated (2006, p. 1), speech consists of sequences of sounds. Syllables, words, phrases and sentences are formed by ordering the sounds in a certain order. When a normal speech act and the sounds produced by this action are analysed, it is seen that speech generally consists of continuous sounds within words and across word boundaries. Speakers of a language can perceive and make sense of this continuous sequence of sounds by dissecting them into words. Although it is relatively more difficult to split them into words, it is also possible to split the components that make up the words. These components, which are included in the sound sequence that make up the speech act, are defined as segment.

Major division made in phonology is explained as segmental and Suprasegmental (or non-segmental) by Crystal (2008). Segmental phonology analyses speech into discrete segments, such as phonemes; the segmental approach is seen as a set of representations which consist of a linear arrangement of segments (or unordered sets of features) and boundaries that are dependent on morphological and syntactic criteria.

Focusing on internal compositions and external interactions, segmental phonology deals with speech sounds – specifically segments – over features.

2.1.3.2. Suprasegmental Aspects

In phonetics and phonology, the term "suprasegmental" is used to refer to a vocal effect that affects sound segments in an utterance, such as a pitch, stress, or juncture pattern. It is regarded as one of the two major groups into which phonological classes can be separated, in contrast to "segmental". According to Crystal, (2008, p. 466) suprasegmentals were analysed as phonemes and sequences of such properties as morphemes in American structuralist theories, but not all phonologists describe these features in emic terms. Plurisegmental, non-segmental, and superfix are alternative terms for Suprasegmental.

Suprasegmental or non-segmental phonology focuses on the features of speech which extend over more than one segment, like intonation, prosody, rhythm, pitch, loudness, and vowel harmony.

2.1.4. Acoustic Phonetics

Acoustic phonetics mainly focuses on the physical processes of speech production, specifically the physical properties and linguistically relevant acoustic properties of speech sounds. Basically, studies on acoustic phonetics depends on phonetic measurements. The measurements on acoustic properties of speech contribute to better understanding of the actual process of spoken language.

An acoustic signal is created when the vocal organs move during speech production. This signal causes a pattern of disturbance to the air molecules in the airstream, which is spread outward in all directions before reaching the listener's ear. The field of acoustic phonetics aims to describe the various acoustic signals that the movement of the vocal folds produces in the creation of speech by male and female speakers across all age groups, in all languages, and in a variety of speaking situations and speaking styles (Harrington, 2010, p. 81).

Although judgment about the measurement of particular acoustic features is frequently required, acoustic analysis is regarded as more "objective" than perceptual analysis. Many acoustic measures enable quantification of differences between groups of speakers (for instance, speech impaired versus healthy controls) and of changes in vowel production over time (for example, due to disease progression or as a result of treatment) (Ciocca & Whitehill, 2013, p. 114).

2.1.4.1. Waveform, Amplitude and Frequency

From psychology to speech therapy, pronunciation training, and forensics, many specialties require knowledge of acoustic phonology. Recently, interactive images based on speech waveform analysis are used in a wide range of fields, as well as by language teachers for pronunciation analysis of foreign language learners. Periodic waveforms are forms in which an identifiable pattern repeats over time and we can count the repetitions. This pattern is based on the speaker's age, gender, etc. and is repeated at different average rates depending on the factors.

Waveforms display the pulses associated with each vocal cord vibration. Therefore, the matching waveform captures the differences in air pressure related to speech sounds along with other patterns apparent on a spectrogram. Voiced sounds consequently have greater patterns on the waveform than voiceless sounds. Since vowels and consonants are different from one another, measurements of different segments may be made rather precisely (Davenport & Hannahs, 2010, p. 60). When a recognizable pattern repeats over time and we can count the repetitions, the waveform is said to be periodic.

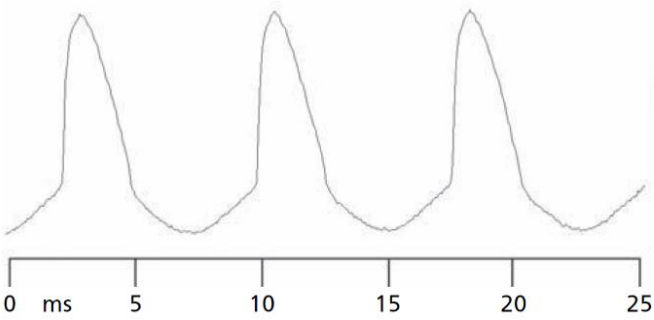


Figure 2.8. The Larynx Waveform for Normal Voice (Ashby, 2011, p. 20).

These repetitions can vary in two dimensions: frequency – how many times per second or per unit time and amplitude – how exaggerated the vertical motion is.

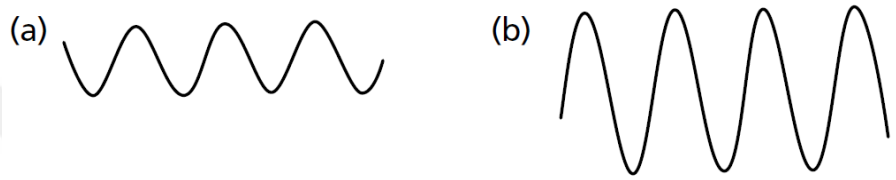


Figure 2.9. Waveforms of 200Hz (frequency) with Different Amplitudes – (a) Low Amplitude (b) Higher Amplitude (Ashby, 2011, p. 90).

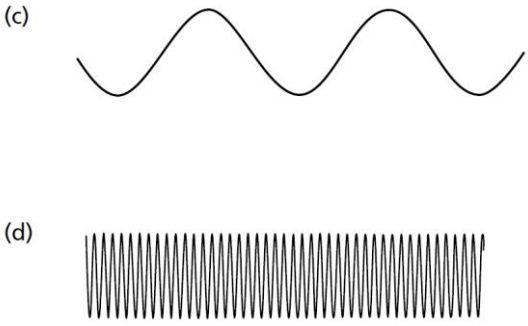


Figure 2.10. Waveforms of the Same Amplitude, Different Frequencies – (c) Low Frequency (d) Higher Frequency (Ashby, 2011, p. 90).

2.1.4.2. Spectrogram and Formants

When analysing speech sounds, another way to represent data is with amplitude/frequency spectra (a/f spectra). In this analysis, along with the intensity and frequency of the sound, energy peaks at certain frequencies are also displayed on spectrogram. These peaks form the defining characteristics of vowels and are known as formants. Each vowel has a different and unique formant pattern.

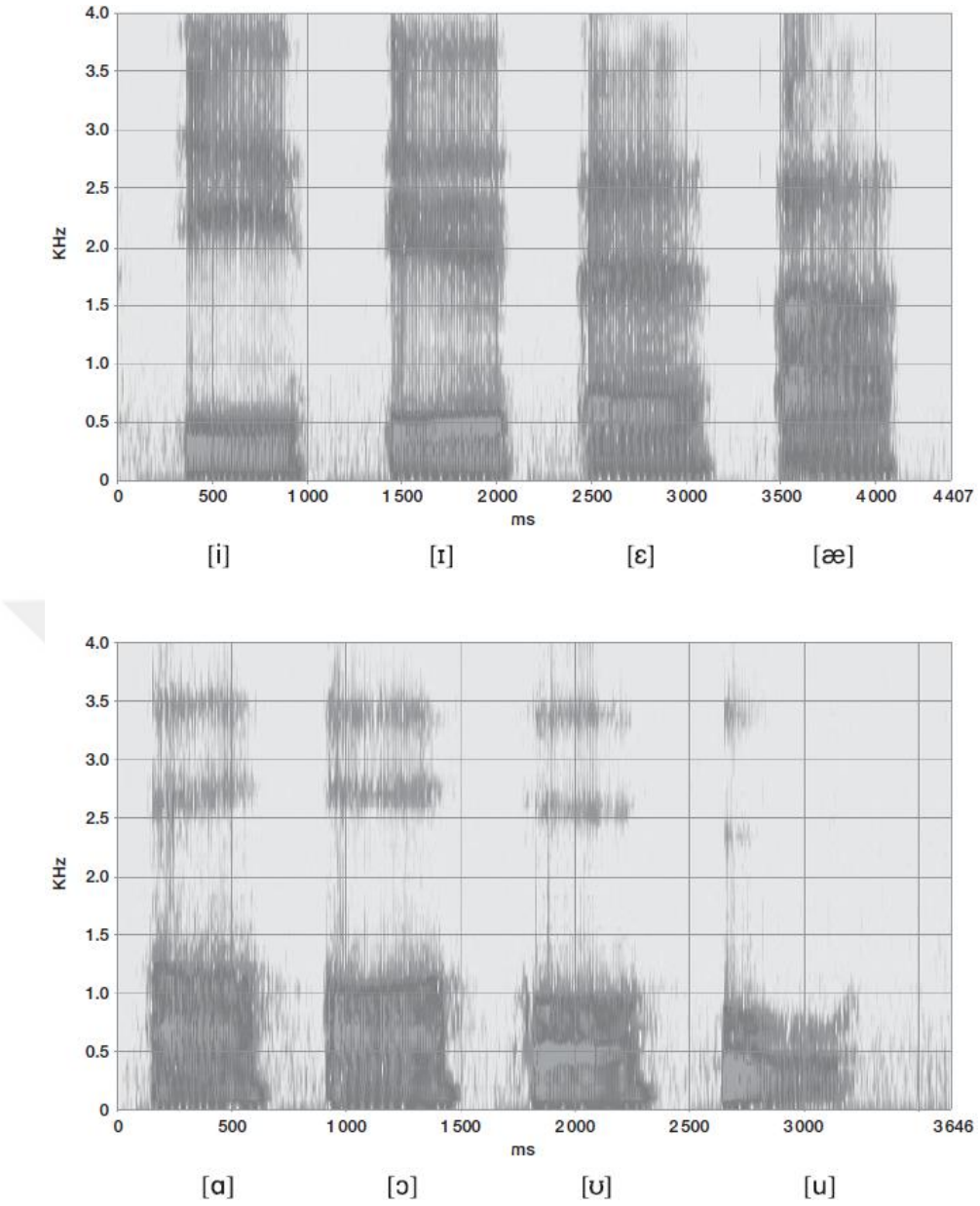


Figure 2.11. Spectrogram of Vowel Formants (Davenport & Hannahs, 2010, p. 63).

Vowel characterization in this study is based on the conventional use of first and second formant frequency measurements. Formant frequency values are correlated with the traditional phonological and phonetic dimensions of height and frontness/backness (Fant, 1960, p. 20).

Vowel height and F1 have a negative correlation, meaning that high vowels are associated with relatively low F1 values and low vowels with relatively high F1 values. Vowel front/backness is correlated with F2 frequency; front vowels are marked by relatively high F2 values, whereas back vowels are characterised by comparatively low F2 values.

2.1.4.3. Acoustic Vowel Space

Each vowel is traced using the centre frequencies of the first three formants. During these monophthongs, the formants are comparatively stable. The spectrogram also demonstrates that the first and second formant frequencies provide information about vowel differences.

Average F1, and F2 frequencies of vowels are used to define the "acoustic vowel space" (see Figure 2.12). As Johnson stated, the classic impressionistic vowel triangle and the acoustic vowel space are related. Vowel height is inversely associated with F1 frequency, with [high] vowels having low F1 and [low] vowels having high F1 (low frequencies are presented at the top of the F1 axis to highlight the relationship between impressionistic vowel height and F1 frequency). Likewise, vowel frontness and F2 are inversely associated; front vowels have high F2 while back vowels have low F2. These acoustic correlates of vowel features have been noticed for decades, and they became particularly clear with the invention of the sound spectrograph. Because of individual differences in vowel articulation, discrepancies between patterns of linguistic vowel "height" and "frontness" and measured tongue height and frontness during vowel production, and disparities between measured muscular tension and linguistic "tenseness," it has been theorized that the distinguishing characteristics of vowels are linked to these acoustic properties rather than to articulatory ones (Johnson, 2003, p. 113).

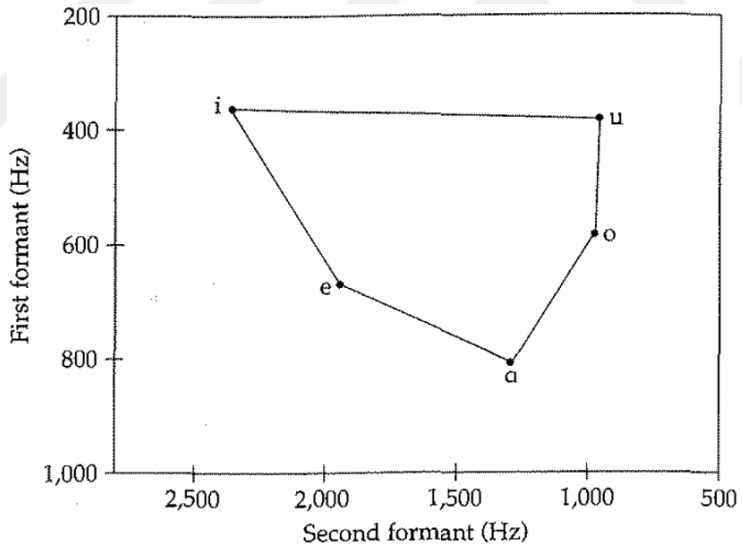


Figure 2.12. The Acoustic Vowel Space of the Plain Voiced Vowels of Jalapa Mazatec. Average of Four Male Speakers (Johnson, 2003, p. 115).

2.2. Second Language

In his book Second Language Learning and Language Teaching Cook (2008, p. 2) provides brief definitions of basic notions of first language and second language as follows:

first language: chronologically the first language that a child learns

second language: 'A language acquired by a person in addition to his mother tongue / native language' (UNESCO)

native speaker: a person who still speaks the language they learnt in childhood, often seen as monolingual

The author indicates the change in the approach to language learning/teaching especially in the last century, claiming that the "traditional" methods which based on grammatical explanation and translation of texts gave its place to priority of spoken language and the naturalness of language by using second language in the classroom rather than the first. Also, it is stated that L2 learning is more that the transfer of the first language. Before it can be decided how and when the first language is involved in the learning of the second, it is necessary to explore a number of L2 learning-related issues. Transfer from the first language does indeed turn out to be significant, frequently in unexpected ways, but rather than the first language taking the fall for everything that goes wrong when learning a second, its function needs to be demonstrated through carefully balanced research (Cook, 2008, p. 2,3).

In the further sections, Cook (2008, p. 558) indicates a crucial issue on the user's knowledge of their first language and their interlanguage in the second language. The overall knowledge that combines both is defined as multi-competence (See Figure 2.13). It was suggested that the poverty-of-the-stimulus argument of language acquisition is more about the child's multicompetence in learning one or more grammars than it is about how the child learns a grammar with a setting for each parameter.

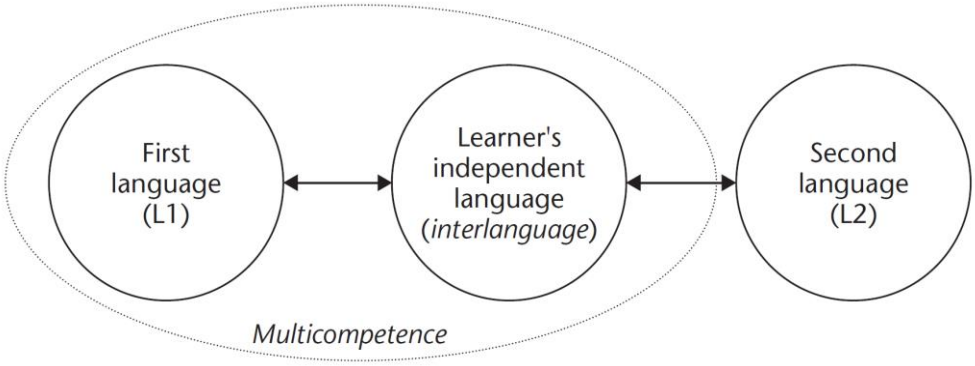


Figure 2.13. Multi-competence (Cook, 2008, p. 15).

On the competences of first and second languages, Watson states that studies on older children and adults reveal that bilinguals behave in ways that are both different from and quite similar to those of monolinguals in terms of production and perception. Within roughly the same bounds, bilinguals adjust the same variables in the creation of both of their languages as do monolinguals, but within these bounds, the specifics of their use of these variables may vary. They may employ acoustic cues to phonemic identity differently in their perception, but it may be more that they give those indicators various weights than that they actually use distinct cues. There does appear to be a discrepancy between bilinguals' production and perception patterns that is absent in monolinguals (Watson, 1991, p. 44).

The phonetic interference of languages is open to discussion. According to Flege (1981, p. 125), if distinguishing characteristics are "commutable," or transferable from sound to sound, then a foreign

language speech sound that fills a "hole in the pattern" of the phonemic inventory of the local language should be simple to acquire. Second, even if the more abstract phonological components that define a sound have been properly mixed, interference may still take place at the level of segmental phonetic features. If just some allophones of a novel foreign language phoneme were mispronounced by language learners, evidence for the existence of this type of interference would be present. Third, there may be interference due to linguistic variations in how a feature is implemented phonetically.

2.2.1. Acquisition and Learning

Language learning and language acquisition are regarded as two distinct processes by the linguists. Basically, language learning refers to the formal process of learning a language in a systematical way with particular teaching/learning techniques or programme within a learning environment set up. Language acquisition is a natural process of language learning -generally of a child- without a regular system or environment set up, by exposition of natural language input; it is considered as "unconscious learning" by most linguists and methodologists.

The distinction of language acquisition and learning is expressed by Shaul (2014, p. 24) as "Language Learning refers to learning about a language, its sound system, its structure. It is largely an intellectual exercise. Language acquisition means somehow absorbing a target language's sound system and structure, ideally without ever thinking explicitly about the language's actual structure".

"Children do not wake up one morning with a fully formed grammar in their heads. In moving from first words to adult competence children pass through linguistic stages. They begin by babbling, they then acquire their first words, and in just a few months they begin to put words together into sentences" (Fromkin et al., 2014, p. 398).

One of the most significant issues of the L2 learners is addition and adaptation of phonetic categories in speech production competences. This process is naturally resulted with the phenomenon of "accent" or "non-native speech". Flege and Strange (1995, p. 233) state that the speech of non-native English speakers frequently carries foreign accents. Listeners pick up on foreign accents when they hear phonetic differences from English norms along a variety of segmental and suprasegmental (i.e., prosodic) dimensions. For speakers who are not natural English speakers, foreign accents may have a variety of negative effects. Particularly under less-than-optimal listening circumstances, they could make it challenging for non-native speakers to grasp.

2.2.2. Accent, Accentedness and Intelligibility

In second language learning, pronunciation differences in the target language are mostly discussed through the concepts of "accent" and "intelligibility".

According to Thomson (2018, p. 2), while communicating meaning when speaking in an L2 with a foreign accent is not always deleterious; some pronunciation qualities that are not similar to the target language can be challenging. Therefore, the primary goal of pronunciation instruction should be

to make sure that students can be understandable. But being accent-free is not a requirement for being understandable.

On the other hand, claiming the accent as a dynamic aspect of linguistic fluency, Moyer states that in terms of simply linguistic content, accent conveys semantic information; at the discourse level, it regulates the conversation and communicates our objectives; socially and psychologically, it places the speaker in terms of group membership and immediately establishes individual identity and stance. These complications are reflected in the definition that follows:

Accent is a set of dynamic segmental and suprasegmental habits that convey linguistic meaning along with social and situational affiliation (Moyer, 2013, p. 11).

Since this definition covers the issues of both native and non-native speakers, the author then focuses on the attitudes toward non-native accents regarding L1-L2 phonological contrasts based on segments, syllable structure and prosody. It is concluded that late language learners are bound to draw comparisons between L2 and L, and perception of slight differences in quality can be difficult. The learners must acquire a new sound category and apply it to an unexpected linguistic environment. In addition to segmental issues, as Kang states (2010, p. 313), suprasegmentals (overall pitch range, speech rate, etc.) enhance instructional speech and affect perceptions of accentedness.

Accentedness is defined by Derwing (2012, p. 1) as "a rating of the degree of difference between an L2 speaker's productions and the local variety of the language in question" and as "how different a pattern of speech sounds compared to the local variety" by Derwing and Munro (2009, p. 478). Here, the matter of the assessing the degree of accent is mentioned. Some researchers asked listeners to assess the degree of accent using rating scales, which aroused the concepts of "judgment" and intelligibility. Major (2013, p. 1) states that by various means the degree of foreign accent can be measured; the most typical of these is when listeners categorize speakers as native or non-native or rate them on a scale of "no foreign accent" to "very heavy foreign accent.".

Munro and Derwing (1995, p. 76) defined intelligibility as "the extent to which a speaker's message is actually understood by a listener".

The native speakers' perception of intelligibility, namely comprehensibility, is another factor and it refers to judgments on a rating scale of how difficult or easy an utterance (or given speech sample) is to understand.

Smith and Nelson (1985, p. 334) suggest specific definitions for the terms "intelligibility", "comprehensibility" and "interpretability" as follows:

intelligibility: word/utterance recognition,

comprehensibility: word/utterance meaning (locutionary force),

interpretability: meaning behind word/utterance (illocutionary force)

Indicating the most obvious basis of a foreign accent as mispronunciations that lead to the perception of segmental sound substitution, Flege (1981, p. 445) states that the perception of a foreign accent results from differences in pronunciation between native speakers and non-native speakers. The author emphasizes the language-specific phonetic characteristics that must be acquired to sound like native speaker, and he points out the many phonetic differences that distinguish two languages as a potential source of foreign accent.

Kenworhty (1987, p. 16) mentions the attitudes of L2 learners facing the new set of sounds existing the target language. For the majority of the learners, perhaps, the most basic tendency is using the sounds of their own language to speak English as an unconscious strategy.

In his research, Uzun (2022, p. 82) highlights the effect of orthography in intelligibility. Indicating the high degree of sound-letter correspondence in Turkish, the researcher mentions the difficulty that Turkish talkers have with English vowels which possibly relates to the indirect nature of sound-spelling correspondence and orthography in English.

Deterding and Mohamad (2016, p. 305) focus on the role of vowel quality in maintaining intelligibility in ELF interactions. The authors conclude that vowel quality is not the sole factor in causing misunderstanding though when shifts in quality are combined with variation in length, it is possible that this may cause more misunderstandings to occur.

The vowel quality factor on ELF intelligibility was also researched by O'Neal (2015, p. 355). The researcher investigated whether vowel quality is critical to the maintenance of mutual intelligibility in ELF interactions among Japanese undergraduate students and non-Japanese exchange students. The study utilizes the conversation analysis methodology by examining segmental repair sequences, and reveals two important things: "(i) several vowel qualities can be critical to the maintenance of mutual intelligibility among the ELF speakers in the examples. (ii) the way in which vowel quality was repaired in these extracts reveals which aspects of vowel quality are most significant for the ELF speakers in the examples".

The issues of accent, intelligibility and comprehensibility are remarkably connected to the interaction between the native and second language phonetic subsystems by linguists. Research by Flege et al. (2003, p. 488) examined Italian-English bilinguals' production of 11 English vowels. The findings of the study were interpreted as providing evidence in favour of the hypothesis that bilinguals' L1 and L2 phonetic subsystems interact through the two separate processes of phonetic category assimilation and phonetic category dissimilation.

On the sound structure of L2, Flege (1987, p. 62) claims that languages range in terms of both the number of contrastive sound units they have and the articulatory realization of those units. The phones in an L2 can be classified acoustically as "new," "similar," or "identical" from the perspective of an L1. This identification of L2 phones by L2 learners is traditionally used to explain the learners'

difficulty in pronouncing L2 phones which did not occur on the phonetic surface of L1. The findings of the study showed that adults can modify their previously established articulation patterns when producing similar L2 phones as well as learn to produce new phones in an L2. They seem to classify acoustically dissimilar phones in L1 and L2 as belonging to the same category as a result of the mechanism of equivalence classification. This may ultimately prevent them from producing authentically similar but new phones.

2.3. Optimality Theory

It is almost out of discussion that the L2 learner's perception of the target language's speech sounds, particularly those who learned it later in life, is influenced by how they perceive speech sounds in their L1. There has been a lot of research done to try and figure out how much the L1 phonological system affects learning the L2 sound system. The acquisition of the L2 is considered somehow different from that of the L1, and explanation is needed for L2 acquisition processes "how" universal grammar operates in L2 acquisition.

The second language learner approaches the task of acquisition already knowing a language, which is one such factor that sets second language acquisition apart from first language acquisition. The majority of current theories of L2 acquisition do in fact presuppose that the learner's native language contributes to acquisition, though it is less clear how. The research by Brown (1998, pp. 137-187) offers evidence that L2 learners can successfully acquire UG-determined properties of the target language; L2 learners are able to acquire a contrast if they are able to auditorily perceive one that is absent in their L1. This suggests that the mechanism for creating novel segmental representations, which is arguably a component of UG, is still active during L2 acquisition.

On the sound system of second language, significant amount of the studies focused on production data. Thereafter, the consideration based on perceptual difficulty raised in phonetics, particularly on the "perception" of the phones of the target language in order to interpret how learners develop the ability to change their perception of the acoustic cues when learning the L2 sound system.

One of the models on perception grammars is *Linguistic Perception* (LP) model, first used by Paola Escudero (2005) is illustrated in Figure 2.14.

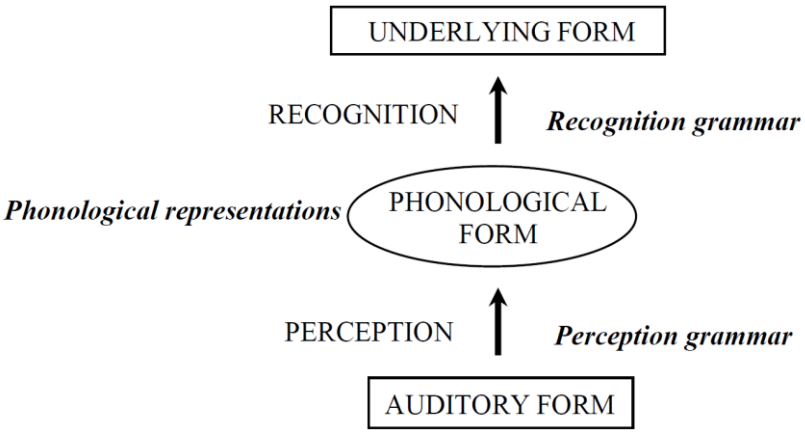


Figure 2.14. A model for speech comprehension composed of two sequential mappings, perception and recognition, and three representations, auditory, phonological and underlying forms (Escudero, 2009, p. 5).

Two major assumptions are made by the LP model. The first is the assumption that speech comprehension is a two-step process with two mappings, namely speech perception and speech recognition. Second, it makes the assumption that speech perception is a bottom-up, pre-lexical process. The model takes into account the notion that linguistic grammars are in charge of processing both speech perception and recognition.

Another model by Best (1991, p. 14), namely *Perceptual Assimilation Model*, offers predictions with such a small number of L1 categories the options for nonnative speakers: (1) to conflate both sounds (single-category assimilation), (2) to map phonemes onto two different native phonemes (two-category assimilation), or (3) to perceive non-native pair to a single native category, but one be more similar than the other to the native phoneme (category-goodness assimilation) (Figure 2.15).

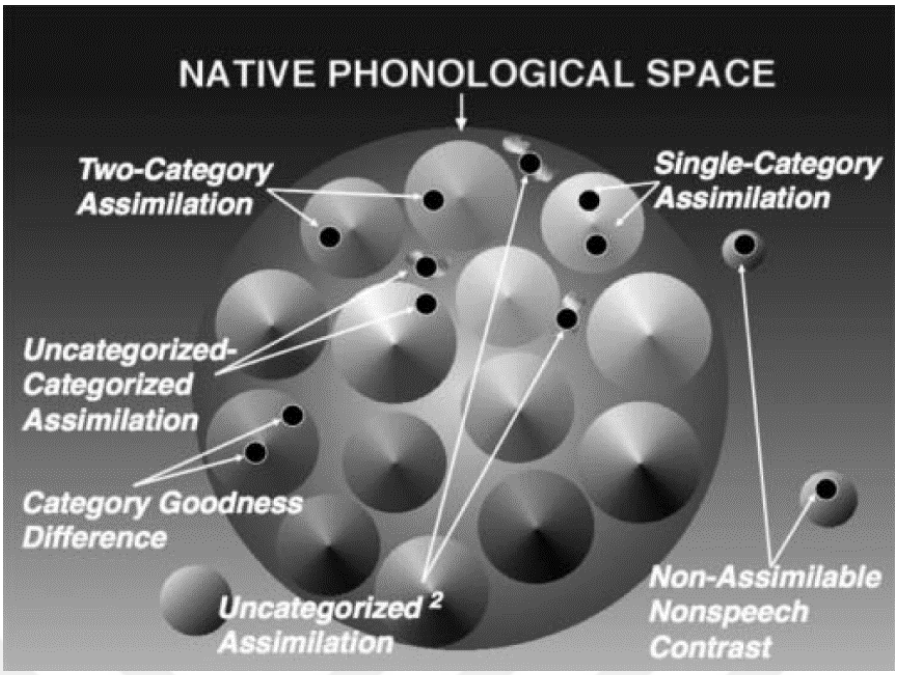


Figure 2.15. Schematic Diagram of the Perceptual Assimilation Model (Best et al., 2016, p. 218).

Apart from any other models offered to interpret phonological structures, *Optimality Theory* (OT), a theory of linguistics which focuses on universals rather than language-specific issues, proposes a universal grammar for phonology (Prince & Smolensky, 2004). The principal empirical questions addressed by OT, as by other theories of universal grammar, concern the characterization of linguistic forms in and across languages (Prince & Smolensky, 1997, p. 1606). OT evolves in the context of particular empirical theses regarding the structure of phonological systems: (i) the role of output targets, (ii) intrinsic relation between change and conditions of change, (iii) universality and difference.

Archangeli (1999, p. 532) reflects the core of the Optimality Theory (OT): "At the heart of OT is the idea of universal constraints, which are nevertheless violable. By being universal, the constraints themselves provide an explicit means of characterizing the cross-linguistic similarities that exist. By being violable, there is a means of expressing language variation: the degrees of violation tolerated for each constraint are unique to each language. OT proposes a single means of expressing which constraints are violable, namely constraint ranking violations of lower-ranked constraints are tolerated in order to satisfy higher-ranked constraints".

OT describes linguistic systems in terms of constraints that limit the possible forms of a language. The kinds of linguistic representation that these constraints assess, as well as many times the constraints themselves, come from earlier Generative Linguistics (GL) work. Contrary to most versions of GL, OT has formal mechanisms for dealing with conflicting constraints. A ranking of constraints is used in OT to select between linguistic representations. When two constraints have preferences that conflict, the result is determined by the constraint with the higher ranking (Pater, 2009, p. 1000).

As Pater indicates, the basis of OT is the concept of constraint interaction, which is conceptually straightforward but surprisingly rich because it allows for the designation of one constraint's satisfaction as having absolute priority over another. A grammar resolves conflicts by ranking constraints in a rigid hierarchy of domination. Over all other constraints higher in the hierarchy, each constraint has absolute priority. Two basic constraints appear in the theory:

(a) *Markedness constraints*: Markedness constraints require that output forms meet some criterion of structural well-formedness.

(b) *Faithfullness constraints*: Faithfulness constraints require that outputs preserve the properties of their basic (lexical) forms, requiring some kind of similarity between the output and its input.

Only evaluating output representations, markedness constraints penalize them for the existence of specific configurations, while faithfulness constraints assess how input and output forms relate to one another and require that the input be precisely replicated along a specified structural dimension.

On the conflict of constraints, Kager (2004, p. 8) states that no unitary or monolithic faithfulness or markedness forces are recognized by the Optimality Theory; instead, the picture is more shattered. The overall struggle between the two "forces" takes the form of more intricate interactions between specific constraints in the grammars of various languages. When individual constraints compete at this level, languages resolve conflicts between "markedness" and "faithfulness" in a variety of ways. With regard to some opposition, a language might place a higher value on faithfulness than markedness, but it might flip those priorities for another opposition.

OT is composed of these three basic foundations:

GEN: The generator (GEN) creates a list of potential outcomes, or candidates, from an input.

All linguistic operations are applied by GEN freely, optionally, and occasionally repeatedly. For two reasons, it is assumed that GEN has the characteristic known as freedom of analysis. The definition of GEN is firstly easier with freedom of analysis than without it. Limits on epenthesis should not complicate GEN since EVAL already imposes limits on epenthesis. Second, the related assumption that GEN is universal necessitates the freedom of analysis of GEN. Because GEN is the same across all languages, it must effectively foresee every possible transformation that a given input could undergo, making sure that each of these possibilities is included in the candidate set. The most straightforward way to accomplish this is to give GEN access to specific operations and let them apply freely, over-generating rather than undergenerating the required range of candidates. Once more, overgeneration by GEN does not equate to overgeneration by grammar because EVAL filters GEN's output (McCarthy, 2007, p. 4).

EVAL: Based on the constraints, the evaluator (EVAL) selects the best candidate, and this candidate is the output.

The most harmonic or optimal member of the candidate set is chosen by EVAL as the grammar's output after it has evaluated the candidate set using some sort of constraint hierarchy. Assume that the candidate set is composed of the constraints {cand1, cand2, cand3} and that the hierarchy consists of the constraints C1, C2, and C3, in that order. The best candidate is cand2 if it violates top-ranked C1 less frequently than both cand1 and cand3 do. On the other hand, if cand1 and cand2 both violate C1 equally and if they do so to a lesser extent than cand3 does, then cand3 is eliminated and the choice between cand1 and cand2 goes to C2, and so on.

/input/	C_1	C_2	C_3	C_4
☞ (a) $cand_1$			*	*
(b) $cand_2$			*	* *!
(c) $cand_3$		*!		*
(d) $cand_4$	*!			

Figure 2.16. A "Classic" tableau (De Lacy, 2007, p. 11).

According to the hierarchy of constraints [C1 >> C2 >> C3] (for >>, read "dominates"), satisfying C1 is categorically more important than satisfying C2, and satisfying C2 is categorically more important than satisfying C3. Only insofar as they choose between candidates who tie for the best C1 performance, the preferences C2 expresses have any real value. In other words, OT constraints are organized according to strict-domination hierarchies, where better performance on lower-ranking constraints can never defeat worse performance on higher-ranking constraints. OT constraints are violable, in contrast to the inviolable filters of the various pre-OT phonological constraints.

/input/	C_1	C_2	C_3	C_4
$winner \sim cand_2$				W
$winner \sim cand_3$		W	L	
$winner \sim cand_4$	W		L	L

Figure 2.17. A comparative tableau (De Lacy, 2007, p. 12).

Each language has a different ranking of constraints. The most compelling argument is that GEN, EVAL, and even the constraints themselves are universal, leaving constraint ranking as the only aspect of the grammar that is language-specific. CON stands for the universal constraint component. The constraints in CON are all present in the grammars of all languages if the ranking of universal CON is the only distinction between them. The only distinction is the ranking (McCarthy, 2007, p. 5).

CON: Using strictly ranked violable constraints, the constraint component (CON) provides the criteria for selecting candidates.

CON is made up of two different kinds of constraints. Constraints on markedness resemble the surface-structure constraints or filters from the 1970s. It is a substantive theory of linguistic well-

formedness to list the markedness constraints in CON. The idea of a faithfulness constraint is a noteworthy innovation in the OT. The output of the grammar must resemble its input because faithfulness constraints are by nature conservative. Since faithfulness constraints oppose changes to input structures, markedness constraints frequently conflict with them because they favour some linguistic structures over others. This conflict is referred to as a constraint, and in OT, ranking is used to resolve it. Conflict between two faithfulness or two markedness constraints is also possible (McCarthy, 2007, p. 5).

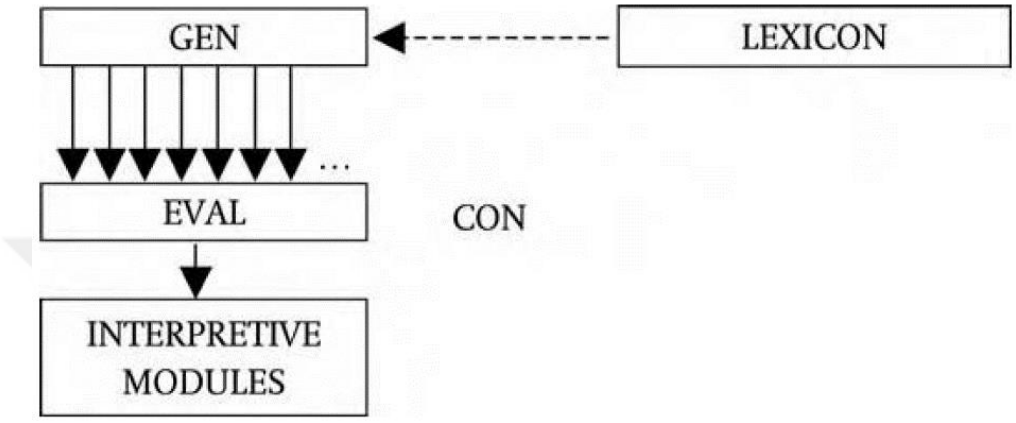


Figure 2.18. Optimality Theory architecture (De Lacy, 2007, p. 9).

The meaning of "optimal" is explained by Prince (2007, p. 34) as "Optimality is composite: the judgment of hierarchy is constructed from the judgment of individual constraints. Proceeding from local to global, definition begins with the 'better than' relation over a single constraint, proceeds to 'better than' over a constraint hierarchy, and then gets optimality out of those relations".

On the input-output transformation process, Zuraw (2003, p. 819) indicates the competition of candidates: Rule-based frameworks apply transformations to lexical entries in a sequential manner to account for linguistic patterns. An explanation for the difference between how the English plural suffix is pronounced in [s] cats and [z] dogs is that the suffix is devoiced after voiceless consonants (like[t]). The rule transforms the input cat + /z/, which was put together from words in the speaker's mental dictionary, into the output cat/s/. In OT the output is determined by competition with other candidates: a constraint that adjacent consonants match in voicing favours cat[s] over cat[z].

2.4. Previous Studies

2.4.1. Acoustic Studies on Vowels of English

Acoustic studies on the sounds of languages provide contribution to a better understanding on structure of speech sounds by means of measured/measurable parameters obtained from acoustic analysis. The parameters allow phoneticians use the data collected in order to calculate mean values and make inferences on specific focus areas, highlight the distribution of variables such as gender, age, language-specific characteristics, or any other issues that are examined. Using the acoustic data,

researchers can make representation of sounds – mostly vowels – and can create charts, schemas, or diagrams to visualize outcomes obtained from numeric values. By plotting the vowels on a vowel chart, they allow anyone who is acquainted with vowel charts to determine the quality of the vowels they are describing by simply observing where the points are.

Vowels of English were acoustically examined by a number of researchers in order to define them in terms of vowel features and vowel quality. The results of previous studies form a basis for other researches and as reference values they allow them to make comparisons, evaluations, or judgments. The researchers occasionally use the acoustic data to compare accents of English, or to compare vowels of English with vowels of other languages.

The study "Control Methods Used in a Study of the Vowels" by Peterson and Barney (1952, p. 184) illustrated results of tests involving 76 speakers and indicates average fundamental frequencies of vowels. In the experiment, a list of words was provided to the participants, and utterances of the words were recorded. The word list contained ten monosyllabic words each beginning with [h] and ending with [d]. The words used were "*heed*", "*hid*", "*head*", "*had*", "*hod*", "*hawed*", "*hood*", "*who'd*", "*hud*", and "*heard*". The researchers highlighted a conclusion that an individual's ability to produce and recognise vowel sounds is dependent on his or her prior language experience, according to an analysis of the data.

		i	ɪ	ɛ	æ	ɑ	ɔ	ʊ	u	ʌ	ɝ
Fundamental frequencies (cps)	*M*	136	135	130	127	124	129	137	141	130	133
	W	235	232	223	210	212	216	232	231	221	218
	Ch	272	269	260	251	256	263	276	274	261	261
Formant frequencies (cps)											
F_1	*M*	270	390	530	660	730	570	440	300	640	490
	W	310	430	610	860	850	590	470	370	760	500
	Ch	370	530	690	1010	1030	680	560	430	850	560
F_2	*M*	2290	1990	1840	1720	1090	840	1020	870	1190	1350
	W	2790	2480	2330	2050	1220	920	1160	950	1400	1640
	Ch	3200	2730	2610	2320	1370	1060	1410	1170	1590	1820
F_3	*M*	3010	2550	2480	2410	2440	2410	2240	2240	2390	1690
	W	3310	3070	2990	2850	2810	2710	2680	2670	2780	1960
	Ch	3730	3600	3570	3320	3170	3180	3310	3260	3360	2160
Formant amplitudes (db)	L_1	−4	−3	−2	−1	−1	0	−1	−3	−1	−5
	L_2	−24	−23	−17	−12	−5	−7	−12	−19	−10	−15
	L_3	−28	−27	−24	−22	−28	−34	−34	−43	−27	−20

Figure 2.19. Averages of fundamental frequencies and formant amplitudes of vowels by 76 speakers (Peterson & Barney, 1952, p. 183).

In their book "A Course in Phonetics" Ladefoged and Johnson (2011, pp. 225-226) shared the first two formants of a group of university students in California (Figure 2.20) and also of a number of participants from northern cities in the United States, such as Pittsburgh and Detroit (Figure 2.21). The vowels in *cot* and *caught* do not contrast in this accent – they are both [ɑ]. It is evident that younger Californians pronounce [eɪ] with a higher vowel (lower first formant) than [ɪ]. Because of their higher second formant, the high back vowels appear more frontal. This is mostly an unrounding issue when it comes to the vowel [ʊ], like in *good*.

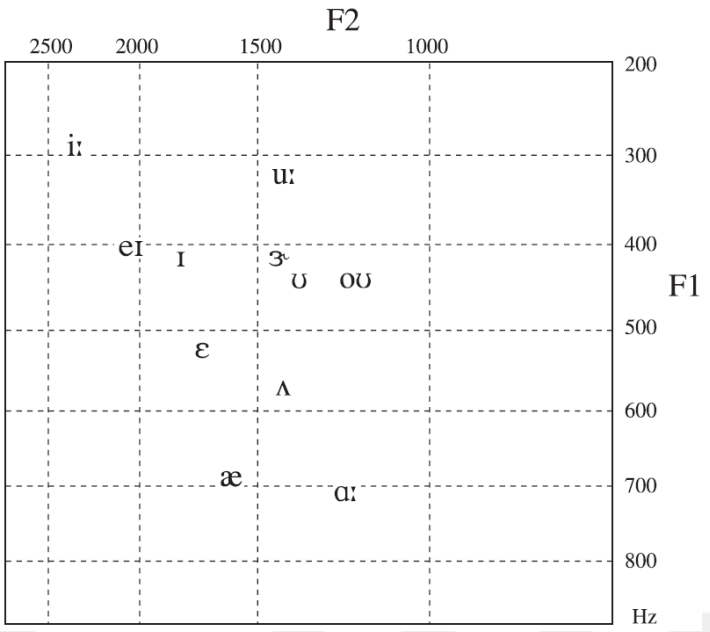


Figure 2.20. A plot of the first two formants of the vowels of a group of Californian English speakers (Ladefoged & Johnson, 2011, p. 225).

The study reflects first and second formant values of vowels that are obtained from speaker groups from Californian English, northers cities English and BBC English.

Indicating that the back vowels have a lower second formant, making them all farther back than in Californian English, they conclude that the accent does distinguish [ɑ] and [ɔ].

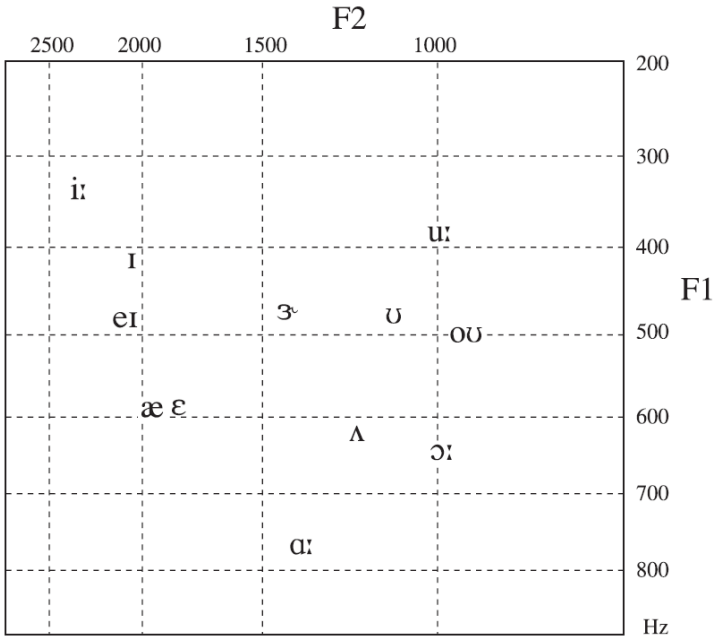


Figure 2.21. A plot of the first two formants of the vowels of (U.S.) northern cities English (Ladefoged & Johnson, 2011, p. 225).

They authors shared the first two formants of the vowels of BBC English speakers (Figure 2.22) concluding that British English speakers distinguish the vowel [ʌ] in cut from the vowel [ɜ] in curt (which does not have any r-colouring) mainly by the frequency of the first formant (Ladefoged & Johnson, 2011, p. 226).

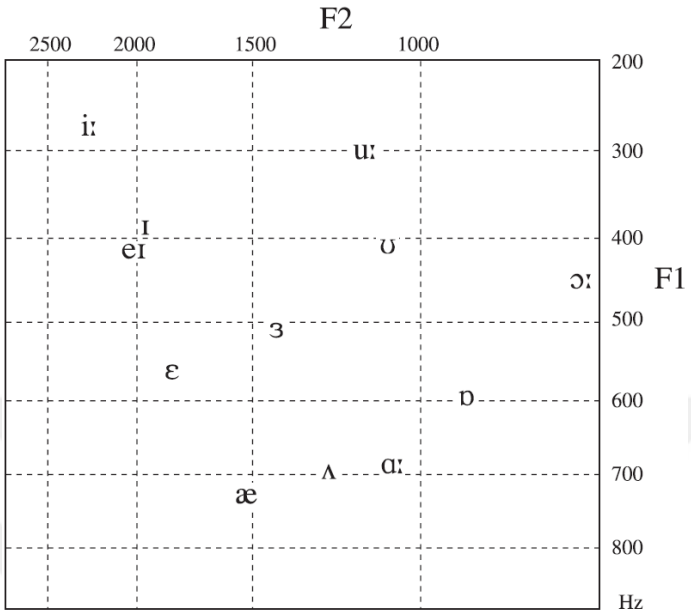


Figure 2.22. A plot of the first two formants of the vowels of BBC English (Ladefoged & Johnson, 2011, p. 226).

Within the "Acoustic Analysis" section, Ladefoged and Johnson (2011, p. 193) also shared average values of first three formants in eight American English vowels (Figure 2.23).

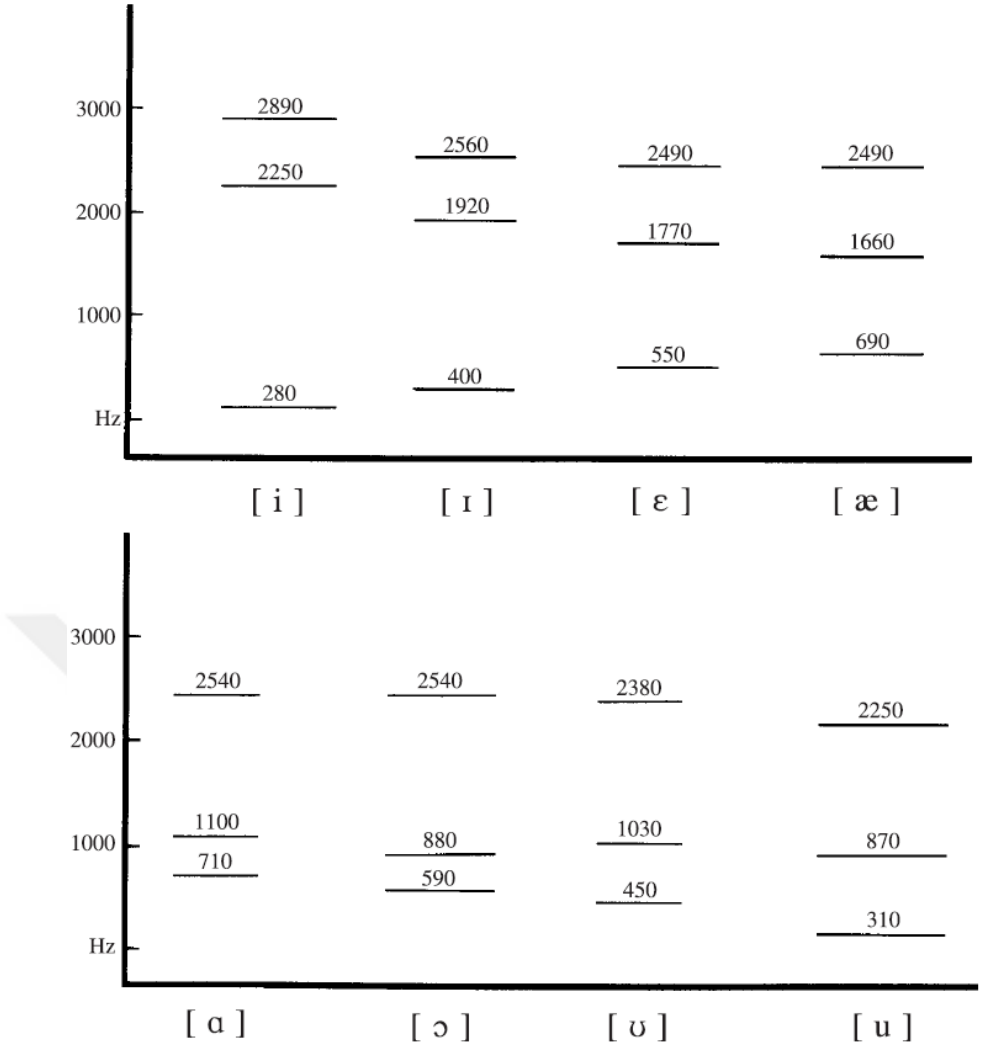


Figure 2.23. The frequencies of the first three formants in eight American English vowels (Ladefoged & Johnson, 2011, p. 193).

In a research study titled "Acoustic Characteristics of American English Vowels", Hillenbrand et al. (1995, p. 3103) examined acoustic properties of American English vowels in terms of duration and formant frequencies. The participants of the study consist of 45 men, 48 women, and 46 children at 10-12 age group. The authors calculated the mean formant values (Figure 2.24) and visualized F1 and F2 values to define vowel spaces (Figure 2.24).

		/i/	/ɪ/	/e/	/ɛ/	/æ/	/ɑ/	/ɔ/	/o/	/ʊ/	/u/	/ʌ/	/ɝ/
Dur	M	243	192	267	189	278	267	283	265	192	237	188	263
	W	306	237	320	254	332	323	353	326	249	303	226	321
	C	297	248	314	235	322	311	319	310	247	278	234	307
*F*0	M	138	135	129	127	123	123	121	129	133	143	133	130
	W	227	224	219	214	215	215	210	217	230	235	218	217
	C	246	241	237	230	228	229	225	236	243	249	236	237
*F*1	M	342	427	476	580	588	768	652	497	469	378	623	474
	W	437	483	536	731	669	936	781	555	519	459	753	523
	C	452	511	564	749	717	1002	803	597	568	494	749	586
*F*2	M	2322	2034	2089	1799	1952	1333	997	910	1122	997	1200	1379
	W	2761	2365	2530	2058	2349	1551	1136	1035	1225	1105	1426	1588
	C	3081	2552	2656	2267	2501	1688	1210	1137	1490	1345	1546	1719
*F*3	M	3000	2684	2691	2605	2601	2522	2538	2459	2434	2343	2550	1710
	W	3372	3053	3047	2979	2972	2815	2824	2828	2827	2735	2933	1929
	C	3702	3403	3323	3310	3289	2950	2982	2987	3072	2988	3145	2143
*F*4	M	3657	3618	3649	3677	3624	3687	3486	3384	3400	3357	3557	3334
	W	4352	4334	4319	4294	4290	4299	3923	3927	4052	4115	4092	3914
	C	4572	4575	4422	4671	4409	4307	3919	4167	4328	4276	4320	3788

Figure 2.24. Average durations, fundamental frequencies, and formant frequencies of vowels produced by 45 men, 48 women, and 46 children (Hillenbrand et al., 1995, p. 3103).

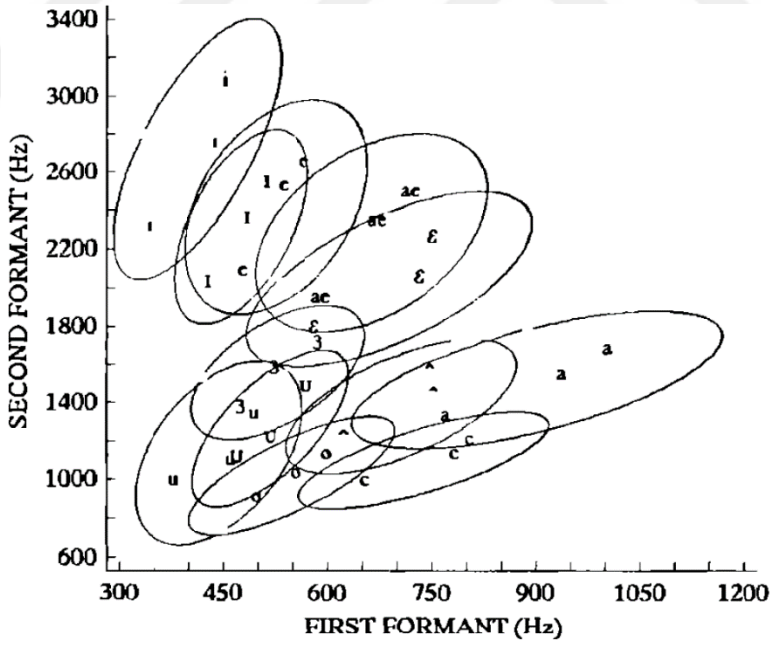


Figure 2.25. Average values of F1 and F2 for men, women, and child talkers for 12 vowels with ellipses fit to the data (Hillenbrand et al., 1995, p. 3103).

Research was carried out by Clopper et al. (2005, p. 15) on acoustic-phonetic description of the characteristics of the major regional varieties of American English. Their work presented a summary and description of the acoustic characteristics of the vowel systems of six regional varieties through acoustic data (Figure 2.26). The authors concluded that vowel systems of American English differ on

the region of origin of the talker. They highlighted vowel shifts as well as frontings or raisings regarding F1 and F2 mean values specific to the regions.

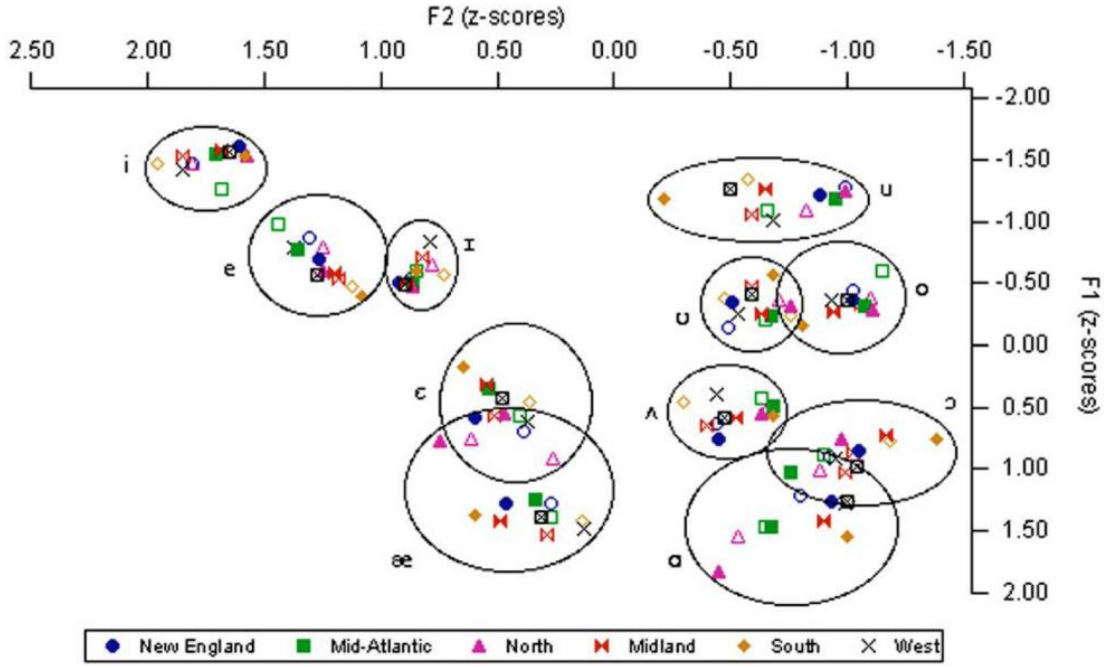


Figure 2.26. Mean z-score normalized formant frequency values for 11 American English vowels for each of the six dialects (Clopper et al., 2005, p. 21).

The study by Deterding (1997) presents data on the formants of the eleven monophthong vowels of Standard Southern British (SSB) pronunciation of English. The researchers measured formant values of vowels of English for five male and five female BBC broadcasters.

	B			C			H			J			K		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
iː	281	2016	2337	276	2218	3090	280	2600	3128	302	2008	2517	261	2402	2752
ɪ	335	1430	2198	396	1659	2592	367	1987	2887	395	1670	2450	344	2041	2653
e	490	1397	2127	509	1520	2590	444	1923	2902	512	1587	2544	515	1823	2573
æ	661	1328	2139	546	1542	2306	579	1769	2790	790	1558	2559	872	1555	2522
ʌ	635	1237	2186	537	1219	2383	687	1382	2833	704	1204	2553	659	1251	2798
ɑː	694	1202	2183	540	1108	2195	625	1165	2738	649	1117	2524	720	1185	2811
ɒ	611	1113	2111	482	1042	2200	609	1125	2753	558	1000	2574	530	956	2769
ɔː	419	906	2157	397	709	2627	448	925	2802	425	835	2657	388	764	2854
ʊ	370	1195	2055	378	1323	2332	391	1136	2642	387	1268	2391	368	945	2804
uː	321	1247	2149	298	1373	2234	327	1123	2659	343	1343	2404	291	870	2593
ɜː	472	1265	2183	507	1397	2482	523	1468	2748	462	1398	2523	425	1651	2506

Figure 2.27. Average formant values for each of the vowels of each of the male speakers (Deterding, 1997, p. 55).

	A			D			E			F			G		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
iː	304	2664	3248	284	2694	3315	300	2582	3234	321	2606	3161	306	2725	3055
ɪ	365	2157	2953	387	2215	2960	410	2070	3032	392	2147	2887	364	2279	2977
e	853	2054	3056	620	2157	2968	634	1926	2992	738	2065	2906	750	2114	3063
æ	1067	1690	2791	971	1892	2761	1045	1766	3121	972	1884	2744	1033	1761	2928
ʌ	1044	1495	2740	950	1512	2851	843	1464	2929	875	1489	2638	860	1335	2998
ɑː	1010	1304	2815	903	1305	2876	903	1393	2945	895	1327	2685	837	1250	2883
ɒ	761	1243	2661	765	1216	2791	680	1249	2869	823	1243	2651	727	1123	2980
ɔː	398	934	2669	373	849	2778	334	959	3027	427	876	2689	412	823	2817
ʊ	391	1798	2627	421	1361	2740	415	1234	2702	406	1199	2638	418	1109	2780
uː	333	1529	2657	319	1521	2627	328	1396	2746	343	1437	2683	316	1302	2657
ɜː	443	1762	2663	746	1627	2842	517	1676	2953	695	1705	2762	631	1704	2974

Figure 2.28. Average formant values for each of the vowels of each of the female speakers (Deterding, 1997, p. 55).

The acoustic properties of monophthongs and diphthongs in Western Sydney Australian English were researched by Elvin et al. (2016). Given the fact that regional variation does exist in Australian English, the researchers selected a single variety of Australian English, namely Western Sydney Australian English (AusEWS). The study reports a set of collected acoustic data of AusEWS vowels which can serve as a reference point for future studies such as acoustic comparisons.

		Monophthongs												
		iː	ɪ	e	eː	ɜː	ɪə	æ	ɐ	ɐː	ə	oː	ʊ	ʉː
M	**dur**	168	101	117	204	195	205	150	125	217	129	200	108	148
	F1^{Ave}	358	378	575	553	537	369	776	688	711	601	484	413	342
	F1^{T1}	407	365	547	527	513	348	731	672	705	590	480	423	363
	F1^{T2}	323	386	574	568	540	405	773	678	710	601	492	401	333
	F2^{Ave}	2202	2079	1820	1915	1475	2147	1609	1226	1173	994	798	991	1736
	F2^{T1}	2051	2094	1842	1939	1501	2165	1619	1259	1205	1009	814	1069	1711
	F2^{T2}	2280	2049	1814	1871	1473	2069	1629	1258	1184	1057	859	981	1749
	F3^{Ave}	2869	2732	2642	2684	2467	2792	2519	2552	2627	2564	2635	2478	2214
	F3^{T1}	2774	2759	2644	2674	2471	2845	2511	2538	2571	2553	2591	2479	2256
	F3^{T2}	2907	2702	2633	2680	2476	2714	2565	2585	2641	2567	2638	2461	2205
F	**dur**	174	112	129	212	205	210	148	132	216	130	202	124	166
	F1^{Ave}	454	469	744	711	715	484	972	879	916	742	608	520	445
	F1^{T1}	484	457	699	672	680	460	916	852	903	715	582	511	453
	F1^{T2}	404	472	739	726	717	535	940	846	898	728	637	507	420
	F2^{Ave}	2580	2529	2048	2141	1844	2489	1768	1522	1422	1272	1033	1192	2130
	F2^{T1}	2503	2523	2077	2158	1862	2523	1836	1550	1462	1280	1057	1210	2101
	F2^{T2}	2548	2431	1976	2063	1834	2366	1742	1546	1450	1303	1134	1249	2158
	F3^{Ave}	3022	3008	2813	2813	2879	2982	2581	2877	2829	2980	3073	2930	2636
	F3^{T1}	2959	3022	2824	2842	2866	3036	2589	2882	2843	2964	3020	2894	2661
	F3^{T2}	3075	2975	2813	2818	2884	2925	2643	2931	2873	3009	3009	2955	2654

Figure 2.29. Duration (ms) and formant values (Hz) averaged across sentence and isolated positions (Elvin et al., 2016, p. 578).

In her PhD dissertation titled "Towards a Definition of Schwa: An Acoustic Investigation of Vowel Reduction in English", Bates (1995) presents results of the study on English "schwa" assessing Schwa's contextual variability in the light of acoustic parameters. Mean first and second formant values of vowels of one male speaker of SSB English were displayed in the study, including formant values of British schwa.

	Present data		*Wells '62*		*P&B '52*	
	F1	*F2*	*F1*	*F2*	*F1*	*F2*
i	372	2080	300	2300	270	2290
ɪ	442	1722	360	2100	390	1990
ɛ	607	1633	570	1970	530	1840
a	756	1503	750	1750	660	1720
ə	481	1445	*	*	*	*
ɜ	555	1380	580	1380	*	*
ɑ	698	1108	680	1100	730	1090
ʌ	663	1195	720	1240	640	1190
ɒ	598	1014	600	900	*	*
ɔ	469	845	450	740	570	840
ʊ	428	1326	380	950	440	1020
u	371	1570	300	940	300	870

Figure 2.30. A comparison of mean first and second vowel formant values (Hz) for SSB and American English vowels (Bates, 1995, p. 37).

"A Contrastive Analysis of Schwa in English and Portuguese", the study by Marusso and Silva (2007) reflects the results of acoustic analysis on phonetic and phonological properties of schwa in Portuguese and English. In the study, the varieties analysed were Minas Gerais Brazilian Portuguese and Southeastern British English (RP). The authors involved four native speakers of Brazilian Portugues and four native speakers of British English into the research, and shared the mean values of measurements.

Full vowels		**schwa**	
[ɑː] F1	[ɑː] F2	[ə] F1	[ə] F2
674	1275	614	1516
[iː] F1	[iː] F2	[ə] F1	[ə] F2
369	2707	635	1729
[uː] F1	[uː][2] F2	[ə] F1	[ə] F2
363	2141	623	1599
[æ] F1	[æ] F2	[ə] F1	[ə] F2
932	1624	626	1600
[ɒ] F1	[ɒ] F2	[ə] F1	[ə] F2
568	1160	636	1495
[ɪ] F1	[ɪ] F2	[ə] F1	[ə] F2
450	2318	596	1637
[ɔː] F1	[ɔː] F2	[ə] F1	[ə] F2
452	878	603	1522
Mean of all schwas		619	1585
Standard deviation		15,38397	82,35059

Figure 2.31. Mean values, by-subjects, for English vowels (Marusso & Silva, 2007, p. 328).

2.4.2. Acoustic Studies on Vowels of Turkish

Vowels of Turkish were subject to researches in terms of acoustic properties; vowel harmony/disharmony were in the focus of significant number of the studies. The vowel harmony, which can be described as "a phonological organisation scheme where all vowels are taken from one of two (potentially overlapping) sets inside harmonic spans in the word itself", with its regularities, irregularities or exceptions attracted attention of linguists, especially phoneticians and phonologists.

The study titled "Türkçenin Ses Dizgesi" (Sound System of Turkish), which presents the basic features of vowels and consonants in a holistic approach to the sound structure of Turkish, provides basic information to researchers. While Ergenç and Bekar Uzun (2017) present the definitions and basic concepts of the voice and speech organs, they present the acoustic appearances of Turkish vowels in terms of formant frequency, pitch, spectrogram, amplitude, along with their features, and express the most significant features of the 8 basic vowels in the vowel system of Turkish as being short, that is, not containing length, that long vowels in words derived from other languages also tend to shorten by following this process, and that there is no more than one vowel in the same syllable (p. 83).

Linguists also examined Turkish vowels regarding various aspects, such as duration or formant frequencies. In the study titled "A Contrastive Analysis Between English and Turkish Vowel Systems" English and Turkish vowel systems were examined in a contrastive approach. The author indicated the difference in rounding of vowels stating the rounding feature is automatic for back vowels in English, while the rounded-unrounded opposition is non-automatic in Turkish. As a factor of time duration, length or short-long opposition was considered as a distinctive feature in Turkish vowels. The position of English vowel /æ/ was highlighted within a contrastive view of both English and Turkish vowels. The researcher stated that the fundamental difference between Turkish and English is that Turkish has a two-by-four grid with only two front unrounded vowels, while English has a three-by-three vowel grid with /æ/ as the low front phonological structure point. When two language grids are overlapped, Turkish does not really have an analogue for the English /æ/. Bineth (1966, p. 212) claims that by combining the discussion of the pertinent facts into a single document and superimposing the two vowel grids, it should be easier to discern where they diverge and coincide.

The difference between vowel structures of Turkish and English was also reviewed within the book "Teaching English Pronunciation". A number of differences were listed by the author as "Problems with Vowels" and were indicated the challenges for learners of Turkish. In this section, the author highlights the contrast between long and short vowels of English such as /ɪ/ and /i:/, /ɒ/ and /ɔ:/ or /ʊ/ and /u:/ stating in some cases the pronunciation would be "troublesome"; she noted common learner tendencies in pronunciation of "problematic" cases. The case of the English /æ/ was also highlighted: "This vowel occurs in Turkish, but only next to certain consonants. Learners may have difficulty in producing this vowel in some English words, but not in others. The vowel may also be confused with /ɑ/ as in "barn" or /ʌ/ as in "but". Use Turkish 'alt' ('bottom') as a help word for this vowel (or any

Turkish word written with the symbol 'â' with a circumflex)". The author also states that schwa does not exist in Turkish, but there is a Turkish vowel which is an adequate substitute; the letter symbol for this vowel is "I", and learners can use this for English schwa (Kenworthy, 1987, p. 158).

A perceptual experiment was carried out by Ng et al. (2008) to assess the amount of accent in the English produced by Turkish speakers as perceived by native monolingual English speakers. The F1 and F2 were obtained from 11 English monophthong vowels produced by 20 Turkish-accented English (10 males and 10 females) bilinguals and 20 native American English speakers. The results indicate that there is evidence to support TE speakers' ability to appropriately articulate both *close* and *distant* vowels. When both TE groups were compared with their AE counterparts, it was discovered that TE male speakers showed less acoustic variation than TE female speakers (see Figure 2.32 and Figure 2.33). Additionally, male TE speakers showed less of the perceived accent associated with TE speakers. Both *distant* and *close* English vowels produced by TE speakers contain inaccuracies, according to the F1 and F2 frequency values. Nonetheless, the degree of perceived accentedness is directly correlated with acoustic descriptions based on the F1 and F2 frequencies. Additionally, the authors conclude that data shows that even adult L2 learners can have their perceived accent level decreased.

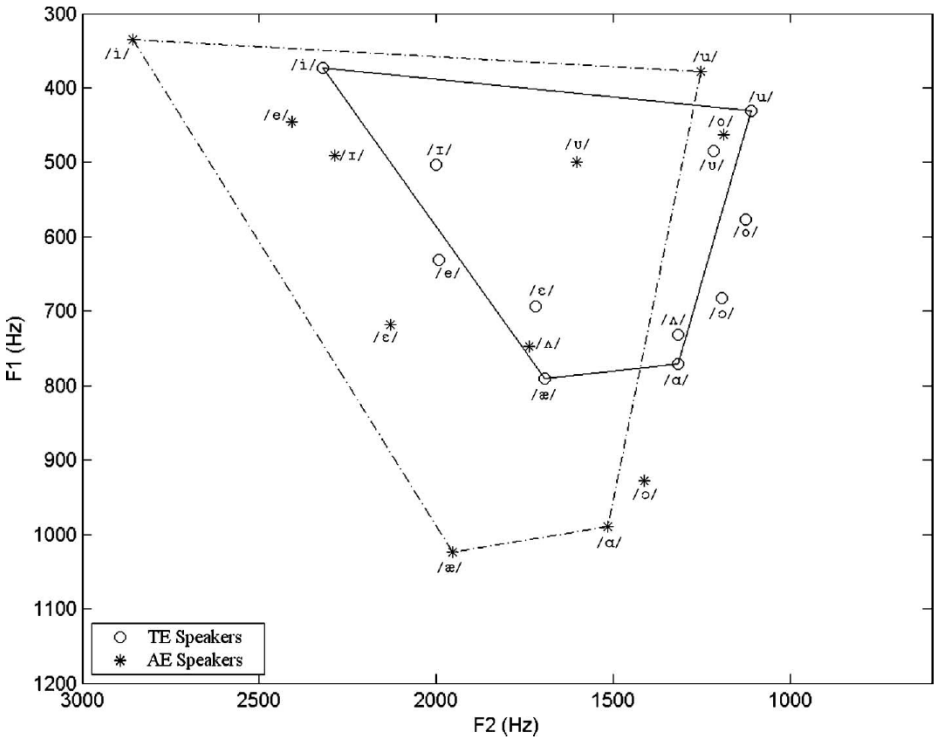


Figure 2.32. Comparison of F1–F2 frequency values for the 11 English vowels produced by the TE and AE female speakers (Ng et al., 2008, p. 410).

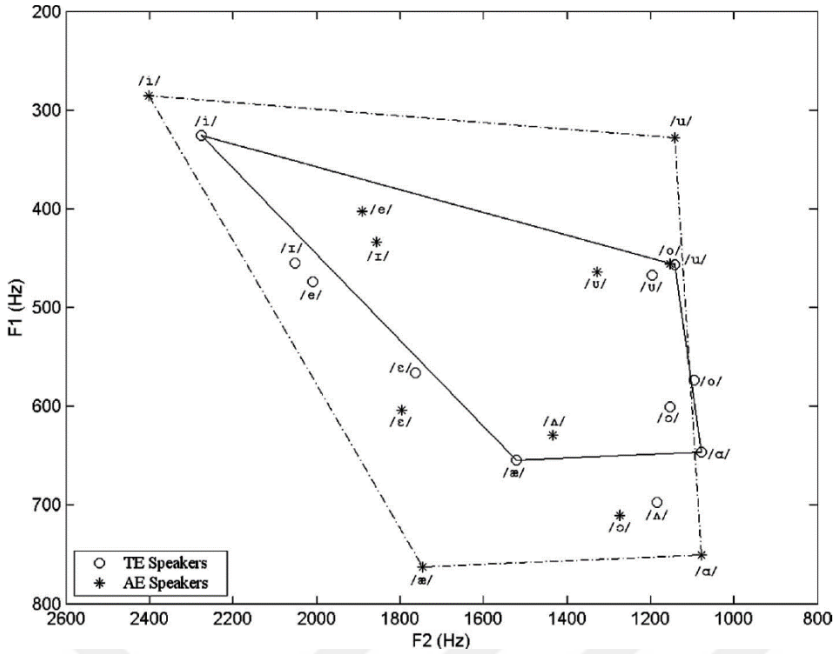


Figure 2.33. Comparison of F1–F2 frequency values for the 11 English vowels produced by the TE and AE male speakers (Ng et al., 2008, p. 410).

Within their work titled "Classification of Turkish Vowels Based on Formant Frequencies" Korkmaz and Boyacı (2018) shared formant values obtained from 10 male Turkish participants. Each of 8 vowels of Turkish were placed within 6 CVC syllables; the speech samples were recorded and segmented for getting formant values. The study offers data to contribute distinction and classification of Turkish vowels in terms of vowel features.

Research on the acoustic structure of Turkish vowels reflects the distribution of mean F1, F2 and F3 values due to the gender and age (Türk et al., 2004). The authors highlight the significant difference in the frequencies between age groups – specifically the higher mean frequency levels of children (p. 10).

Vowel	Syllables	Formants Frequencies (Hz)		
		f1	*f2*	*f3*
/a/	*pas*	679	1125	2678
	bal	646	1036	2783
	tas	654	1177	2752
	dal	645	1060	2771
	kar	646	1210	2560
	gar	624	1201	2528
/e/	*pek*	498	1845	2604
	bez	497	1750	2602
	tek	474	1861	2614
	def	498	1780	2614
	kem	581	1704	2531
	gen	561	1768	2577
/ı/	*pır*	438	1427	2456
	bık	417	1434	2479
	tın	432	1460	2465
	dış	394	1675	2547
	kır	428	1501	2366
	gık	399	1544	2360
/i/	*pil*	314	2070	2914
	bir	297	2084	2869
	tik	318	2049	2833
	dik	294	2091	2899
	kim	352	2077	2886
	git	303	2080	2907
/o/	*poz*	499	841	2748
	boş	485	826	2719
	tor	520	889	2657
	doz	500	897	2793
	kol	508	844	2667
	gol	492	884	2577
/ö/	*pöç*	462	1434	2343
	böl	477	1387	2388
	tör	496	1333	2397
	dök	451	1539	2373
	köz	469	1465	2307
	göl	481	1428	2321
/u/	*put*	413	895	2685
	buz	391	832	2695
	tuz	392	982	2617
	dur	378	985	2597
	kul	385	875	2656
	gut	374	968	2457
/ü/	*pür*	370	1622	2323
	bük	315	1772	2293
	tül	340	1714	2300
	düz	313	1701	2386
	küs	335	1752	2290
	güz	301	1829	2311

Figure 2.34. Average Formant Frequency Values of Vowels in Each Syllable (Korkmaz & Boyaci, 2018, p. 3).

Hunter and Yarkiner (2014) examined issues related to vowel production in a subject's second language, specifically on the vowel systems of Standard Southern British English and Cypriot Turkish. Within the study, the first and second formants of the vowels were examined. The findings were then contrasted with measurements of Turkish vowels produced by L1 speakers and SSB English from earlier investigations. The discussion was then extended to perceptual theories, including the perceptual magnet effect. The researcher concluded that the "quality" of the SSBE vowels that each participant produced varied significantly from one another. Predicting this, when a Turkish vowel was close to the needed SSBE one in the F1–F2 region, the participants typically produced "good" examples of SSBE vowels. Though they produced much poorer SSBE vowels—for which there was no close equivalent in Turkish—the formants of the resulting words were frequently quite similar to those of other Turkish vowels. Thus, the subjects often confused several SSBE vowels for one another. The perceptual magnet theory makes sense in light of these observations.

Formant frequency values are also available within the research titled "Turkish Vowel Formants and Formant Based Vowel Quadrilateral" by Malkoç (2009). The findings from standard Turkish male and female speakers obtained in the study (see Figure 2.35) were compared with values from previous studies to determine the formant frequency range and averages for standard Turkish.

			F0 (Hz)	F1 (Hz)	F2 (Hz)	F3 (Hz)	F4 (Hz)
a	Ortalama	Kadın	236	771	1338	2998	4168
		Erkek	130	642	1128	2714	3707
	Minimum	Kadın	112	510	964	2153	3342
		Erkek	94	382	747	1983	3122
	Maksimum	Kadın	281	949	1673	3694	4976
		Erkek	210	818	1321	3226	4329
	St.Sapma	Kadın	24,07	86,53	162,60	286,28	381,65
		Erkek	20,47	61,40	105,59	258,50	277,89
e	Ortalama	Kadın	231	578	2205	2961	4128
		Erkek	127	470	1866	2563	3715
	Minimum	Kadın	187	420	1024	2090	2730
		Erkek	97	330	1590	2221	2778
	Maksimum	Kadın	306	776	2760	3420	5184
		Erkek	198	585	2176	3033	4821
	St.Sapma	Kadın	22,66	68,09	269,48	310,31	609,83
		Erkek	21,57	41,18	122,32	143,51	354,31
i	Ortalama	Kadın	245	430	2591	3325	4308
		Erkek	138	306	2111	2897	3751
	Minimum	Kadın	190	201	1156	2602	3134
		Erkek	93	129	1486	2458	3163
	Maksimum	Kadın	331	958	2952	3911	4880
		Erkek	352	463	2403	3481	4914
	St.Sapma	Kadın	28,94	89,45	222,92	212,08	296,85
		Erkek	39,29	42,74	141,25	191,29	285,78
ı	Ortalama	Kadın	233	492	1629	2976	4232
		Erkek	128	396	1500	2479	3782
	Minimum	Kadın	180	241	1321	2519	3520
		Erkek	128	396	1500	2479	3782
	Maksimum	Kadın	309	775	2712	3411	4867
		Erkek	196	520	1927	2912	4592
	St.Sapma	Kadın	25,52	64,74	163,30	189,00	337,55
		Erkek	19,72	47,24	139,36	152,63	360,77
o	Ortalama	Kadın	243	564	959	2976	3794
		Erkek	130	483	860	2733	3668
	Minimum	Kadın	193	135	672	2157	3235
		Erkek	101	301	581	2079	3033
	Maksimum	Kadın	352	771	1239	3598	4572
		Erkek	198	667	1161	3458	4590
	St.Sapma	Kadın	33,11	67,40	95,07	264,37	214,25
		Erkek	18,99	51,78	122,14	243,70	356,51
ö	Ortalama	Kadın	212	543	1636	2764	3947
		Erkek	124	469	1510	2439	3554
	Minimum	Kadın	170	383	1300	2116	3306
		Erkek	96	347	1148	2013	3010
	Maksimum	Kadın	287	692	2088	3219	4388
		Erkek	184	673	2151	3398	4525
	St.Sapma	Kadın	21,03	57,89	184,07	194,85	184,47
		Erkek	20,19	43,15	198,01	259,92	341,60
u	Ortalama	Kadın	247	452	961	2940	3825
		Erkek	141	379	980	2490	3558
	Minimum	Kadın	182	252	609	2187	3159
		Erkek	105	165	676	1899	2970
	Maksimum	Kadın	452	669	1691	3522	4746
		Erkek	225	539	1355	3137	4278
	St.Sapma	Kadın	30,19	57,17	135,66	261,84	267,30
		Erkek	29,10	62,32	106,71	233,55	275,67
ü	Ortalama	Kadın	234	424	1938	2742	3694
		Erkek	139	333	1769	2337	3342
	Minimum	Kadın	112	241	1443	2195	3131
		Erkek	103	192	1417	2002	2861
	Maksimum	Kadın	322	634	2408	3120	4382
		Erkek	233	458	2081	3154	4163
	St.Sapma	Kadın	33,07	52,03	189,42	154,60	212,65
		Erkek	27,36	54,52	132,66	173,53	231,38

Figure 2.35. Fundamental frequency and formant frequency values for Turkish vowels (Malkoç, 2009, p. 80,81).

In his Master's Thesis, Börtlü (2020) studied Turkish vowels in terms of acoustic properties, especially in terms of vowel fronting ang laxing. The researcher obtained F1 and F2 values from 10 (5 male and 5 female) volunteer participants and evaluated Turkish vowels in terms of "disorganized" view of vowel plots within the vowel triangle. The study indicates mean formant values of Turkish vowels.

		a	**ɑ**	**e**	**ɛ**	**ɯ**	**i**	**o**	**o̞**	**ø**	**u**	**u̟**	**y**
Female speakers	F_1	843	792	569	768	450	427	538	579	534	435	427	411
	F_2	1582	1431	2136	1753	1612	2448	1126	1210	1677	1058	1202	1890
Male speakers	F_1	668	625	494	625	377	338	466	478	455	379	386	338
	F_2	1318	1142	1824	1582	1349	2034	969	1086	1437	959	1096	1635

Figure 2.36. Mean F1 and F2 values of the vowels for female and male speakers (in Hertz) (Börtlü, 2020, p. 73).

3. DATA AND METHOD

3.1. Participants and Procedure

The collection of data was subject to approval of Ethical Committee of Mersin University Institute of Social Sciences with 06/06/2022 date and 248 number of approval (see Appendix 1); and data collection process started after the official approval the Ethical Committee.

The study is based on research to examine Turkish native language effect on 14-19 age group English L2 learners' articulation of L2 vowels, in terms of vowel features. 10 male and 10 female, totally 20 participants voluntarily participated in the study. The participants were at 14-19 age group, native monolingual speakers of Turkish language, attending secondary schools that are bound to Ministry of National Education at 9th, 10th, 11th, and 12th grades, having English classes for minimum 2 hours a week, living in environments such as families or dorms where Turkish is spoken on a daily basis.

The application was performed at 4 secondary schools located in Kahramanmaraş Province:

- Türkiye Odalar ve Borsalar Birliği Fen Lisesi
- Dulkadiroğlu Anadolu Lisesi
- Şehit Erol Olçok Anadolu İmam Hatip Lisesi
- Kadriye Çalık Anadolu Lisesi

Selection of the participants and application were carried out under research consents and approvals of Mersin University Social and Humanity Sciences Research Ethics Committee, Ministry of National Education Kahramanmaraş Directorate of National Education, school administrations, and parents of students that were under the age of 18 (see Appendix 2, 3, 4).

Minimal pair charts were created for 12 monophthong vowels of English ([iː], [ɪ], [ʊ], [uː], [e], [ə], [ɜː], [ɔː], [æ], [ʌ], [ɑː], [ɒ]) (Figure 3.1) and 8 vowels of Turkish ([a], [e], [ɯ], [i], [o], [ø], [u], [y]) (Figure 3.2).

Minimal Pair Chart for Vowels of English

	/ɪ/	/iː/	/ʊ/	/uː/	/e/	/ə/	/ɜː/	/ɔː/	/æ/	/ʌ/	/ɑː/	/ɒ/
/ɪ/	*	ship sheep	bill bull	fill fool	mess miss	precede proceed	bid bird	bill ball	bid bad	bitter butter	list last	ship shop
/iː/		*	feet foot	teeth tooth	neat net	seaport support	bead bird	weak walk	feet fat	teach touch	least last	least lost
/ʊ/			*	full fool	pet put	backwoods backwards	pull pearl	port put	pat put	look luck	part put	pot put
/uː/				*	fell fool	boot but	pool pearl	fall fool	man moon	shoot shut	bath booth	poll pool
/e/					*	essay assay	bed bird	fell fall	bad bed	better butter	pet part	less loss
/ə/						*	foreword forward	audition addition	objection abjection	discus dicuss	radar raider	on an
/ɜː/							*	walk work	bad bird	bud bird	dart dirt	poll pearl
/ɔː/								*	pat port	torch touch	part port	pot port
/æ/									*	cat cut	pat part	pat pot
/ʌ/										*	butter barter	lock luck
/ɑː/											*	part pot
/ɒ/												*

Figure 3.1. Minimal Pair Chart for Vowels of English

Minimal Pair Chart for Vowels of Turkish

	/a/	/e/	/ɯ/	/i/	/o/	/ø/	/u/	/y/
/a/	*	baş beş	kaz kız	kan kin	baş boş	köle kale	az uz	tam tüm
/e/		*	kez kız	kel kil	ten ton	gez göz	kum kem	gel gül
/ɯ/			*	dış diş	kır kor	kör kır	kıl kul	dış düş
/i/				*	kol kil	kör kir	pil pul	süren siren
/o/					*	kor kör	buz boz	dün don
/ø/						*	köle kule	güz göz
/u/							*	tür tur
/y/								*

Figure 3.2. Minimal Pair Chart for Vowels of Turkish

Each minimal pair was presented to the participants within sentence forms. The sentences where the target words in English appear were obtained from the online dictionary of Cambridge Dictionary (https://dictionary.cambridge.org/) on 03/07/2022 (Cambridge Dictionary, n.d.) (Figure 3.3).

sheep

noun [C]

UK /ʃiːp/ US /ʃiːp/

plural **sheep**

Digital Zoo/Photodisc/GettyImages

A1

a farm animal with thick wool that eats grass and is kept for its wool, skin, and meat:

- *The farmer has several large **flocks** (= groups) of long-haired sheep.*
- *We heard sheep **bleating/baaing** in the field.*

Figure 3.3. The sample sentence for the word "sheep"

ship

noun [C]

UK /ʃɪp/ US /ʃɪp/

Pierre-Yves Babelon/Moment/GettyImages

A2

a large boat for travelling on water, especially across the sea:

- *a sailing ship*
- *a merchant/naval ship*
- *They **boarded** (= went on to) a ship that was **sailing** (= leaving) the next day.*

More examples

- *The crane lifted the container off the ship.*
- *We spent two months aboard ship .*
- *The ship sank slowly to the depths of the ocean.*
- *Hundreds of people turned up to see the ship dock at Southampton.*
- *The ship was flying the Spanish flag.*

Figure 3.4. The sample sentence for the word "ship"

Figure 3.5. The sample sentence for the word "bull"

The sentences in English containing the minimal pairs were grouped and the set of 132 sentences were formed (see Appendix 6). Then the sequence of the sentences were organized in "1-3-2-4, 5-7-6-8, 9-11-10-12,…" order so that the sentences with the minimal pairs were not consecutively presented to the readers within the reading list (see Appendix 8).

The sentences where the target words in Turkish appear were obtained from Turkish National Corpus (TNC) database (Turkish National Corpus, n.d.) (Figure 3.6) (Aksan et al., 2012). The corpus is a large-scale linguistic resource that contains a vast collection of spoken and written texts in Turkish, aiming to represent the diverse usage of the Turkish language across various contexts. The corpus serves as a resource for linguistic research, language processing implementations and for educational purposes. TUD Version 3.0 is a comprehensive, balanced, and representative general-purpose reference corpus with 50 million words that includes spoken and written examples of modern Turkish from a wide range of fields and genres. Queries were made on Turkish National Corpus on 03/07/2022.

Figure 3.6. The sample query for the word "kır"

Figure 3.7. The sample sentence for the word "kır"

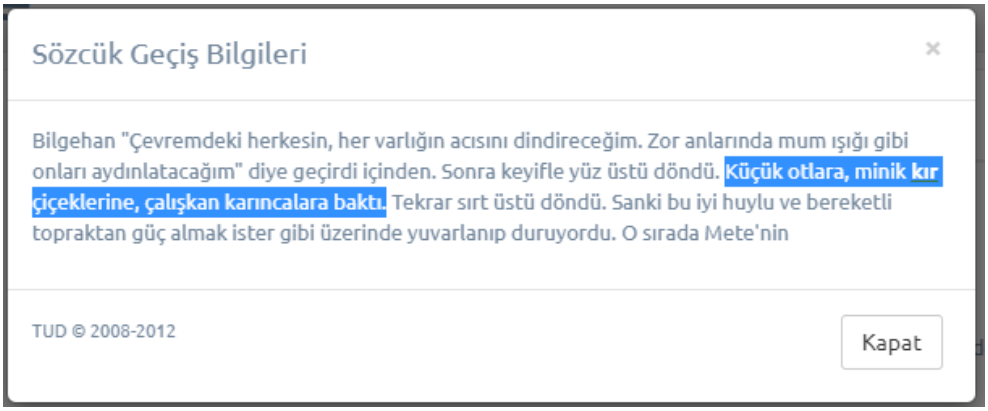


Figure 3.8. Contextual information for the word "kır"

Figure 3.9. The sample query for the word "kor"

Figure 3.10. The sample sentence for the word "kor"

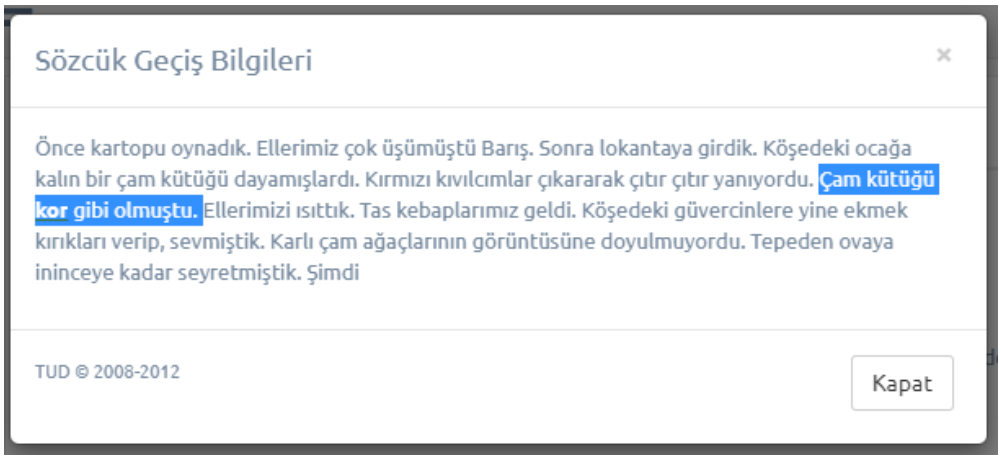


Figure 3.11. Contextual information for the word "kor"

Figure 3.12. The sample query for the word "kör"

Figure 3.13. The sample sentence for the word "kör"

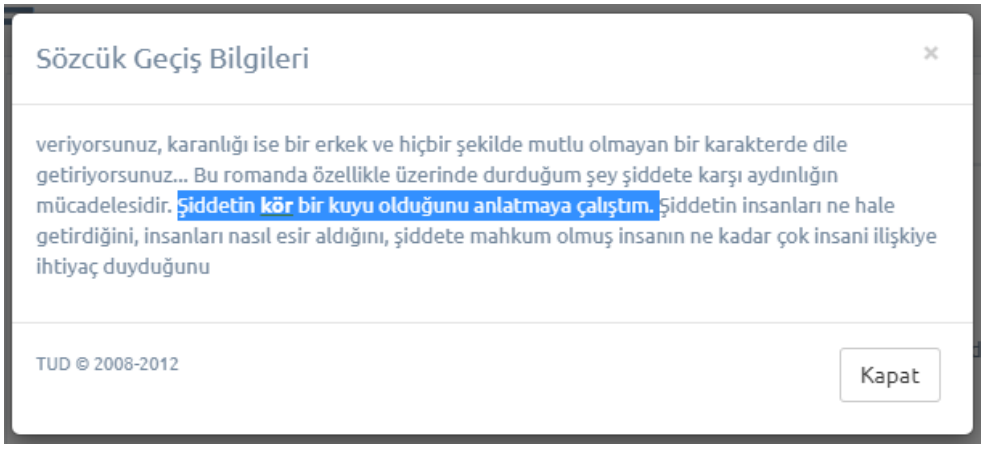


Figure 3.14. Contextual information for the word "kör"

The sentences in Turkish containing the minimal pairs were grouped and the set of 56 sentences were formed (see Appendix 7). Then the sequence of the sentences were organized in "1-3-2-4, 5-7-6-8, 9-11-10-12,…" order so that the sentences with the minimal pairs were not consecutively presented to the readers within the reading list (see Appendix 9).

The recordings were performed at the schools in relatively quiet rooms allocated by school administrations. The participants filled out and signed "Informed Consent Form" and "Demographic Information Form" respectively. The reading lists in English and Turkish were provided to the participants for pre-reading and each participant received the oral instruction before recording session:

"Dear participant,

The sound recording session will start when you are ready. Please read aloud each sentence with normal/natural loudness and speed. Starting with English sentences or Turkish sentences is of your choice. When you have a hesitation or disruption, you can repeat the sentence. In such case, the last reading of the sentence will be regarded. Please read aloud the sentences with an interval of one-or-two seconds at the end of each sentence. Thank you for your participation and for your contribution."

During the recordings, mean temperature was measured between 24-30°C, and the mean ambient noise was measured between 41.5-42.8 dB. Participants were not distracted by any external auditory or visual stimulus.

3.2. Tools and Software

The sounds of the participants were recorded with Zoom H1N sound recorder with 24-bit/96 kHz sampling rate, with built-in stereo microphones of the device. Using a shock mount, the device was positioned approximately 10 cm away from speakers' mouths in a right angle, and a pop filter was set in front of the microphone. "Auto-Level", "Lo-Cut", and "Limiter" functions were deactivated and input gain were set at 7. The audio files were saved in ".wav" format.

The ambient noise was measured with Benetech GM1351 Digital Sound Level Meter, and the ambient temperature was measured with Xiaomi Mijia Thermometer.

Sound records were segmented and analysed with Praat (version 6.2.14) (Boersma & Weenink, n.d.).

Graphical representations and vowel plots and vowel space areas were generated with RStudio (Posit PBC, n.d.) using the package phonR (McCloy, n.d.).

3.3. Method

The sound records obtained from the participants were analysed with Praat. All sound records were segmented manually, and formant values (F0, F1, and F2) were noted as well as the information for selection start and selection end in milliseconds. See Figure 3.15 for sample segmentation. During the selection, the patterns on the spectrogram and waveform were taken into consideration to clarify clear and consistent sample part to be selected. Each selection was also checked by listening preceding and posterior parts of the selection.

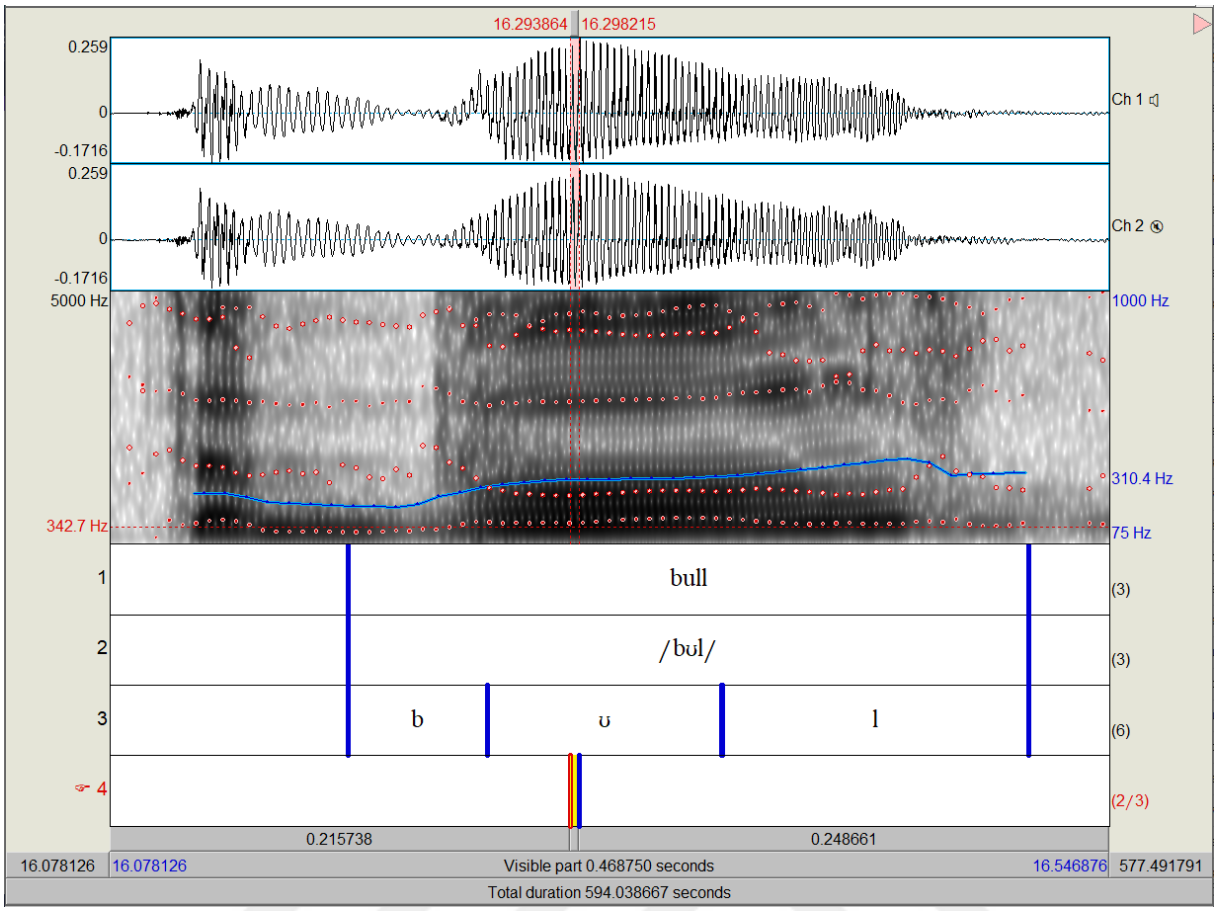


Figure 3.15. Sample segmentation for P3, (word: "bull", vowel: /ʊ/)

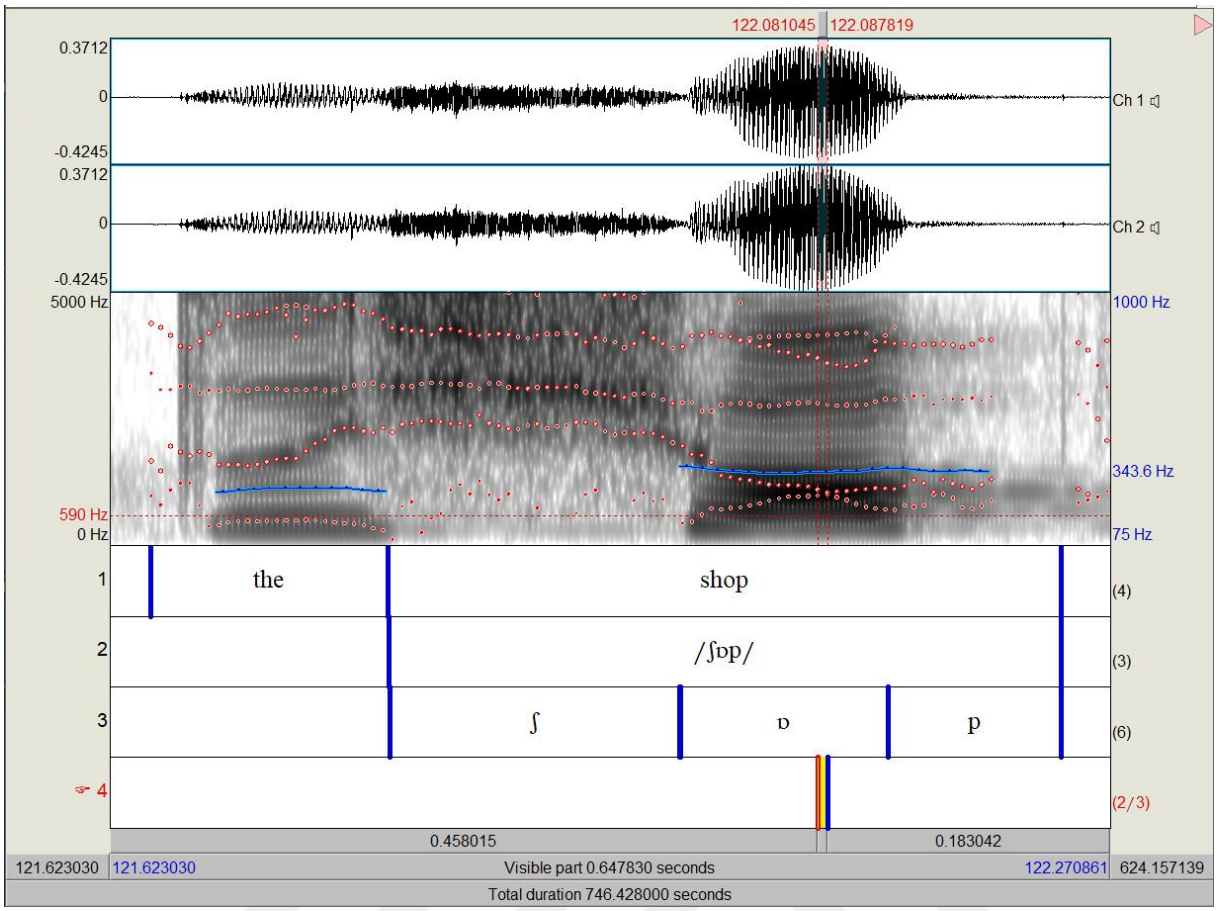


Figure 3.16. Sample segmentation for P5, (word: "shop", vowel: /ɒ/)

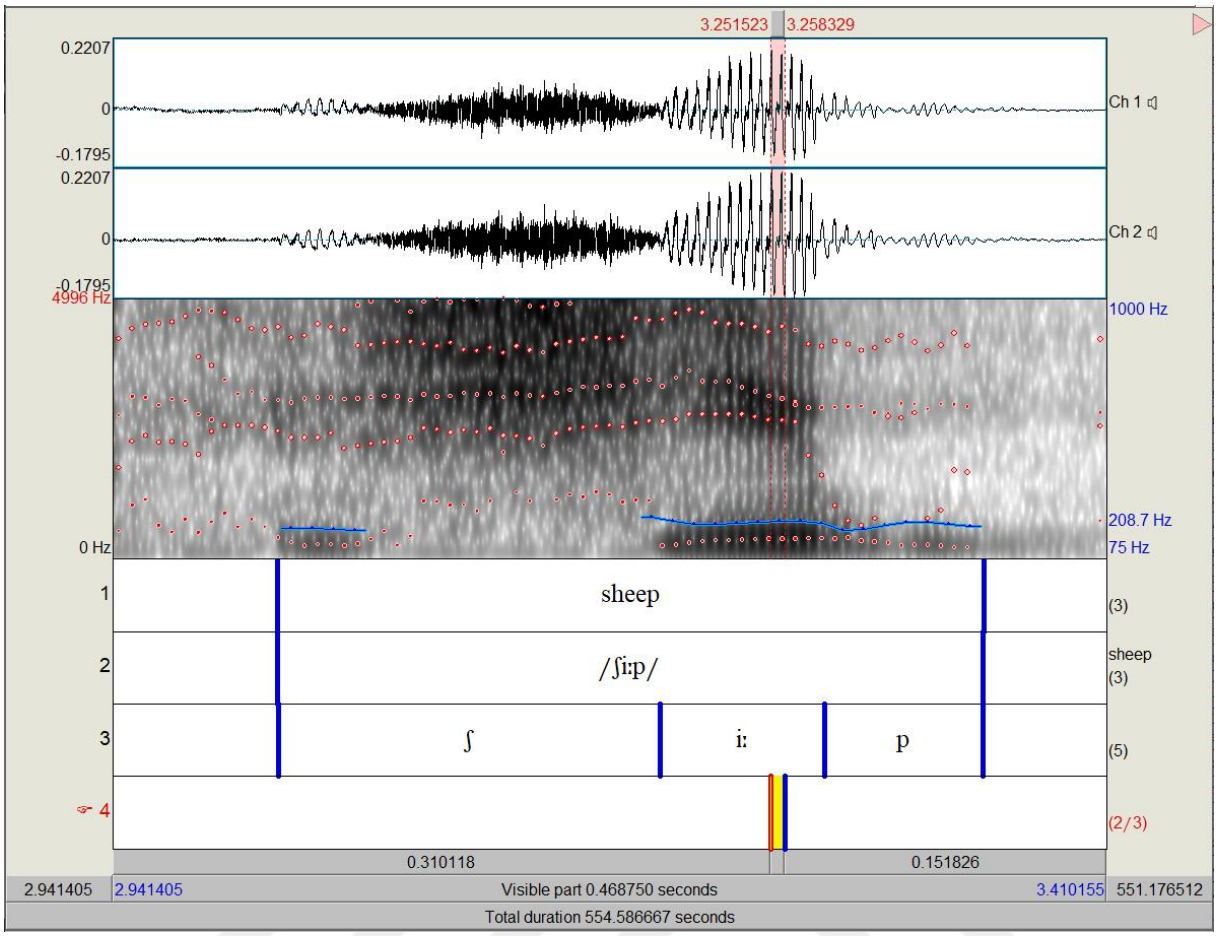


Figure 3.17. Sample segmentation for P20, (word: "sheep", vowel: /i:/)

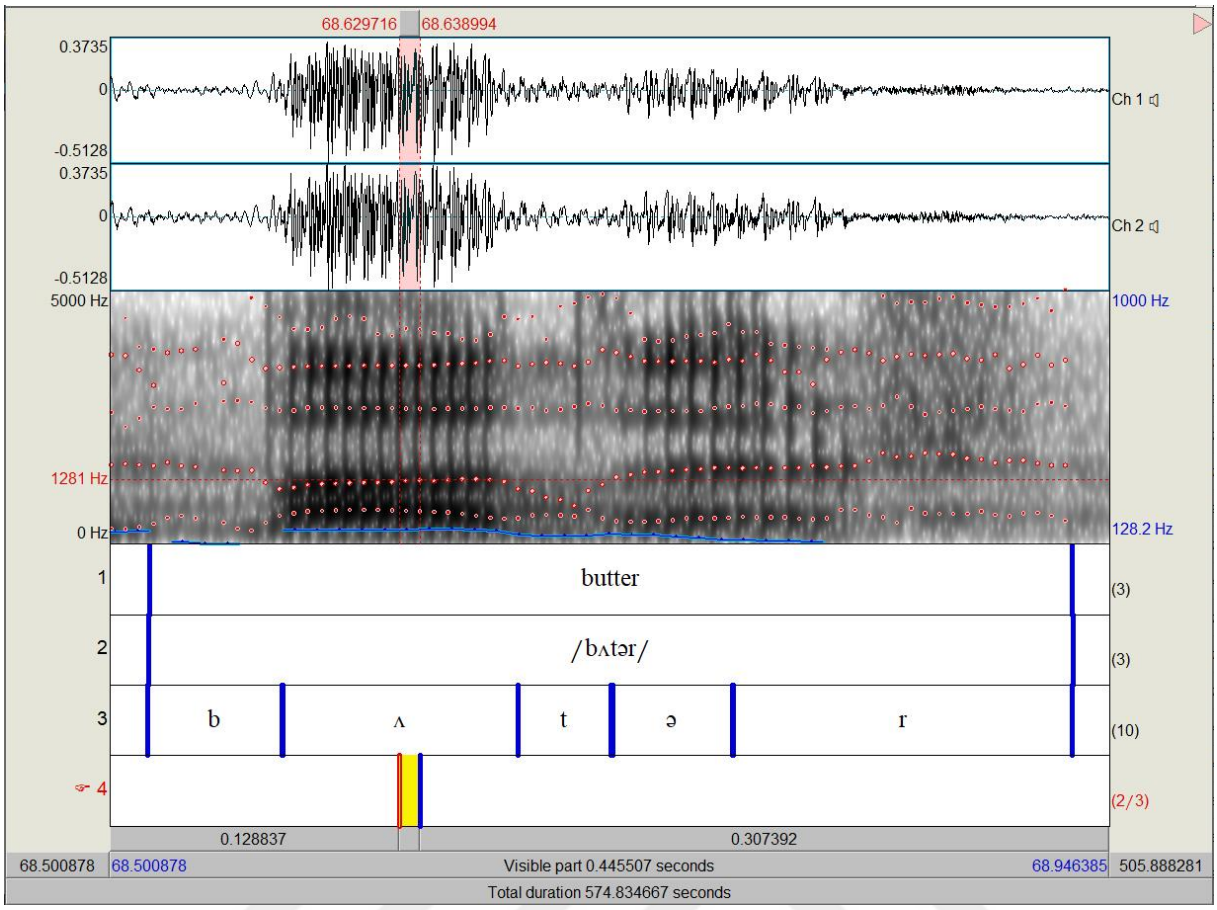


Figure 3.18. Sample segmentation for P15, (word: "butter", vowel: /ʌ/)

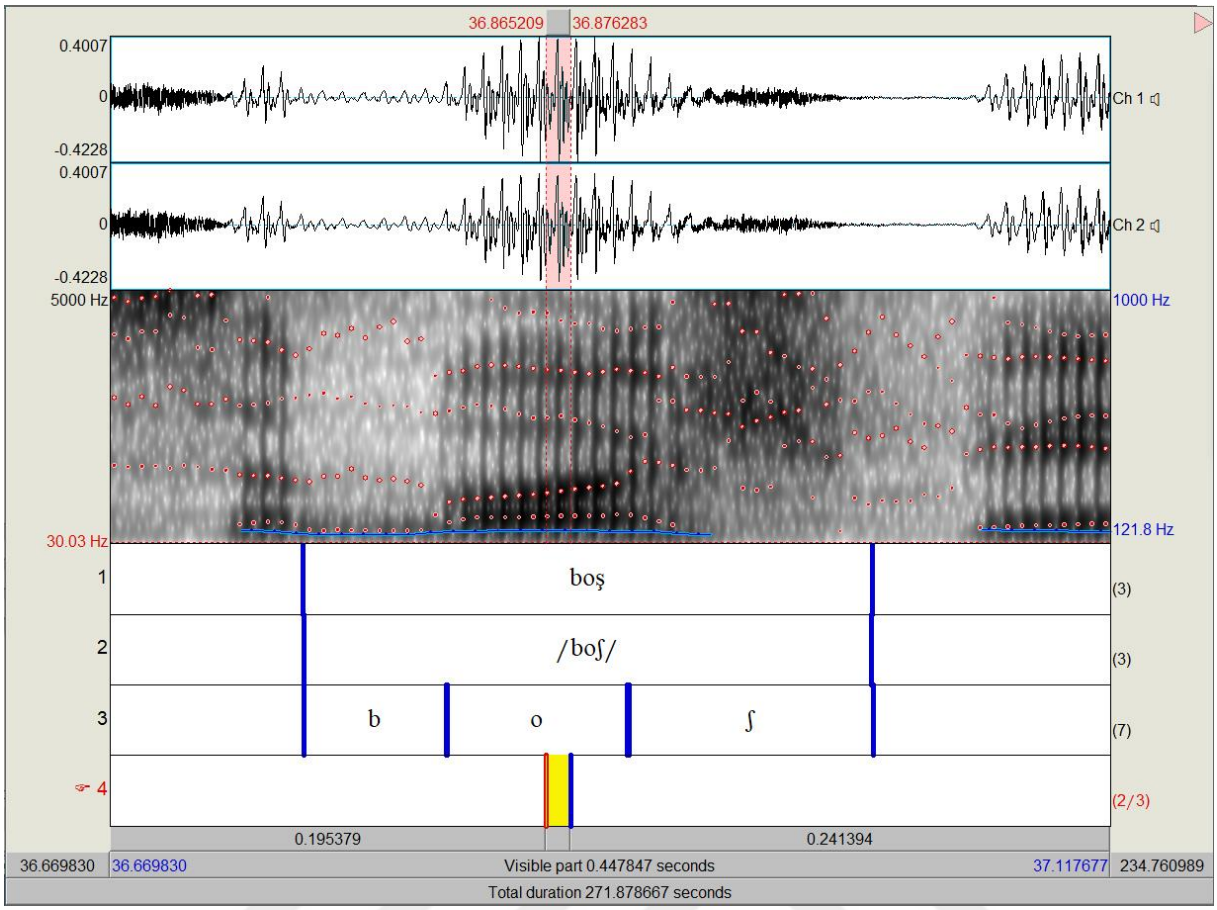


Figure 3.19. Sample segmentation for P2, (word: "boş", vowel: /o/)

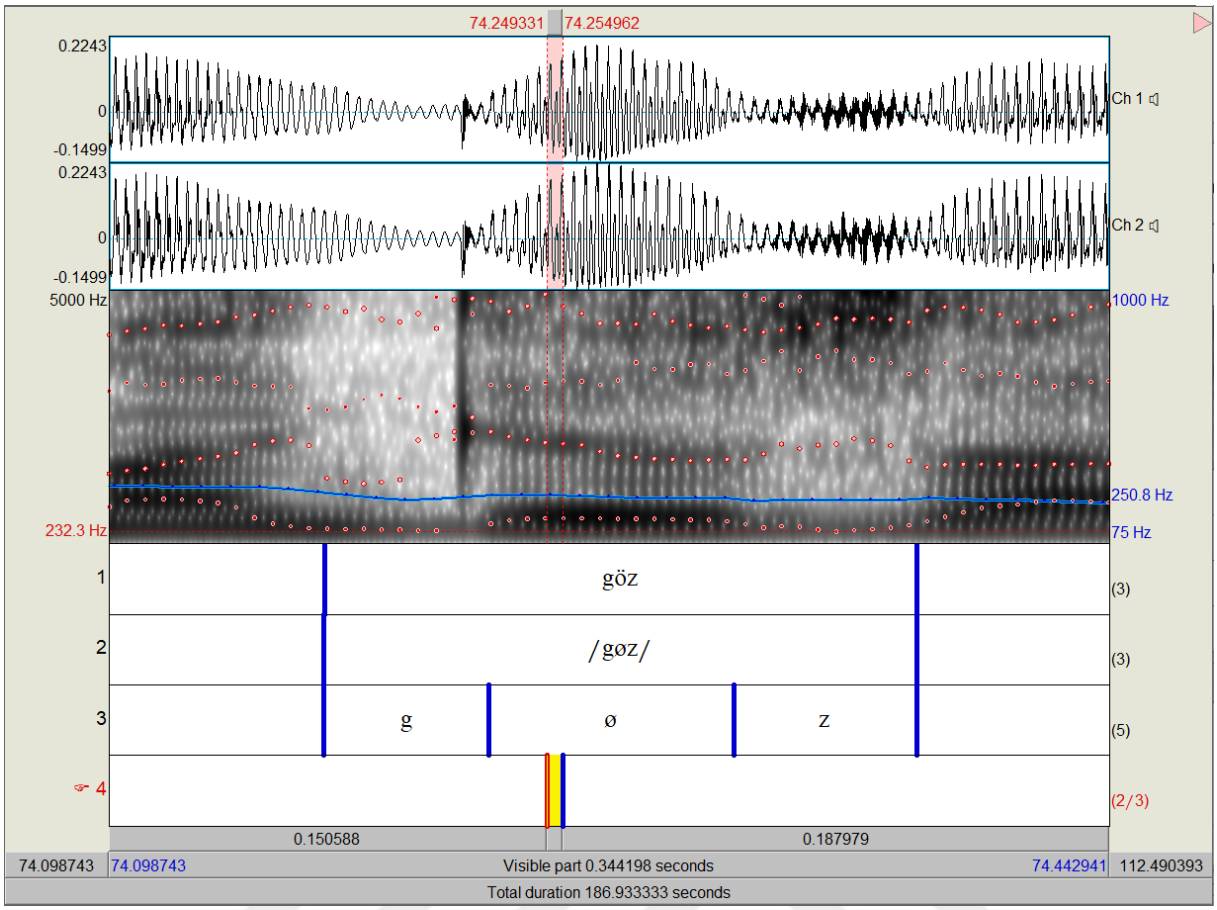


Figure 3.20. Sample segmentation for P11, (word: "göz", vowel: /ø/)

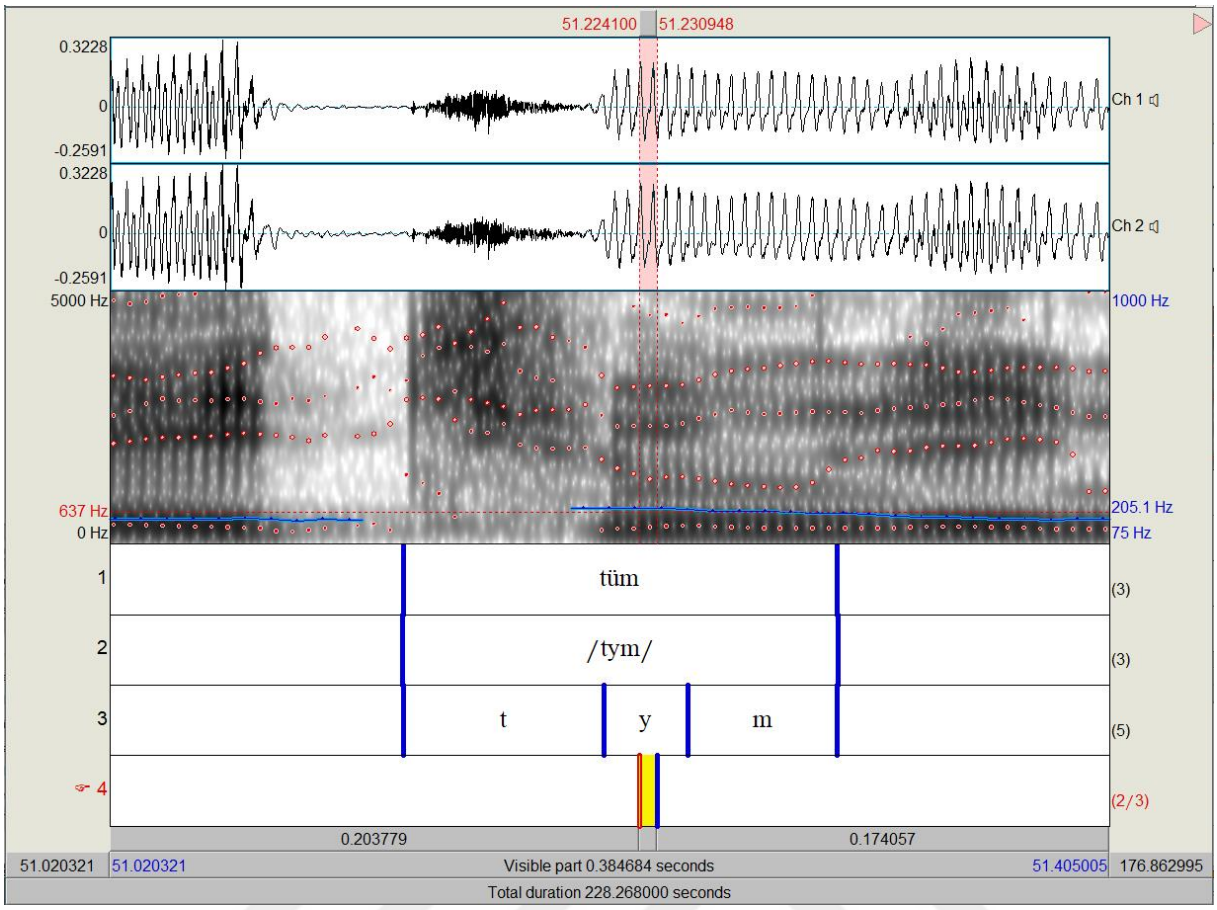


Figure 3.21. Sample segmentation for P12, (word: "tüm", vowel: /y/)

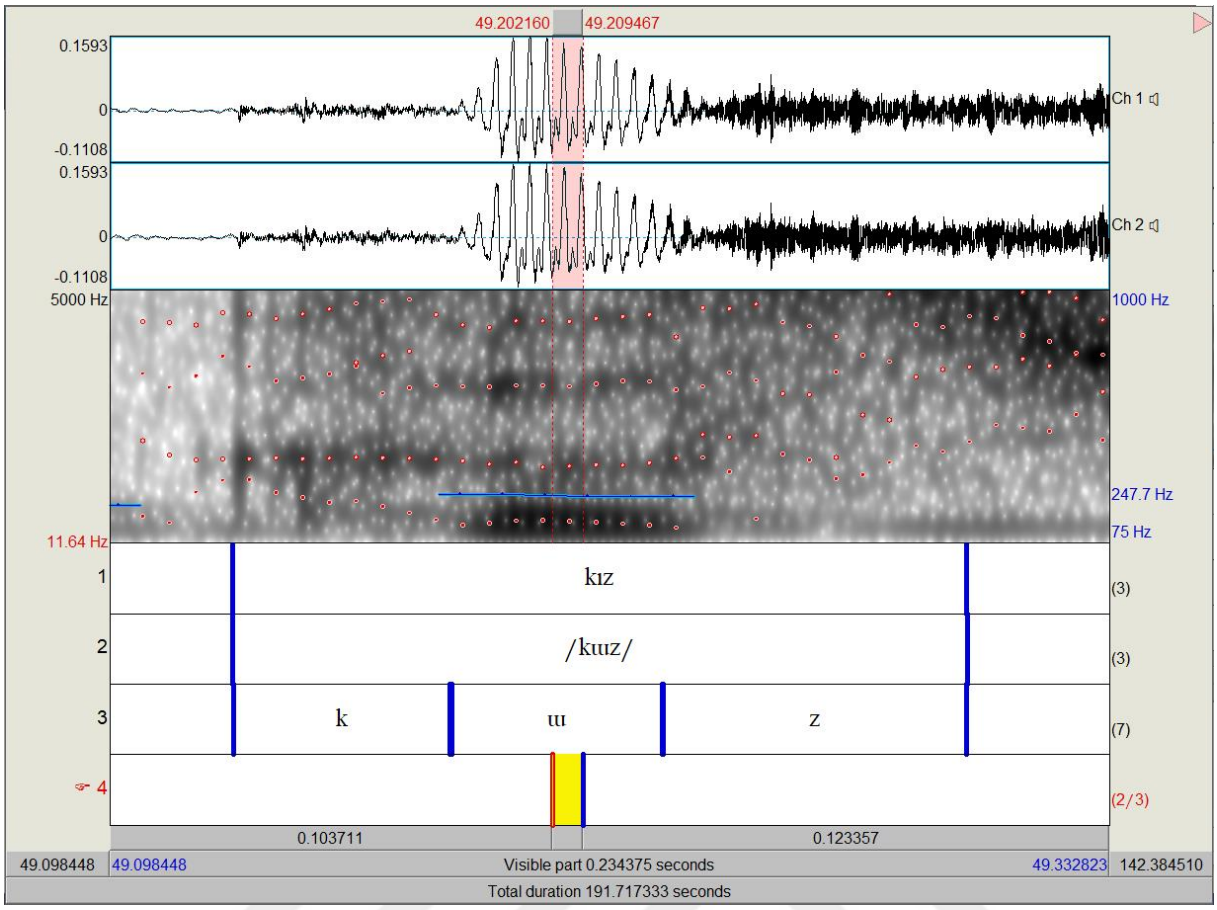


Figure 3.22. Sample segmentation for P17, (word: "kɪz", vowel: /ɯ/)

Through the analysis of sound records with Praat, mean formant values for F0, F1, and F2 were noted for each selection. The obtained numeric data were listed and saved in Excel format.

4. FINDINGS AND DISCUSSION

4.1. Findings

The numeric data collected from the Turkish participants were sorted, and processed to be used in analysis. A sample set of data of Participant 20 (Figure 4.1) and a sample set of data of Participant 9 (Figure 4.2) is presented which indicates information such as gender, target word, specific vowel, F0 mean of selection, F1 mean of selection, F2 mean of selection and selection start and end parameters.

LIST ORDER	P NR	GENDER	WORD	VOWEL	F0 MEAN	F1 MEAN	F2 MEAN	SAMPLE DURATION
1	P20	M	sheep	/i:/	208,53269254552114	382,2792791772576	2657,0381852017767	Selection start: 3.2515227256718795 seconds Selection end: 3.2583293590909905 seconds
2	P20	M	bill	/ɪ/	139,54136616746732	398,3465548467665	2410,7081665926976	Selection start: 6.919977107924901 seconds Selection end: 6.92891691198898 seconds
3	P20	M	ship	/ɪ/	211,15344751931005	421,18639664502234	2649,937494438341	Selection start: 8.071067456852356 seconds Selection end: 8.080209020731408 seconds
4	P20	M	bull	/ʊ/	250,5337242259257	479,2489637468655	1010,5201964103696	Selection start: 11.535273432225488 seconds Selection end: 11.543893155100527 seconds
5	P20	M	fill	/ɪ/	203,46247782852183	401,24157300624626	2600,286969755962	Selection start: 15.48785563006328 seconds Selection end: 15.49615724240632 seconds
6	P20	M	mess	/e/	134,4974539718457	685,6663345131672	1966,6682313695808	Selection start: 19.5557181450742 seconds Selection end: 19.566226481785534 seconds
7	P20	M	fool	/u:/	212,91392610789535	437,55144683594693	1059,8575008927035	Selection start: 21.002537624713145 seconds Selection end: 21.013029966101644 seconds
8	P20	M	miss	/ɪ/	169,42536830994788	465,13055622946854	1104,5950168644408	Selection start: 26.656281637913107 seconds Selection end: 26.662785616823683 seconds
9	P20	M	precede	/ə/	137,70405598934548	428,7512767280684	2452,3418842037195	Selection start: 31.479866133481952 seconds Selection end: 31.48862472086605 seconds
10	P20	M	bid	/ɪ/	129,03760500402961	423,94795951400016	2197,1308325455557	Selection start: 38.05527757318128 seconds Selection end: 38.068254309950504 seconds
11	P20	M	proceed	/ɪ/	154,72762903145437	478,3205676566897	1291,5901603142643	Selection start: 41.23458866179834 seconds Selection end: 41.245282253532864 seconds
12	P20	M	bird	/ɜ:/	154,92196576422808	533,1093340000305	1180,8820878993374	Selection start: 45.02483360413296 seconds Selection end: 45.035045275028004 seconds
13	P20	M	bill	/ɪ/	183,64379625151625	366,8657282123227	2494,6372499995014	Selection start: 51.461285345291095 seconds Selection end: 51.46842736221197 seconds
14	P20	M	bid	/ɪ/	174,24081292556204	360,32444104334746	2411,612318790218	Selection start: 53.740969512272585 seconds Selection end: 53.74940731139737 seconds
15	P20	M	ball	/ɔ:/	197,32352314471098	556,4252770144644	975,1299246339214	Selection start: 56.44250213396972 seconds Selection end: 56.452522595496575 seconds
16	P20	M	bad	/æ/	162,48919936727367	576,4551803143443	1915,478601765297	Selection start: 61.955870054689136 seconds Selection end: 61.96591162456809 seconds
17	P20	M	bitter	/ɪ/	174,2434751686903	343,6526943167237	2430,3966520511367	Selection start: 64.14767335118695 seconds Selection end: 64.15709972733833 seconds
18	P20	M	list	/ɪ/	180,28357492617266	524,1669223739974	1983,1324299415553	Selection start: 67.45460651431537 seconds Selection end: 67.46255869433229 seconds
19	P20	M	butter	/ʌ/	139,67029707207683	763,5605908413172	1354,4813964337322	Selection start: 69.3562222694365 seconds Selection end: 69.36471127855252 seconds
20	P20	M	last	/ɑ:/	186,2258666287617	847,6868402991909	1484,7399597931324	Selection start: 71.60926439950859 seconds Selection end: 71.61739721642722 seconds
21	P20	M	ship	/ɪ/	239,55047201435173	463,74540989177433	2464,8097962062984	Selection start: 74.91017375063609 seconds Selection end: 74.91685072633165 seconds
22	P20	M	feet	/i:/	133,84968299393628	314,7280069190513	2684,710704191612	Selection start: 80.49421662046298 seconds Selection end: 80.50084035967629 seconds

Figure 4.1. Sample formant values list for P20 (English)

23	P20	M	shop	/ɒ/	206,51530378441106	671,3977029846119	1150,9764886941327	Selection start: 81.91277166571463 seconds Selection end: 81.92130929173653 seconds
24	P20	M	foot	/ʊ/	--undefined--	344,2144162507639	809,2392089429283	Selection start: 85.78805450403961 seconds Selection end: 85.7976690851153 seconds
25	P20	M	teeth	/iː/	176,89261982088885	357,16856740099996	2727,252298991453	Selection start: 87.41013744594432 seconds Selection end: 87.41625902082367 seconds
26	P20	M	neat	/iː/	191,6647331246932	396,9247367225591	1141,7769304874641	Selection start: 91.86027374459567 seconds Selection end: 91.87081211854446 seconds
27	P20	M	tooth	/uː/	140,95781584790043	329,6589247900684	1069,753892652559	Selection start: 95.75540748827326 seconds Selection end: 95.76673836221003 seconds
28	P20	M	net	/e/	190,2426380680197	666,3177488545932	1136,4284295756866	Selection start: 101.14993760401018 seconds Selection end: 101.15805262788265 seconds
29	P20	M	seaport	/iː/	199,94946978766748	389,4213919782688	2413,4461633540805	Selection start: 103.87102814916702 seconds Selection end: 103.8788979170085 2 seconds
30	P20	M	bead	/iː/	191,4172809792245	357,95243157941627	2823,487326363704	Selection start: 107.38414080860984 seconds Selection end: 107.39354726616017 seconds
31	P20	M	support	/ə/	145,9879604375025	734,1993692360764	1309,090550137948	Selection start: 115.52094412519585 seconds Selection end: 115.528672356715 seconds
32	P20	M	bird	/ɜː/	135,40048887179282	520,9538029531566	1262,4839276568746	Selection start: 120.70895983232778 seconds Selection end: 120.71687389325108 seconds
33	P20	M	weak	/iː/	183,743493727658	366,5265184766947	2763,9273375330677	Selection start: 123.59610832707342 seconds Selection end: 123.6058992765613 seconds
34	P20	M	feet	/iː/	208,11394194969463	421,0527243052023	2383,0047990174558	Selection start: 125.09910627833783 seconds Selection end: 125.1069934044178 seconds
35	P20	M	walk	/ɔː/	142,464534682763	555,484022688358	898,1723226384789	Selection start: 130.74394609183253 seconds Selection end: 130.75295443607442 seconds
36	P20	M	fat	/æ/	142,18846511828318	730,0301152013745	1600,5539666426087	Selection start: 134.0202568714499 seconds Selection end: 134.03163005588593 seconds
37	P20	M	teach	/iː/	233,44131984638432	445,5347956478712	1129,7236331507213	Selection start: 135.46383880349958 seconds Selection end: 135.47337082866312 seconds
38	P20	M	least	/iː/	159,30487495408858	773,7089307323571	1452,5100179758115	Selection start: 139.58461788628 35 seconds Selection end: 139.5911870529642 seconds
39	P20	M	touch	/ʌ/	143,155396674396	805,8044440315359	1803,431306078317	Selection start: 143.22617603293958 seconds Selection end: 143.23395588314025 seconds
40	P20	M	last	/ɑː/	172,7949987663734	763,742624356791	1347,2406769167198	Selection start: 145.26307693099736 seconds Selection end: 145.271008445397 seconds
41	P20	M	least	/iː/	143,39399765647653	293,157825498465	2871,905841874447	Selection start: 151.35225050708 seconds Selection end: 151.36195683932294 seconds
42	P20	M	full	/ʊ/	147,09157855381392	381,8453812137056	916,4305960667728	Selection start: 153.9422042563018 seconds Selection end: 153.95154196402075 seconds
43	P20	M	lost	/ɒ/	181,5400097645477	581,1466272885034	1080,8526934379024	Selection start: 155.2554140605961 seconds Selection end: 155.2631229259769 seconds
44	P20	M	fool	/uː/	196,84528417510256	385,51850589822504	1030,1919761972345	Selection start: 158.01690262957695 seconds Selection end: 158.0261525888621 seconds
45	P20	M	pet	/e/	186,0224425095057	734,4930951663804	1888,1128215019282	Selection start: 162.81958911862523 seconds Selection end: 162.82557508022788 seconds

46	P20	M	backwoods	/ʊ/	160,1923687656244	417,2696883716072	1179,3544131618821	Selection start: 167.69555489250558 seconds Selection end: 167.70360560645773 seconds
47	P20	M	put	/ʊ/	216,3437841152735	673,5078655250509	1106,0926738562744	Selection start: 172.02292575274967 seconds Selection end: 172.03094790707135 seconds
48	P20	M	backwards	/ə/	163,81873107908433	499,7307642880956	1208,695492657632	Selection start: 174.9355400855302 seconds Selection end: 174.94306934510308 seconds
49	P20	M	pull	/ʊ/	235,54248245322975	470,3578700516277	978,895005805511	Selection start: 177.2860901772676 seconds Selection end: 177.29670756024157 seconds
50	P20	M	port	/ɔː/	150,85492811315447	528,1187479381596	928,446237132782	Selection start: 183.81479787881545 seconds Selection end: 183.82325647907646 seconds
51	P20	M	pearl	/ɜː/	185,07095100312281	640,42208689118	1236,032992381264	Selection start: 185.84222507113938 seconds Selection end: 185.8518050676864 seconds
52	P20	M	put	/ʊ/	215,54054259014674	806,4799694266273	1259,149817970418	Selection start: 189.40137568462 06 seconds Selection end: 189.4134828215874 seconds
53	P20	M	pat	/æ/	186,7802053237279	775,9966361133131	1789,5198133524377	Selection start: 193.7506348807715 seconds Selection end: 193.7596864694823 seconds
54	P20	M	look	/ʊ/	221,68300345210565	452,97517866649406	1283,4705684648643	Selection start: 195.70711999115684 seconds Selection end: 195.71253819640543 seconds
55	P20	M	put	/ʊ/	211,33421683707948	830,8155188840099	1226,9160040593179	Selection start: 198.6229325233132 seconds Selection end: 198.63139782978863 seconds
56	P20	M	luck	/ʌ/	--undefined--	776,8550590029502	1400,1464010960183	Selection start: 204.86357415007294 seconds Selection end: 204.87243233296113 seconds
57	P20	M	part	/ɑː/	163,61956911685672	705,5995487304627	1260,069047479203	Selection start: 207.2156846688916 seconds Selection end: 207.22426250231888 seconds
58	P20	M	pot	/ɒ/	156,2725774900293	670,6823569177171	1092,7614726209345	Selection start: 210.01424364063357 seconds Selection end: 210.0248301736139 seconds
59	P20	M	put	/ʊ/	173,14481988355385	678,6317758720865	1308,340641470831	Selection start: 216.09854287699406 seconds Selection end: 216.10340283958286 seconds
60	P20	M	put	/ʊ/	216,09794091491594	756,2889187928308	1280,4217323202656	Selection start: 218.8757635961666 seconds Selection end: 218.88201675231437 seconds
61	P20	M	fell	/e/	183,1662152309025	766,528826409998	1532,8213140656792	Selection start: 223.59135244202315 seconds Selection end: 223.59836486679816 seconds
62	P20	M	boot	/uː/	148,53821692218258	323,81386792731644	753,9869185966786	Selection start: 232.75414434805145 seconds Selection end: 232.76644017328155 seconds
63	P20	M	fool	/uː/	182,10130679040938	379,3360659093144	845,9503686095387	Selection start: 235.20163074421814 seconds Selection end: 235.2169990358497 seconds
64	P20	M	but	/ə/	150,93147235479253	791,6045919635925	1402,0744958494117	Selection start: 239.6597531413109 seconds Selection end: 239.66759209513438 seconds
65	P20	M	pool	/uː/	169,09340687531872	367,80783907744524	978,7926065272065	Selection start: 257.5992484050259 seconds Selection end: 257.60885032757864 seconds
66	P20	M	fall	/ɔː/	134,19172576328106	581,8325534898082	956,7017416570332	Selection start: 260.8637888469338 seconds Selection end: 260.87253993845496 seconds
67	P20	M	pearl	/ɜː/	206,80136940353484	630,8971336949278	1228,1030520307386	Selection start: 265.12396443422335 seconds Selection end: 265.1320620520447 seconds
68	P20	M	fool	/uː/	200,06988103261276	407,16634880879667	836,5062228032288	Selection start: 270.08150388801283 seconds Selection end: 270.09016174340553 seconds

Sample formant values list for P20 (English) (continuation of Figure 4.1.)

69	P20	M	man	/æ/	226,006998799305	685,5549470723001	1778,624976707478	Selection start: 272.66793853621044 seconds Selection end: 272.6766012480936 seconds
70	P20	M	shoot	/u:/	--undefined--	736,3907823858558	1595,4385759895154	Selection start: 277.57684930207984 seconds Selection end: 277.59203219586107 seconds
71	P20	M	moon	/u:/	151,31009761438628	416,76771883085627	1339,3392309071326	Selection start: 279.6752365967311 seconds Selection end: 279.6833979602271 seconds
72	P20	M	shut	/ʌ/	187,18108823682277	779,8532114308229	1575,1115177407873	Selection start: 281.5472033582384 seconds Selection end: 281.5572631933377 seconds
73	P20	M	bath	/ɑ:/	202,69424445174874	766,7728092040918	1789,6862572897187	Selection start: 283.9555644080586 seconds Selection end: 283.9665155862032 seconds
74	P20	M	poll	/ɒ/	177,8672605457484	533,2653129586599	896,1381835283169	Selection start: 300.1767858283828 seconds Selection end: 300.1851368288678 seconds
75	P20	M	booth	/u:/	127,11773250677113	511,46026073543214	886,2954604210335	Selection start: 312.12873482993194 seconds Selection end: 312.1383694578181 seconds
76	P20	M	pool	/u:/	164,74125256360455	477,3660683994358	845,5522338319869	Selection start: 316.9054232010999 seconds Selection end: 316.91597947290427 seconds
77	P20	M	essay	/e/	182,6151873115901	382,6485826377387	2648,0195478804862	Selection start: 321.40618677923936 seconds Selection end: 321.41415283050816 seconds
78	P20	M	bed	/e/	194,60268681322069	673,6412656170203	1992,761227012495	Selection start: 324.834051479252 seconds Selection end: 324.8437586029087 seconds
79	P20	M	assay	/ə/	160,7469148178806	636,405498214857	1957,9370779315846	Selection start: 330.7388633883654 seconds Selection end: 330.745861630898 seconds
80	P20	M	bird	/ɜ:/	175,9721394257663	588,9365690631108	1283,9940857540478	Selection start: 335.14979525290676 seconds Selection end: 335.1610947703969 seconds
81	P20	M	fell	/e/	176,21038071210327	730,8168544401144	1491,4326346383389	Selection start: 336.92960219490567 seconds Selection end: 336.9354869159027 seconds
82	P20	M	bad	/æ/	140,88435683626864	425,3261538459565	1926,5903726760528	Selection start: 341.06644660022334 seconds Selection end: 341.08200009193746 seconds
83	P20	M	fall	/ɔ:/	169,15446382083243	506,30581656656307	939,8146969280007	Selection start: 344.1750740892818 seconds Selection end: 344.18462611608425 seconds
84	P20	M	bed	/e/	135,3559093710445	657,8980611854203	1650,6251304406649	Selection start: 349.02077492845103 seconds Selection end: 349.0339701846892 seconds
85	P20	M	better	/e/	160,28297678520295	545,4124196740732	1695,500551439552	Selection start: 350.4621254066356 seconds Selection end: 350.472276780788 seconds
86	P20	M	pet	/e/	182,46251795541122	594,382228849642	2018,2733491559065	Selection start: 352.8235897093154 seconds Selection end: 352.8325406919145 seconds
87	P20	M	butter	/ʌ/	167,48468986649286	712,8835044593394	1239,3822782778218	Selection start: 354.8969050873513 seconds Selection end: 354.9062336893245 seconds
88	P20	M	part	/ɑ:/	167,96018531539175	735,970063689405	1282,8800402434042	Selection start: 359.5082755724254 seconds Selection end: 359.5181676636873 seconds
89	P20	M	less	/e/	135,85388505613912	624,7289448198364	1861,0314706587435	Selection start: 362.98553888349637 seconds Selection end: 362.9975758784747 seconds
90	P20	M	foreword	/ɜ:/	145,1550478583758	500,67750420286313	1071,0848707693528	Selection start: 366.9868650360682 seconds Selection end: 366.99761869872725 seconds
91	P20	M	loss	/ɒ/	177,69769179832298	574,1156087967914	1053,98476158721	Selection start: 373.4367355094356 seconds Selection end: 373.44500653415776 seconds
92	P20	M	forward	/ə/	154,71593466722	457,7396846056642	1092,8641417446945	Selection start: 375.98898738253655 seconds Selection end: 375.99820064666403 seconds
93	P20	M	audition	/ɔ:/	201,7520038758579	582,68629503299999	1184,9100881428337	Selection start: 383.8440327012034 seconds Selection end: 383.85425387245954 seconds
94	P20	M	objection	/ə/	145,92304177050556	579,6630456633748	1077,5838662849371	Selection start: 391.33501313402104 seconds Selection end: 391.34433508730586 seconds
95	P20	M	addition	/ə/	201,77292616584305	664,0540238027344	2075,038106172397	Selection start: 393.6473467034787 seconds Selection end: 393.6563917606439 seconds
96	P20	M	abjection	/æ/	167,25510626779433	712,6750676556342	1350,2287041517047	Selection start: 400.88220099270734 seconds Selection end: 400.8914876485752 seconds
97	P20	M	discus	/ə/	180,50531177549857	722,7516795647948	1353,1650990090297	Selection start: 410.3303463762 seconds Selection end: 410.34115416358554 seconds
98	P20	M	radar	/ɑ:/	--undefined--	564,1408131713106	1338,5090538817424	Selection start: 417.7033150232342 seconds Selection end: 417.7153344954798 seconds
99	P20	M	discuss	/ʌ/	175,98135067294612	724,76820704995	1265,4035119261293	Selection start: 420.0289561980984 seconds Selection end: 420.03942375590356 seconds
100	P20	M	raider	/ə/	145,6815495939704	431,6380828628824	1882,4492853837082	Selection start: 423.60505206510715 seconds Selection end: 423.6108820788037 seconds
101	P20	M	on	/ɒ/	157,28307305455698	550,8291315402831	1143,351259236371	Selection start: 427.66089582086687 seconds Selection end: 427.66893987332395 seconds
102	P20	M	walk	/ɔ:/	182,0538726091951	776,1245095969365	1159,5981620682205	Selection start: 430.54830800955773 seconds Selection end: 430.5585446277984 seconds
103	P20	M	an	/ə/	152,48735131469732	581,1890604155475	1612,592922193966	Selection start: 433.4052828767702 seconds Selection end: 433.41497652039766 seconds
104	P20	M	work	/ɜ:/	170,4381580549952	629,6907381091163	1166,9798818276665	Selection start: 436.7377938029878 seconds Selection end: 436.7471520250323 seconds
105	P20	M	bad	/æ/	150,0706560072103	658,7115537355128	1704,611412449455	Selection start: 439.79293021668195 seconds Selection end: 439.80607906922546 seconds
106	P20	M	bud	/ʌ/	135,7810145639752	366,21183947894747	977,3380310396275	Selection start: 445.6926833412319 seconds Selection end: 445.70223557215286 seconds
107	P20	M	bird	/ɜ:/	--undefined--	574,0701781836673	1289,4119996593568	Selection start: 448.0983677396948 seconds Selection end: 448.1077665420348 seconds
108	P20	M	bird	/ɜ:/	152,11634792406204	496,56048964987644	1205,6449082671963	Selection start: 453.13587122786197 seconds Selection end: 453.1424430037031 seconds
109	P20	M	dart	/ɑ:/	164,3396415834844	729,604522101375	1435,071604705493	Selection start: 455.4206907146249 seconds Selection end: 455.4282773482322 seconds
110	P20	M	poll	/ɒ/	233,66821497743706	465,43642942108653	939,9696830513363	Selection start: 457.19480530168 seconds Selection end: 457.2064873374774 seconds
111	P20	M	dirt	/ɜ:/	169,14111577123825	407,94111231996675	2319,665498518635	Selection start: 463.7928319286814 seconds Selection end: 463.80337683194375 seconds
112	P20	M	pearl	/ɜ:/	184,3054569322438	557,500995134202	1183,1402866366705	Selection start: 466.81258643175437 seconds Selection end: 466.8204806589543 seconds
113	P20	M	pat	/æ/	167,66398847070863	649,1478651165679	1757,218639168353	Selection start: 471.3310353995136 seconds Selection end: 471.344403359275 seconds
114	P20	M	torch	/ɔ:/	184,30254629533832	538,3892680547682	944,0415489492693	Selection start: 473.51668821650355 seconds Selection end: 473.5244995482283 seconds

Sample formant values list for P20 (English) (continuation of Figure 4.1.)

115	P20	M	port	/ɔ:/	230,20820416637102	595,6116545236991	962,5643980719178	Selection start: 475.8367276031361 seconds Selection end: 475.8466613228823 seconds
116	P20	M	touch	/ʌ/	197,05851624988284	804,2712436103279	1485,8361586905987	Selection start: 482.40937384079194 seconds Selection end: 482.41509751160066 seconds
117	P20	M	part	/ɑ:/	196,19257848115342	818,6649046909397	1332,91422765918	Selection start: 485.11568335290326 seconds Selection end: 485.12259534468177 seconds
118	P20	M	pot	/ɒ/	159,72142063095149	716,8220707931074	1203,2592231661715	Selection start: 490.86346427896797 seconds Selection end: 490.8702251240424 seconds
119	P20	M	port	/ɔ:/	82,62825079336008	574,9787567538835	1069,7039701889541	Selection start: 496.4746611243158 seconds Selection end: 496.48160226212343 seconds
120	P20	M	port	/ɔ:/	181,75359918565184	812,4908541405773	1205,9753396893364	Selection start: 499.65450673994224 seconds Selection end: 499.6617565421312 seconds
121	P20	M	cat	/æ/	205,42533204414602	383,7943818650426	2509,4423880979666	Selection start: 505.08117901622074 seconds Selection end: 505.0923607593848 seconds
122	P20	M	pat	/æ/	217,84902226342862	711,51753891493	1908,3683528534211	Selection start: 509.1929075762966 seconds Selection end: 509.2021706224655 seconds
123	P20	M	cut	/ʌ/	147,9044633744171	707,9702193894385	1321,2984184260706	Selection start: 513.8707296810258 seconds Selection end: 513.8789601116125 seconds
124	P20	M	part	/ɑ:/	185,08073717478376	785,5477360106385	1240,7191426324168	Selection start: 519.2213219844875 seconds Selection end: 519.2297421599278 seconds
125	P20	M	pat	/æ/	169,53271186636601	748,0802505199701	1580,7640764350376	Selection start: 524.2012314792349 seconds Selection end: 524.2109439609106 seconds
126	P20	M	butter	/ʌ/	119,0331553509582	672,1855505557163	1228,8871791413633	Selection start: 527.2162680797754 seconds Selection end: 527.2248467875902 seconds
127	P20	M	pot	/ɒ/	188,91231288196812	572,1257903019531	987,2574249028347	Selection start: 531.3148875352683 seconds Selection end: 531.3240574329501 seconds
128	P20	M	barter	/ɑ:/	160,26415092811524	728,3837179734588	1242,9209654811	Selection start: 535.6479995062571 seconds Selection end: 535.6566818628419 seconds
129	P20	M	lock	/ɒ/	142,6330011149947	638,9141216391384	1046,9392125456493	Selection start: 541.8382408969944 seconds Selection end: 541.8491000183158 seconds
130	P20	M	part	/ɑ:/	160,79046614393178	784,3533743216146	1231,9528263395757	Selection start: 544.3645787671605 seconds Selection end: 544.374809728668 seconds
131	P20	M	luck	/ʌ/	179,23520057299146	818,4729499497872	1363,4903546410908	Selection start: 546.918108324766 seconds Selection end: 546.9284983604828 seconds
132	P20	M	pot	/ɒ/	148,76245230286122	808,0923743409143	1348,7685741725973	Selection start: 549.708256229603 seconds Selection end: 549.718215142042 seconds

Sample formant values list for P20 (English) (continuation of Figure 4.1.)

LIST ORDER	P NR	GENDER	WORD	VOWEL	F0 MEAN	F1 MEAN	F2 MEAN	SAMPLE DURATION
1	P9	F	baş	/a/	463,0667093384721	904,0053593460952	1692,382639362372	Selection start: 2,8806770794516363 seconds Selection end: 2,8836052662028027 seconds
2	P9	F	kaz	/a/	268,1220364993035	1043,5703244359913	1398,1863990732006	Selection start: 12,962738799482974 seconds Selection end: 12,96791943758119 seconds
3	P9	F	beş	/e/	286,00434122364607	570,1995106055563	2031,26083291838	Selection start: 14,52449173082018 seconds Selection end: 14,530348104322513 seconds
4	P9	F	kız	/ɯ/	356,99958925660235	413,35722678301585	1598,595337119267	Selection start: 17,09291625354519 seconds Selection end: 17,09719591110459 seconds
5	P9	F	kan	/a/	321,8998771527738	715,8808414190762	1215,2208754081764	Selection start: 21,19144424309934 seconds Selection end: 21,194822920119915 seconds
6	P9	F	baş	/a/	291,19461818793343	705,1348815161064	1249,823734563581	Selection start: 23,728106592022264 seconds Selection end: 23,7318231367449 seconds
7	P9	F	kin	/i/	325,0639438005548	407,0268867793797	2587,7509805460822	Selection start: 27,589550996136616 seconds Selection end: 27,595182124504245 seconds
8	P9	F	boş	/o/	334,8503447731604	407,1277059390476	963,2901307277065	Selection start: 29,787369912007044 seconds Selection end: 29,79018547619086 seconds
9	P9	F	köle	/ø/	254,1625718368865	291,36076277730405	1897,8241977524767	Selection start: 33,186608533339718 seconds Selection end: 33,1922396617648 seconds
10	P9	F	az	/a/	--undefined--	785,3572231268633	1187,8074296934233	Selection start: 37,048166038837564 seconds Selection end: 37,05109422558873 seconds
11	P9	F	kale	/a/	291,57653362321844	619,106833011332	1919,682253187261	Selection start: 39,34356491649664 seconds Selection end: 39,34705621608457 seconds
12	P9	F	uz	/u/	290,59386110514316	416,95921774763644	929,3261528988925	Selection start: 41,570921265295446 seconds Selection end: 41,57542616798955 seconds
13	P9	F	tam	/a/	387,77503929686964	772,3712995668081	1295,8374998564277	Selection start: 44,778906376908296 seconds Selection end: 44,78408701500651 seconds
14	P9	F	kez	/e/	447,59451502777677	546,0710135017127	1515,6698952700908	Selection start: 48,28643476903091 seconds Selection end: 48,29161540712913 seconds
15	P9	F	tüm	/y/	387,3577391727277	409,1453669578908	1824,788203265417	Selection start: 54,05904846204743 seconds Selection end: 54,06310287447212 seconds
16	P9	F	kız	/ɯ/	377,7829341470903	408,607703302071	1685,5116412751213	Selection start: 57,78314524968124 seconds Selection end: 57,78765015237534 seconds
17	P9	F	kel	/e/	308,8005037131524	711,3966528912388	1883,3947242152758	Selection start: 62,25562980535967 seconds Selection end: 62,2617114239967 seconds
18	P9	F	ten	/e/	223,26258366187687	831,1342117921813	1624,4974275019283	Selection start: 64,51306290267804 seconds Selection end: 64,51824354077627 seconds
19	P9	F	kil	/i/	338,3856922574878	343,5376352156977	2242,3375407954754	Selection start: 76,20072827601827 seconds Selection end: 76,20500793357766 seconds
20	P9	F	ton	/o/	310,1660556261872	570,0963435619312	755,2844744573667	Selection start: 80,62387150432664 seconds Selection end: 80,6306288583678 seconds

Figure 4.2. Sample formant values list for P9 (Turkish)

21	P9	F	gez	/e/	385,15115774735716	486,51240595783077	2410,8394174361856	Selection start: 83,0083914490788 seconds Selection end: 83,01559929338937 seconds
22	P9	F	kem	/e/	406,35569921312685	781,9089932072443	2085,3626884498435	Selection start: 85,7499399875187 seconds Selection end: 85,75602160615574 seconds
23	P9	F	göz	/ø/	366,5067568672244	463,5963958055022	1469,1339881093143	Selection start: 88,34112249401488 seconds Selection end: 88,34652837724781 seconds
24	P9	F	kum	/u/	362,3583849795215	445,42116806587336	982,4902899265804	Selection start: 90,86133512113702 seconds Selection end: 90,86516428842701 seconds
25	P9	F	gel	/e/	218,86296531290006	677,325673085505	1902,9224334121695	Selection start: 94,30079131985336 seconds Selection end: 94,30619720308628 seconds
26	P9	F	dış	/ɯ/	328,1295687639773	342,6846253655547	2278,631480393845	Selection start: 96,95397099399284 seconds Selection end: 96,95734967101342 seconds
27	P9	F	gül	/y/	311,3941166836009	322,6916657270098	1607,2736893827494	Selection start: 100,64263203097707 seconds Selection end: 100,64871364961411 seconds
28	P9	F	diş	/i/	329,3758414704451	347,13241203920273	2634,184603184987	Selection start: 102,79563326858445 seconds Selection end: 102,80047603898062 seconds
29	P9	F	kır	/ɯ/	386,2178177101919	455,84675222172416	1580,780646621315	Selection start: 106,10652748707817 seconds Selection end: 106,11193337031109 seconds
30	P9	F	kır	/ɯ/	369,124994646394	389,16642289157363	1838,8509174252551	Selection start: 110,95514915498435 seconds Selection end: 110,95920356740905 seconds
31	P9	F	kor	/o/	341,18561764947486	457,7546104185619	950,3930683725341	Selection start: 113,93036065547479 seconds Selection end: 113,935541293573 seconds
32	P9	F	kör	/ø/	416,5184531272301	567,7705660293054	1301,018940587701	Selection start: 116,26306205728355 seconds Selection end: 116,26756695997764 seconds
33	P9	F	kıl	/ɯ/	371,5168143892582	395,5865914943478	1476,6272909381246	Selection start: 120,06333984276014 seconds Selection end: 120,06716901005014 seconds
34	P9	F	dış	/ɯ/	336,20035112003615	354,1347935793552	1971,8769210988642	Selection start: 124,01819603212846 seconds Selection end: 124,02292617995727 seconds
35	P9	F	kul	/u/	428,84263490566116	480,1630318245871	1197,1849862144568	Selection start: 126,88938422170712 seconds Selection end: 126,892537653593 seconds
36	P9	F	düş	/y/	341,1970320626289	344,5888572463775	2005,7960826163032	Selection start: 130,3609374149616 seconds Selection end: 130,36589280792512 seconds
37	P9	F	kol	/o/	339,8447694586702	512,8292786356309	868,4582491500845	Selection start: 133,55406757821453 seconds Selection end: 133,55992395171688 seconds
38	P9	F	kör	/ø/	410,4316777314854	722,6856757427511	1376,4284067657882	Selection start: 141,97466793872297 seconds Selection end: 141,98074955736 seconds
39	P9	F	kil	/i/	360,4253016348904	362,2852198255701	2551,3813218997248	Selection start: 146,16278518776437 seconds Selection end: 146,16796582586258 seconds
40	P9	F	kir	/i/	414,1154332141849	419,3252452639387	2820,199590639175	Selection start: 149,7557049947696 2 seconds Selection end: 149,76178661340666 seconds
41	P9	F	pil	/i/	374,7569050627176	377,80461997498367	2719,70667564179	Selection start: 154,4069167633287 seconds Selection end: 154,41187215629222 seconds

42	P9	F	süren	/y/	--undefined--	784,0946815197635	2018,6838105644433	Selection start: 157,33120377362454 seconds Selection end: 157,33660965685746 seconds
43	P9	F	pul	/u/	362,7913838786334	371,3605988631906	987,3439640501559	Selection start: 162,4646808157512 seconds Selection end: 162,47053718925352 seconds
44	P9	F	siren	/i/	322,13170102332157	334,3547115539888	2209,3186772268036	Selection start: 165,70831468155285 seconds Selection end: 165,7139458099205 seconds
45	P9	F	kör	/ø/	257,5292838536147	541,3223629217877	1457,0739288425866	Selection start: 169,7977144865148 seconds Selection end: 169,80154365380477 seconds
46	P9	F	buz	/u/	380,51827715581464	399,141870649061	1128,981986264235	Selection start: 172,4066990253813 seconds Selection end: 172,41120392807542 seconds
47	P9	F	kor	/o/	322,5374232924155	612,9449510030296	819,7006168185485	Selection start: 178,76300360194713 seconds Selection end: 178,76863473031474 seconds
48	P9	F	boz	/o/	279,59538931779923	547,3120699818766	861,6158935722549	Selection start: 182,16390643271683 seconds Selection end: 182,17246574783562 seconds
49	P9	F	dün	/y/	357,26037007275846	373,16922093697286	1732,6381258312197	Selection start: 185,82287094911635 seconds Selection end: 185,83007879342694 seconds
50	P9	F	köle	/ø/	306,98997589974186	423,3312777813654	1671,4834841499428	Selection start: 191,90893880960041 seconds Selection end: 191,91434469283334 seconds
51	P9	F	don	/o/	338,28094557583853	654,4139394912319	894,0367082331418	Selection start: 194,3300196505042 seconds Selection end: 194,3349750434677 seconds
52	P9	F	kule	/u/	395,3690599515555	407,06008094875835	1596,3886489286735	Selection start: 198,39539415404275 seconds Selection end: 198,3997864341695 seconds
53	P9	F	güz	/y/	304,58744594948723	323,80722921172656	1805,2777655123534	Selection start: 202,94397103373163 seconds Selection end: 202,95027789750338 seconds
54	P9	F	tür	/y/	322,24007120099225	351,6320263089243	1633,4080526940197	Selection start: 205,84883326165942 seconds Selection end: 205,85446439002706 seconds
55	P9	F	göz	/ø/	349,74446021388343	422,26154575777906	1358,0031798670605	Selection start: 210,7675795295269 seconds Selection end: 210,77388639329862 seconds
56	P9	F	tur	/u/	255,57671125633843	450,91072802878404	1413,6204845633501	Selection start: 215,0716756817204 seconds Selection end: 215,07471649102007 seconds

Sample formant values list for P9 (Turkish) (Continuation of Figure 4.2.)

All formant values were combined on two single Excel worksheets, one worksheet for English formant values and one for Turkish formant values, the particular lists of specific formant values were obtained by filtering the data within the Excel software.

In the calculation of the mean formant values, the F1 and F2 values of the vowels whose F0 value was marked as "undefined" by Praat were excluded from the calculation. The values were rounded up to an integer numeral value by Excel during the mean calculation.

Mean F1 and F2 values for each participant and/or for each specific vowel were calculated by filtering the spreadsheet (Table 4.1 and Table 4.2).

Table 4.1. Sample calculation of mean F1 and F2 values for English vowel /ɒ/ for P1

P1 Mean Formant Values for English Vowel /ɒ/				
P Nr	**Word**	**Vowel**	**F1 Mean**	**F2 Mean**
P1	shop	/ɒ/	504	1369
P1	lost	/ɒ/	467	964
P1	pot	/ɒ/	439	981
P1	poll	/ɒ/	330	904
P1	loss	/ɒ/	457	958
P1	on	/ɒ/	526	967
P1	poll	/ɒ/	371	977
P1	pot	/ɒ/	484	986
P1	pot	/ɒ/	478	975
P1	lock	/ɒ/	478	1017
P1	pot	/ɒ/	467	1032
		MEAN	**455**	**1012**

Table 4.2. Sample calculation of mean F1 and F2 values for Turkish vowel /ɯ/ for P4.

P4 Mean Formant Values for Turkish Vowel /ɯ/				
P Nr	**Word**	**Vowel**	**F1 Mean**	**F2 Mean**
P4	kız	/ɯ/	530	1548
P4	kız	/ɯ/	335	1627
P4	dış	/ɯ/	328	2004
P4	kır	/ɯ/	460	1916
P4	kır	/ɯ/	344	1980
P4	kıl	/ɯ/	492	1571
P4	dış	/ɯ/	331	1967
		MEAN	**403**	**1802**

Mean F1 and F2 values for each specific vowels of Turkish (Figure 4.3) and vowels of English (Figure 4.4) were combined in spreadsheets.

Table 4.3. Mean F1 and F2 Values for Turkish Vowels

Mean Formant Values for Turkish Vowels									
P Nr	**F**	**/a/**	**/e/**	**/ɯ/**	**/i/**	**/o/**	**/ø/**	**/u/**	**/y/**
P1	***F1***	540	493	383	339	463	423	370	336
	F2	1200	1593	1418	1930	953	1353	1187	1604
P2	***F1***	705	586	397	342	558	504	507	351
	F2	1255	1751	1594	1889	946	1544	1392	1757
P3	***F1***	758	644	407	356	537	510	408	391
	F2	1521	2061	1586	2435	948	1486	1106	1671
P4	***F1***	880	736	403	348	607	520	431	373
	F2	1473	1921	1802	2059	1141	1553	1149	1778
P5	***F1***	948	885	636	494	785	721	562	537
	F2	1455	1996	1951	2173	1086	1650	1264	1939
P6	***F1***	810	824	425	412	625	567	401	343
	F2	1650	2026	1967	2685	1148	1651	1232	2007
P7	***F1***	756	709	415	381	556	512	428	370
	F2	1380	2011	1600	2432	955	1463	1060	1722
P8	***F1***	771	761	464	345	556	531	396	357
	F2	1487	2011	1681	2192	1011	1653	1302	1871
P9	***F1***	793	658	394	370	538	490	424	354
	F2	1462	1922	1776	2538	873	1504	1176	1768
P10	***F1***	943	798	573	411	660	638	439	404
	F2	1554	2079	1859	2295	1074	1639	1219	2015
P11	***F1***	859	712	524	435	559	541	432	414
	F2	1607	2173	1802	2744	1090	1645	1267	1784
P12	***F1***	655	573	415	323	541	485	387	358
	F2	1338	1806	1623	2019	924	1540	1122	1741
P13	***F1***	528	453	309	289	418	422	348	303
	F2	1249	1701	1550	2119	981	1331	1062	1777
P14	***F1***	585	522	367	330	486	454	393	368
	F2	1277	1757	1619	2021	866	1374	1090	1673
P15	***F1***	671	569	389	331	532	481	447	509
	F2	1358	1776	1671	1947	1016	1485	1488	1903
P16	***F1***	682	588	396	381	565	477	412	348
	F2	1342	1860	1666	2100	1001	1513	1227	1840
P17	***F1***	805	653	456	412	493	518	459	398
	F2	1597	2225	1731	2373	1114	1753	1153	1884
P18	***F1***	651	506	383	320	478	442	418	328
	F2	1190	1739	1536	1957	1091	1504	1244	1667
P19	***F1***	617	512	360	316	514	408	372	310
	F2	1260	1758	1562	1983	838	1572	1087	1719
P20	***F1***	729	629	422	403	530	511	444	409
	F2	1402	2071	1704	2441	976	1433	1125	1717

Table 4.4. Mean F1 and F2 Values for English Vowels

Mean Formant Values for English Vowels													
P Nr	**F**	**/ɪ/**	**/iː/**	**/ʊ/**	**/uː/**	**/e/**	**/ə/**	**/ɜː/**	**/ɔː/**	**/æ/**	**/ʌ/**	**/ɑː/**	**/ɒ/**
P1	***F1***	329	321	392	433	483	491	447	515	500	498	556	455
	F2	1958	2050	1024	1177	1452	1255	1329	998	1410	1164	1171	1012
P2	***F1***	352	377	550	503	581	566	546	580	656	643	659	612
	F2	1910	1973	1203	1043	1643	1367	1167	950	1506	1140	1245	1020
P3	***F1***	418	405	453	428	714	609	562	574	753	743	805	675
	F2	2347	2600	1228	1182	1951	1775	1436	1055	1945	1542	1465	1311
P4	***F1***	429	384	508	427	674	574	580	667	741	754	723	592
	F2	2149	2316	1161	1047	1879	1696	1490	1160	1809	1381	1490	1142
P5	***F1***	527	562	651	526	934	803	724	659	1014	978	930	736
	F2	2348	2560	1197	1039	1992	1664	1670	947	1939	1497	1356	1063
P6	***F1***	525	370	625	403	944	682	715	706	927	888	978	762
	F2	2174	2572	1445	1521	1835	1853	1400	1185	1670	1649	1527	1334
P7	***F1***	460	358	479	436	738	656	608	573	778	770	803	642
	F2	2360	2845	1079	962	1845	1592	1260	920	1746	1540	1318	1116
P8	***F1***	448	489	448	417	808	638	632	616	805	803	809	630
	F2	2149	2196	1126	1151	1603	1581	1339	1056	1603	1370	1401	1114
P9	***F1***	451	325	456	375	706	637	578	639	801	756	825	664
	F2	2111	2803	1109	999	1815	1578	1238	1038	1690	1422	1378	1187
P10	***F1***	472	508	749	560	786	695	737	751	951	809	957	764
	F2	2312	2487	1283	1144	1973	1675	1514	1320	1672	1434	1540	1232
P11	***F1***	482	478	562	506	778	647	620	667	786	806	824	672
	F2	2707	2683	1281	1081	2044	1894	1497	1243	1883	1678	1533	1304
P12	***F1***	412	325	468	396	661	578	587	614	640	730	747	587
	F2	1921	2292	1073	1013	1684	1414	1263	964	1647	1352	1305	1042
P13	***F1***	327	354	492	412	555	482	469	502	559	575	578	511
	F2	1973	1855	1042	983	1461	1386	1179	975	1396	1229	1218	1038
P14	***F1***	257	337	400	386	526	501	463	463	539	605	616	472
	F2	1975	2228	1084	1013	1678	1350	1156	983	1709	1222	1173	918
P15	***F1***	345	364	477	399	614	575	535	604	626	632	722	584
	F2	2055	2101	1206	1083	1657	1460	1183	1443	1590	1345	1342	1179
P16	***F1***	384	398	439	519	589	545	533	576	574	634	701	572
	F2	2160	2201	1080	1096	1770	1499	1340	942	1800	1444	1289	1014
P17	***F1***	419	437	454	423	737	677	547	568	772	861	765	608
	F2	2504	2635	1130	1027	2059	1783	1630	1103	2022	1552	1635	1119
P18	***F1***	348	349	451	414	567	541	512	597	599	617	632	607
	F2	1906	2021	1292	903	1569	1484	1190	982	1572	1235	1133	832
P19	***F1***	338	293	466	355	530	530	525	548	561	611	670	582
	F2	1929	2114	1041	1020	1639	1395	1153	826	1647	1251	1169	996
P20	***F1***	422	409	595	404	642	593	551	601	642	716	767	617
	F2	2185	2277	1155	965	1807	1584	1314	1020	1802	1361	1365	1086

Distribution of Mean F1 and F2 values for each gender for each specific vowels of Turkish (Table 4.5) and vowels of English (Table 4.6) were defined by filtering the spreadsheet.

Table 4.5. Distribution of Mean Formant Values for Turkish Vowels for Genders

Distribution of Mean Formant Values for Turkish Vowels for Genders									
Gender	**F**	**/a/**	**/e/**	**/ɯ/**	**/i/**	**/o/**	**/ø/**	**/u/**	**/y/**
Female	***F1***	833	738	470	396	592	555	438	393
	F2	1519	2042	1777	2388	1044	1600	1193	1841
Male	***F1***	636	543	382	337	509	461	410	362
	F2	1287	1781	1594	2040	959	1465	1202	1740

Table 4.6. Distribution of Mean Formant Values for English Vowels for Genders

Distribution of Mean Formant Values for English Vowels for Genders													
Gender	**F**	**/ɪ/**	**/iː/**	**/ʊ/**	**/uː/**	**/e/**	**/ə/**	**/ɜː/**	**/ɔː/**	**/æ/**	**/ʌ/**	**/ɑː/**	**/ɒ/**
Female	***F1***	463	431	539	450	782	663	630	642	833	817	842	674
	F2	2316	2570	1204	1116	1900	1709	1447	1103	1798	1506	1466	1192
Male	***F1***	361	353	473	422	575	540	516	560	589	624	664	560
	F2	1997	2111	1121	1030	1636	1419	1227	1008	1608	1273	1240	1014

Overall mean F1 and F2 values for vowels of Turkish (Table 4.7) and vowels of English (Table 4.8) were calculated by filtering the spreadsheet.

Table 4.7. Overall Mean Formant Values for Turkish Vowels

Overall Mean Formant Values for Turkish Vowels									
	F	**/a/**	**/e/**	**/ɯ/**	**/i/**	**/o/**	**/ø/**	**/u/**	**/y/**
Overall Mean	***F1***	734	641	426	367	550	508	424	377
	F2	1402	1912	1685	2213	1002	1532	1198	1789

Table 4.8. Overall Mean Formant Values for English Vowels

Overall Mean Formant Values for English Vowels													
	F	**/ɪ/**	**/iː/**	**/ʊ/**	**/uː/**	**/e/**	**/ə/**	**/ɜː/**	**/ɔː/**	**/æ/**	**/ʌ/**	**/ɑː/**	**/ɒ/**
Overall Mean	***F1***	412	393	506	436	678	601	574	600	711	721	754	616
	F2	2156	2338	1163	1073	1768	1562	1338	1055	1703	1390	1354	1102

To be used for comparative analysis, set of reference formant values was obtained from the works of Deterding (1997) and Bates (1995). Formant values of English eleven monophthong vowels excluding British schwa was measured by Deterding (see Figure 2.27 and Figure 2.28). F1 and F2 values of British schwa was obtained from Bates's study which presents values of one male speaker (see Figure 2.30) (Bates, 1995), and from the research by Marusso and Silva (2007) which presents values by four native British English speakers (see Figure 2.31). The set of reference formant values was formed by combination of data obtained (Table 4.9 and Table 4.10).

Table 4.9. Distribution of Reference Mean Formant Values for English Vowels for Genders

Distribution of Reference Mean Formant Values for English Vowels for Genders													
Gender	**F**	**/ɪ/**	**/iː/**	**/ʊ/**	**/uː/**	**/e/**	**/ə/**	**/ɜː/**	**/ɔː/**	**/æ/**	**/ʌ/**	**/ɑː/**	**/ɒ/**
Female	***F1***	384	292	395	322	607	619	542	402	854	779	778	655
	F2	2174	2654	1340	1437	2063	1585	1695	888	1799	1459	1316	1215
Male	***F1***	367	280	379	316	494	481	478	415	690	644	646	558
	F2	1757	2249	1173	1191	1650	1445	1436	828	1550	1259	1155	1047

Table 4.10. Distribution of Overall Reference Mean Formant Values for English Vowels

Distribution of Overall Reference Mean Formant Values for English Vowels													
	F	**/ɪ/**	**/iː/**	**/ʊ/**	**/uː/**	**/e/**	**/ə/**	**/ɜː/**	**/ɔː/**	**/æ/**	**/ʌ/**	**/ɑː/**	**/ɒ/**
Overall	***F1***	376	292	395	322	607	550	542	402	854	779	778	655
Mean	***F2***	1966	2452	1257	1314	1857	1515	1565	858	1675	1359	1236	1131

Representation of average F1 and F2 values makes it possible to review the positions of vowels on an F1-F2 axis. The figures were generated both on average F1 and F2 values and on normalized values with the Bark Scale (Traunmüller, 1990). The normalization of the data was processed using the following formula:

$$\text{Bark} = [(26.81f)/(1960 + f)] - 0.53$$

The vowel space areas were calculated as the area of the convex hulls and the outer borders limit the outermost spots of the vowel space. The fill colours represent the genders – green colour for males and red colour for females.

The confidence ellipses were calculated with the confidence level 68.27% (roughly 68%) corresponding to ±1 standard deviation of the normal density contour estimated from the data; the figures of confidence ellipses without individual tokens were preferred in order to simplify the view of the figure.

Vowel plots and confidence ellipses for English vowels performed by Turkish participants are shown in Figure 4.3. The calculation was based on the means of F1 and F2 values of the vowels. The vowel plots are on the left, the confidence ellipses are on the right; green colours represent data from male participants and red colour represent data from female participants. Figure 4.4 presents the vowel plots and confidence ellipses for the same groups and the same vowels whereas the calculation was based on the normalized data with Bark scale.

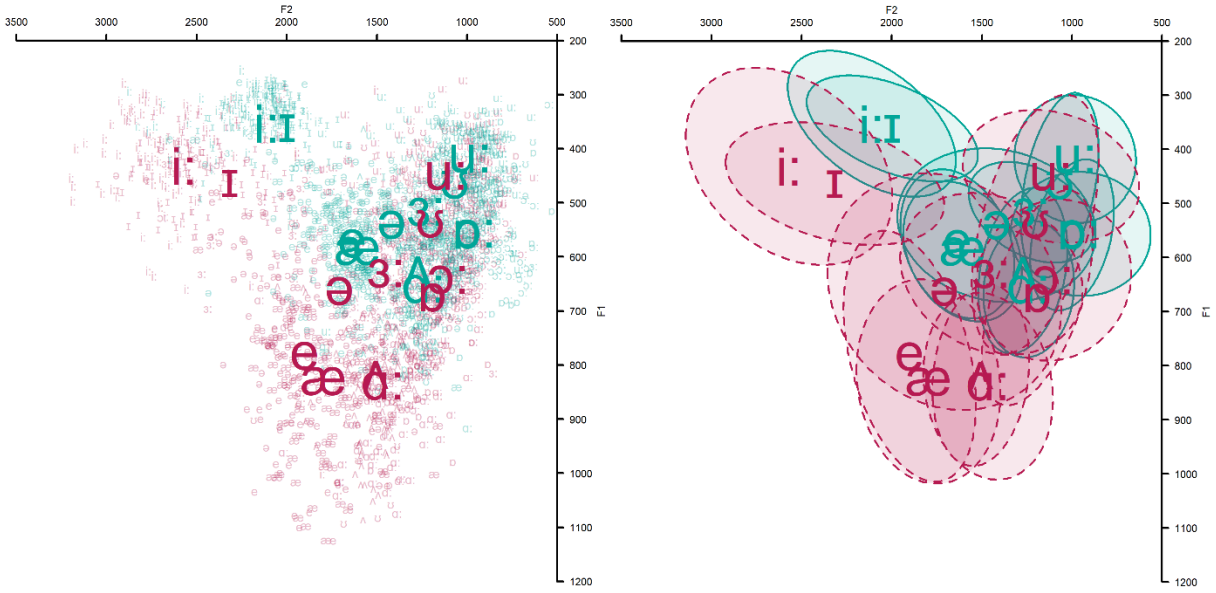


Figure 4.3. Vowel plots and confidence ellipses for English vowels performed by Turkish participants.

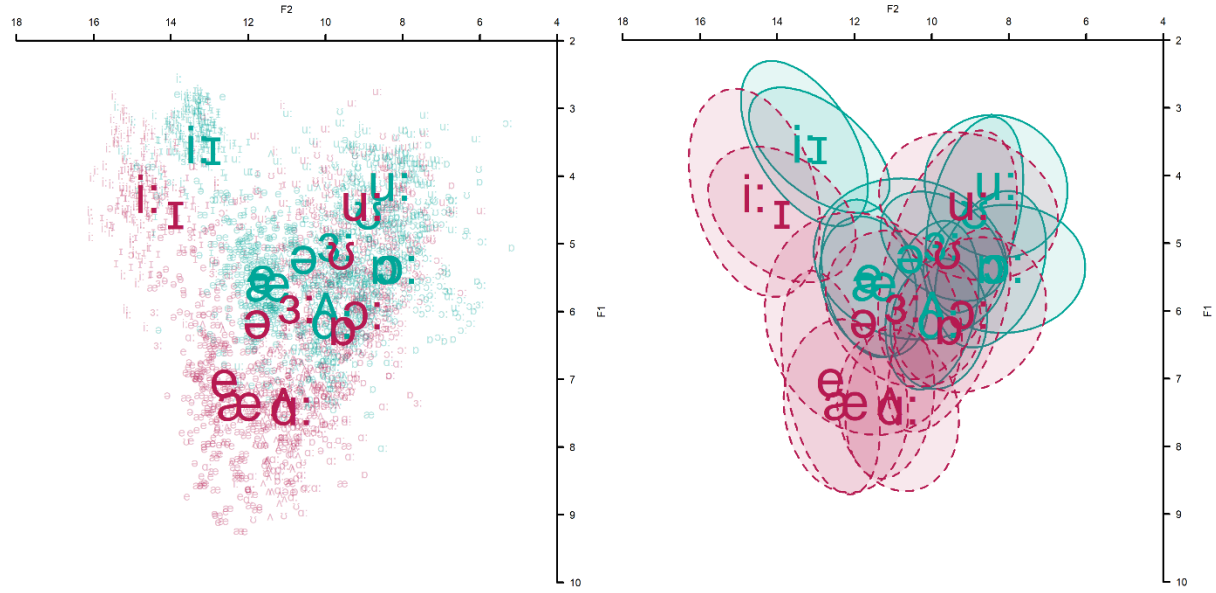


Figure 4.4. Normalized view of vowel plots and confidence ellipses for English vowels performed by Turkish participants (Bark).

Vowel space areas for English vowels performed by Turkish participants are shown in Figure 4.5. The calculation of vowel space on the left was based on the means of F1 and F2 values of the vowels while the calculation of vowel space on the right was based on normalized data with Bark scale. Green colours represent data from male participants and red colour represent data from female participants.

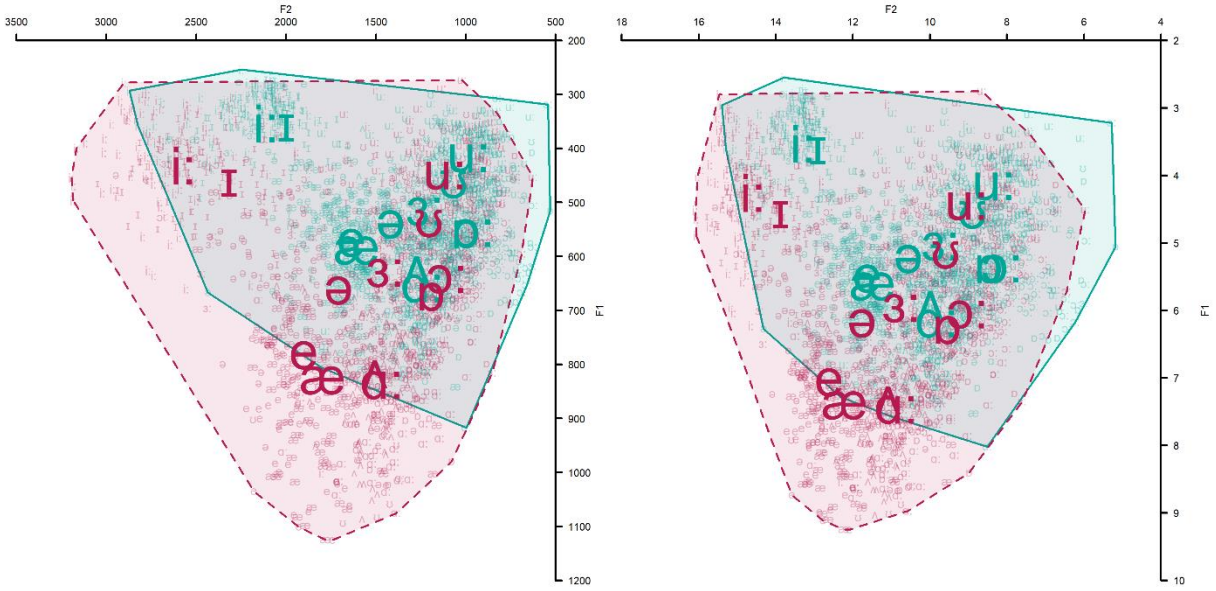


Figure 4.5. Vowel space areas for English vowels performed by Turkish participants.

Prior to examining the numerical data, it is evident from the overall perspective of Figures 4.3 and 4.4, as well as from the placement of the F1 and F2 values derived from the Turkish participants' English vowel pronunciations on the axes, that there is a visible disparity in the vowel pronunciations of the male and female participants. The vowel space areas show this natural distinction more clearly (Figure 4.5).

On the chart, some vowels that may have comparable articulation in both genders can be seen to be close to one another and form groups (/ɪ/ and /i:/), (/ʊ/ and /u:/), (/ɔ:/ and /ɒ/), (/ʊ/ and /u:/). Certain vowels (/ɔ:/ and /ɒ/ in males), (/e/ and /æ/ in males), (/ʌ/ and /ɑ:/ in males), (/ʌ/ and /ɑ:/ in females) can be observed to overlap beyond proximity.

Figure 4.6 displays vowel plots and confidence ellipses for English vowels performed by British participants. The computation relied on the averages of the vowel F1 and F2 values. The confidence ellipses are on the right, while the vowel plots are on the left. The data from male participants is represented by green colour, and the data from female participants is represented by red colour. While the computation was based on the normalised data using Bark scale, Figure 4.7 shows the vowel plots and confidence ellipses for the same groups and vowels.

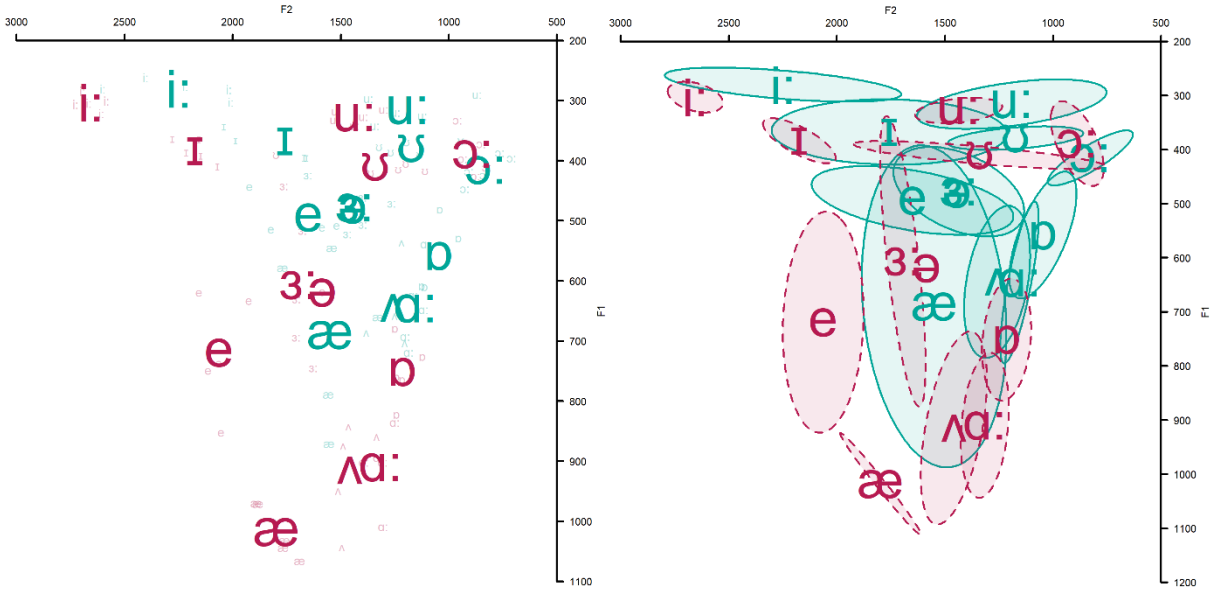


Figure 4.6. Vowel plots and confidence ellipses for English vowels performed by British participants (reference values).

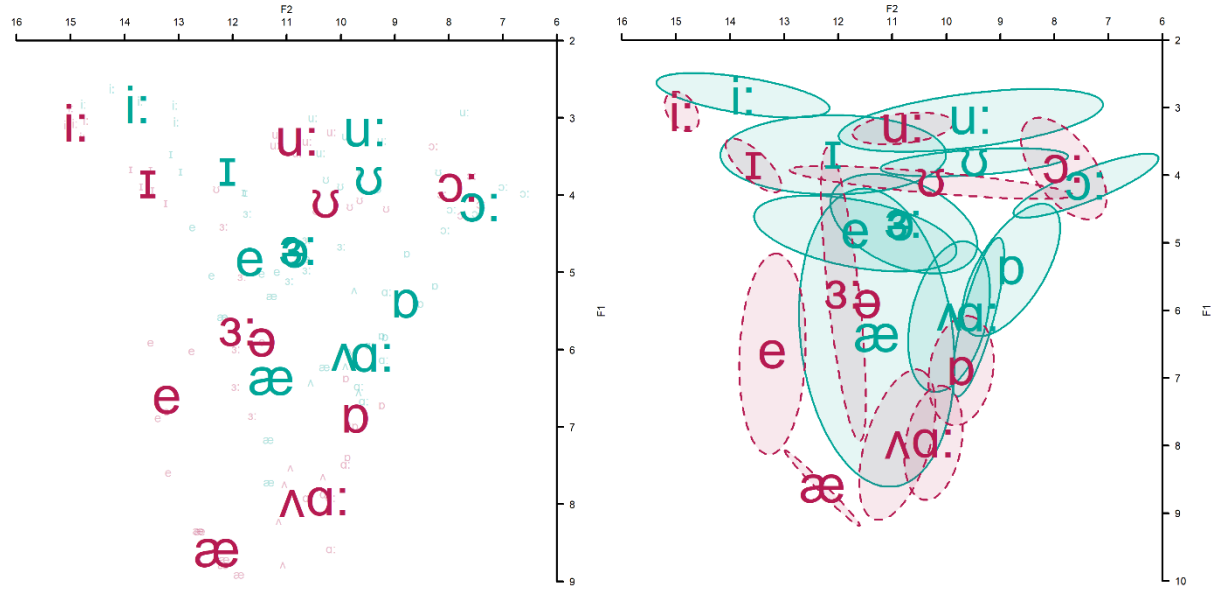


Figure 4.7. Normalized view of the vowel plots and confidence ellipses for English vowels performed by British participants (reference values) (Bark).

Figure 4.8 displays the vowel space areas for English vowels as performed by British individuals. Whereas the computation of vowel space on the right was based on normalised data using the Bark scale, the computation of vowel space on the left was based on the means of the vowels' F1 and F2 values. Data from male participants is represented by green colours, while data from female participants is represented by red colours.

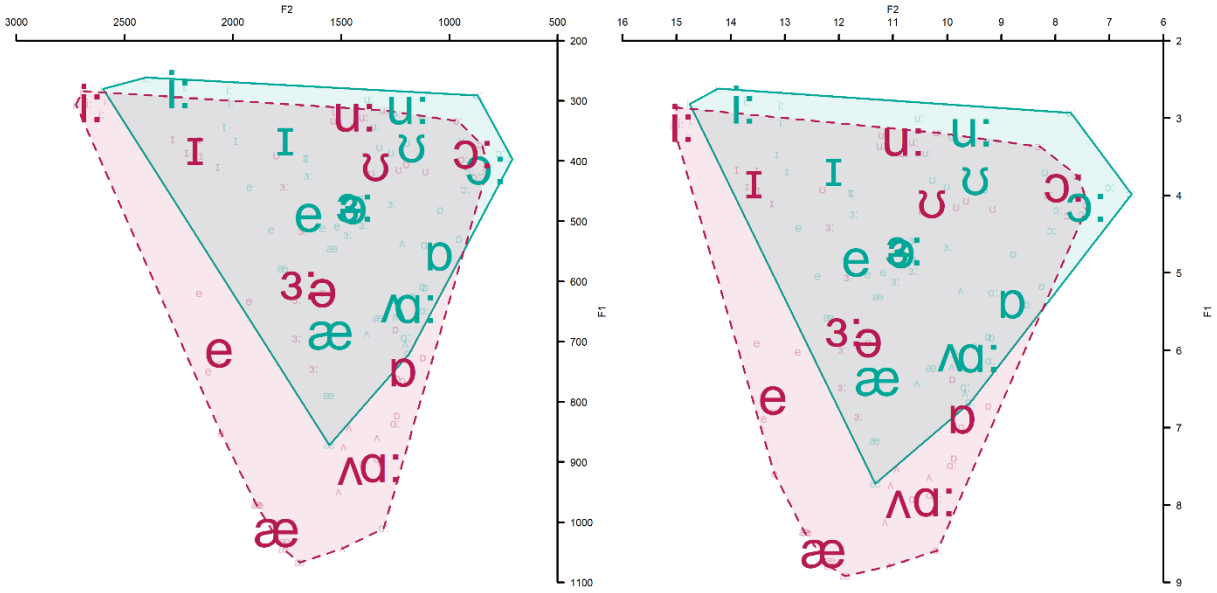


Figure 4.8. Vowel space areas for English vowels performed by British participants (reference values).

Once again, a visual inspection of the charts prior to the numerical analysis reveals that there is a gender-based natural variation in British speakers' pronunciation (Figure 4.6, 4.7, 4.8). Also, it is visible that by exhibiting close proximity, the vowels /ɪ/ and /iː/, /ʊ/ and /uː/, /ɔː/ and /ɒ/, /ʊ/ and /uː/ form regional groups. It is visible that /ɜː/ and /ə/ in female speakers and /ʌ/ and /ɑː/ in male speakers are near together, whereas /ə/ and /ɜː/ in male speakers overlap.

In Figure 4.9, Turkish participants' vowel plots and confidence ellipses on Turkish vowels are displayed. Based on the average F1 and F2 values of the vowels, the computation was performed. Green indicates data from male participants, and red indicates data from female participants; the vowel plots are on the left, and the confidence ellipses are on the right. Figure 4.10 shows the vowel plots and confidence ellipses for the same groups and vowels where normalised data with Bark scale was used for the calculation.

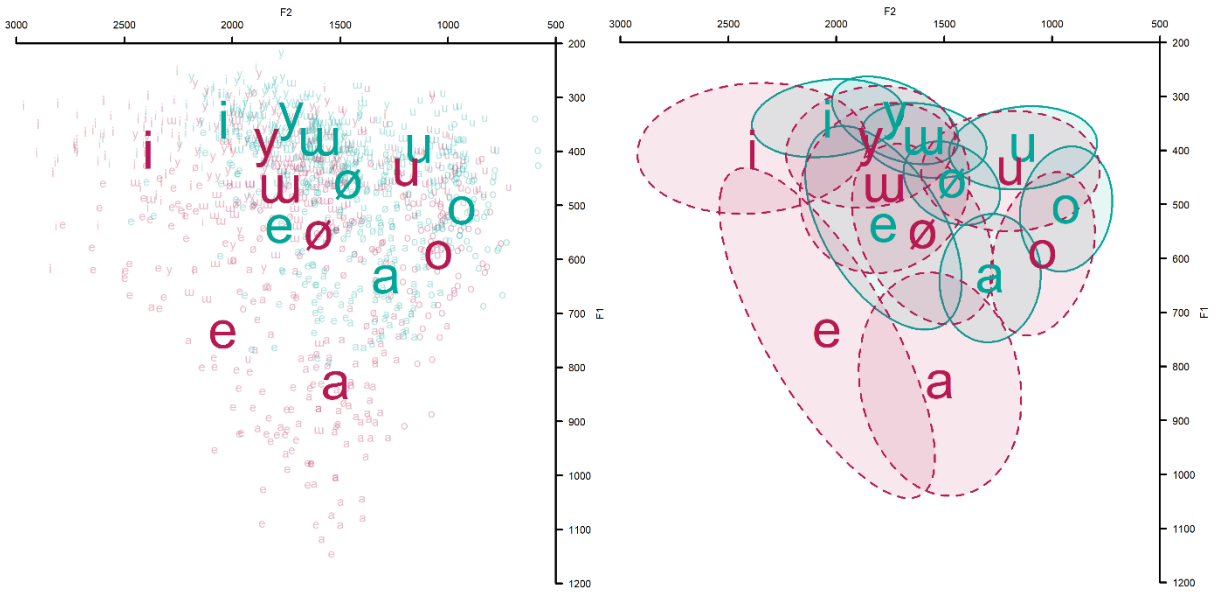


Figure 4.9. Vowel plots and confidence ellipses for Turkish vowels performed by Turkish participants.

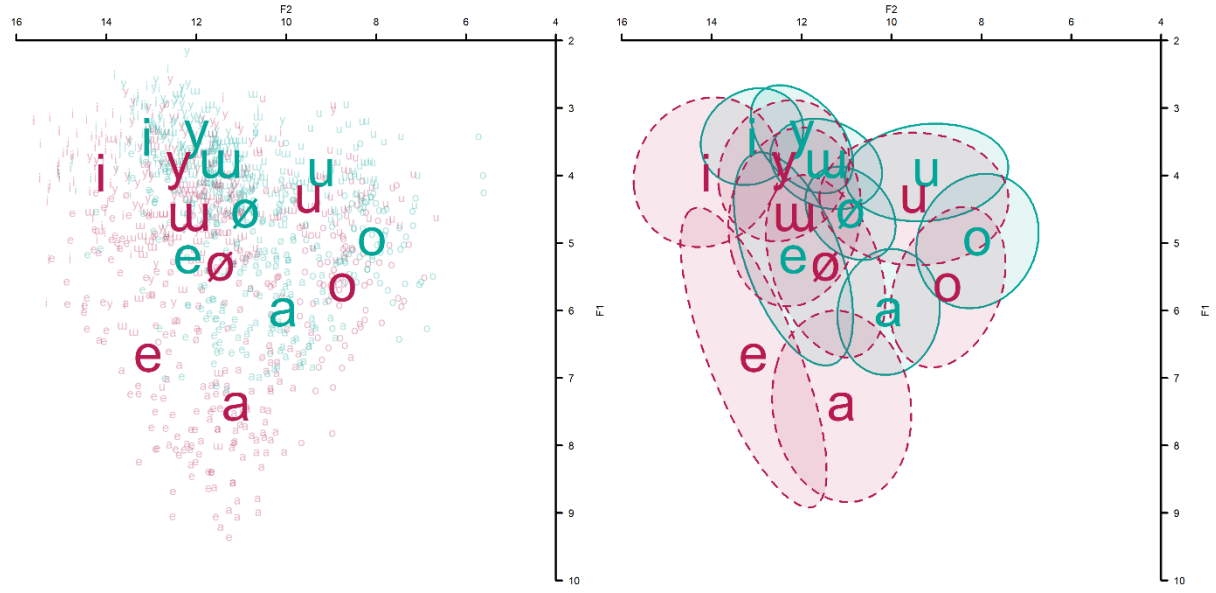


Figure 4.10. Normalized view of the vowel plots and confidence ellipses for Turkish vowels performed by Turkish participants (Bark).

Figure 4.11 displays the Turkish vowel space areas for Turkish participants' performance. Vowel space was calculated using the means of the vowel F1 and F2 values on the left, and normalised data using the Bark scale was used for the computation of vowel space on the right. Male participant data is represented by green colours, and female participant data is represented by red colours.

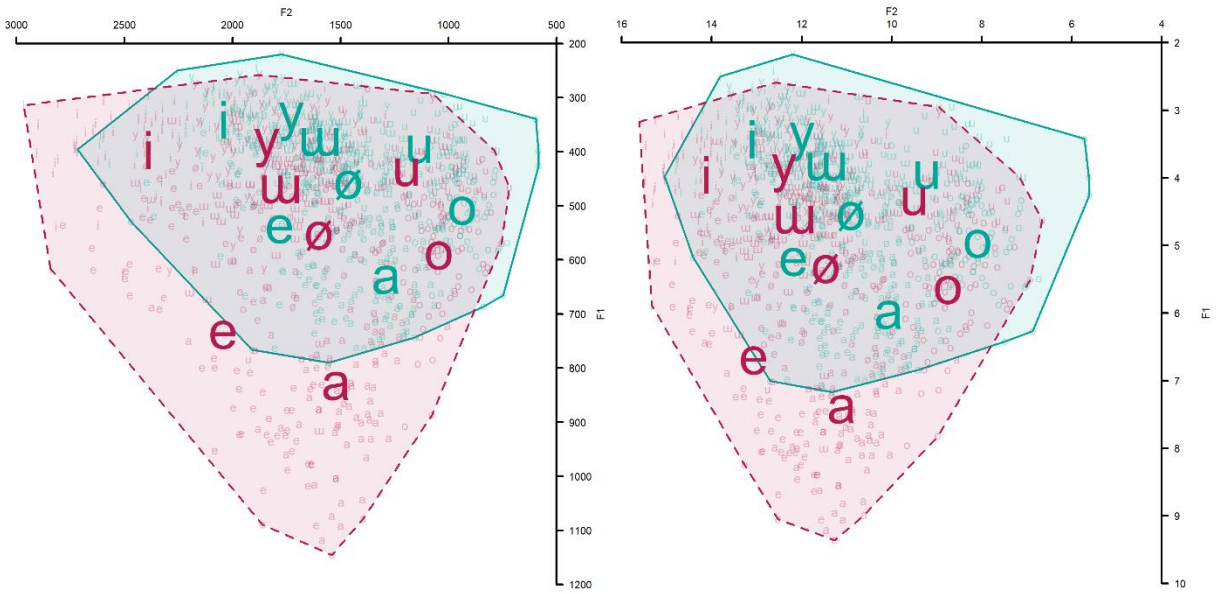


Figure 4.11. Vowel space areas for Turkish vowels performed by Turkish participants.

Vowel plots and confidence ellipses for English vowels performed by British participants, English vowels performed by Turkish participants, and Turkish vowels performed by Turkish participants combined are shown in Figure 4.12. The computation was based on the vowel F1 and F2 averages. The data from English vowels from British participants (reference values) is represented by green, Turkish vowels from Turkish participants by red, and Turkish vowels from Turkish participants by blue. The vowel plots are on the left, and the confidence ellipses are on the right. Figure 4.13 shows the vowel plots and confidence ellipses for the same groups and vowels where the calculation was based on the normalised data with Bark scale.

Charts based on the Turkish vowel pronunciations of the participants show variances in the vowel space area based on gender as well as the distribution of vowels according to F1 and F2 values (Figures 4.9, 4.10, 4.11).

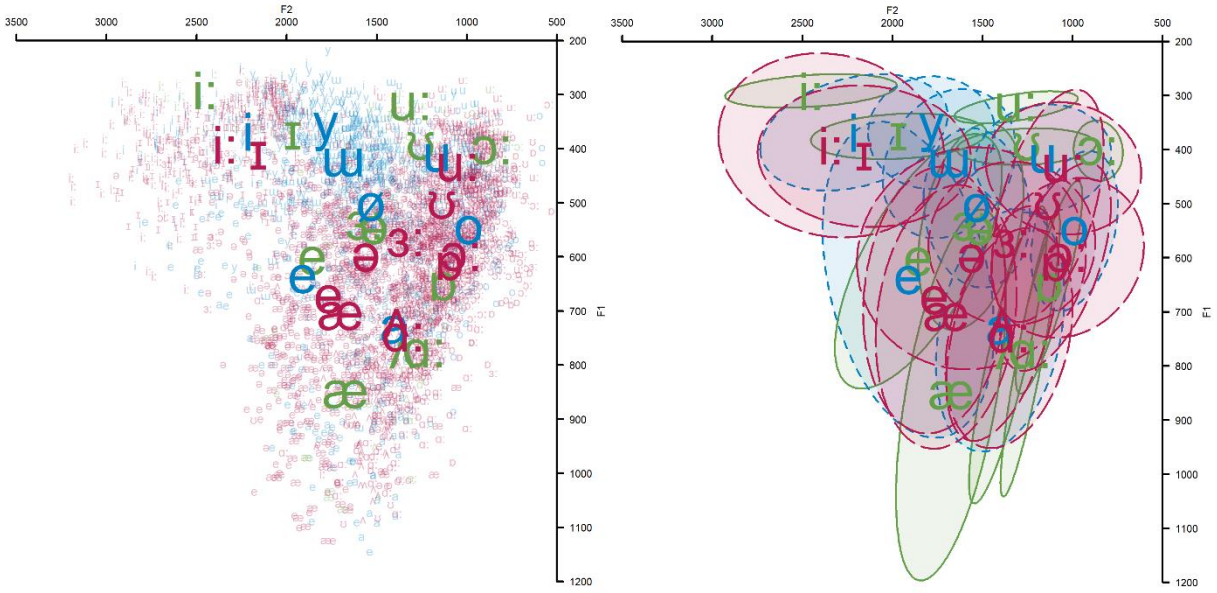


Figure 4.12. Vowel plots and confidence ellipses for English vowels performed by Turkish participants, English vowels by British participants (reference values) and Turkish vowels for Turkish participants altogether.

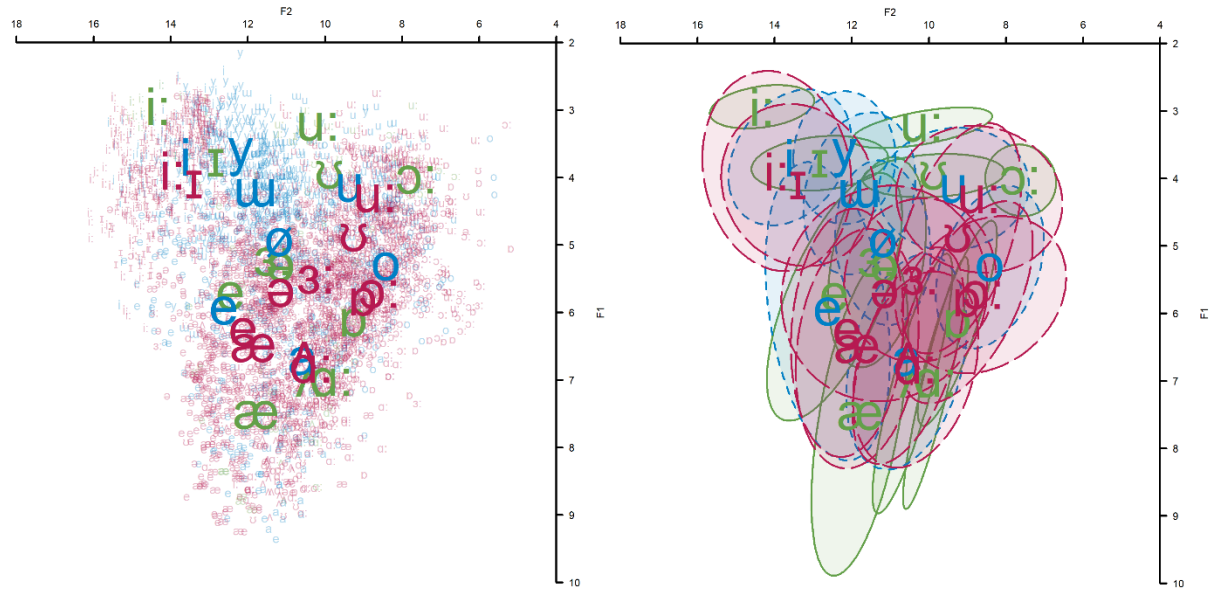


Figure 4.13. Normalized view of the vowel plots and confidence ellipses for English vowels performed by Turkish participants, English vowels by British participants (reference values) and Turkish vowels for Turkish participants altogether (Bark).

Figure 4.14 displays the combined vowel space areas for English vowels performed by British participants, Turkish vowels performed by Turkish participants, and Turkish vowels performed by Turkish participants. Whereas the computation of vowel space on the right was based on normalised data using the Bark scale, the computation of vowel space on the left was based on the means of the

vowels' F1 and F2 values. Turkish participants' data on English vowels is represented by red colours, British participants' data on English vowels is represented by green colours (reference values), and Turkish participants' data on English vowels is represented by blue colours.

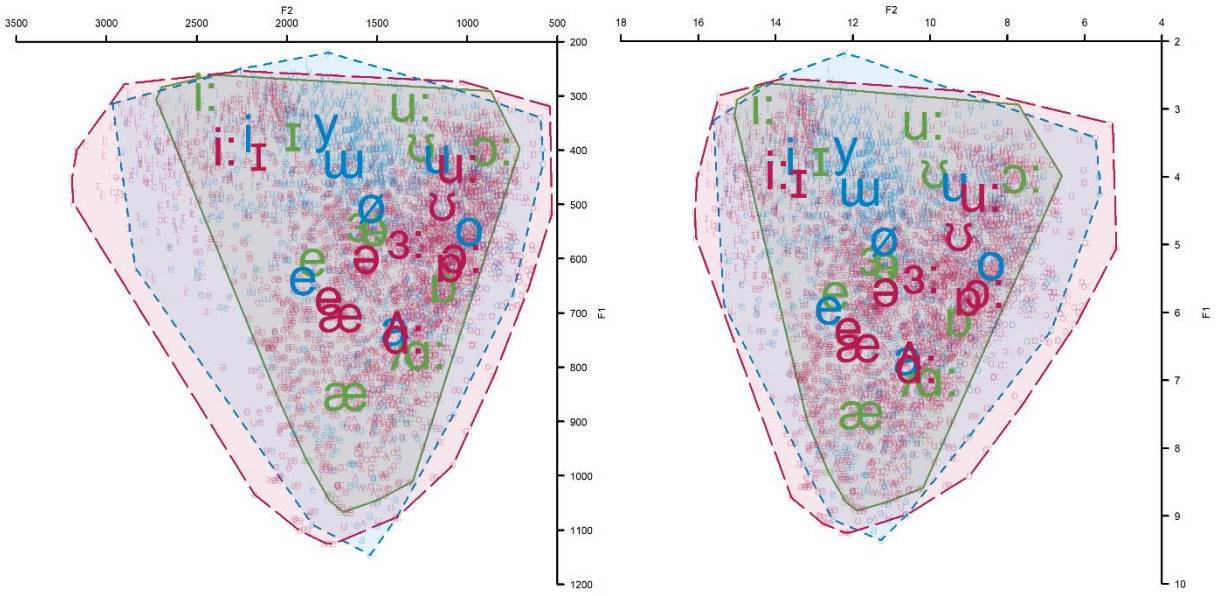


Figure 4.14. Vowel space areas for English vowels performed by Turkish participants, English vowels by British participants (reference values) and Turkish vowels for Turkish participants altogether.

Figures 4.12, 4.13, and 4.14 show the combined distributions of vowels based on F1 and F2 values based on the three data sets that form the basis of this study prior to the analysis of numerical data. Attention is drawn to the vowel space areas in particular because of their harmonious and consistent appearance.

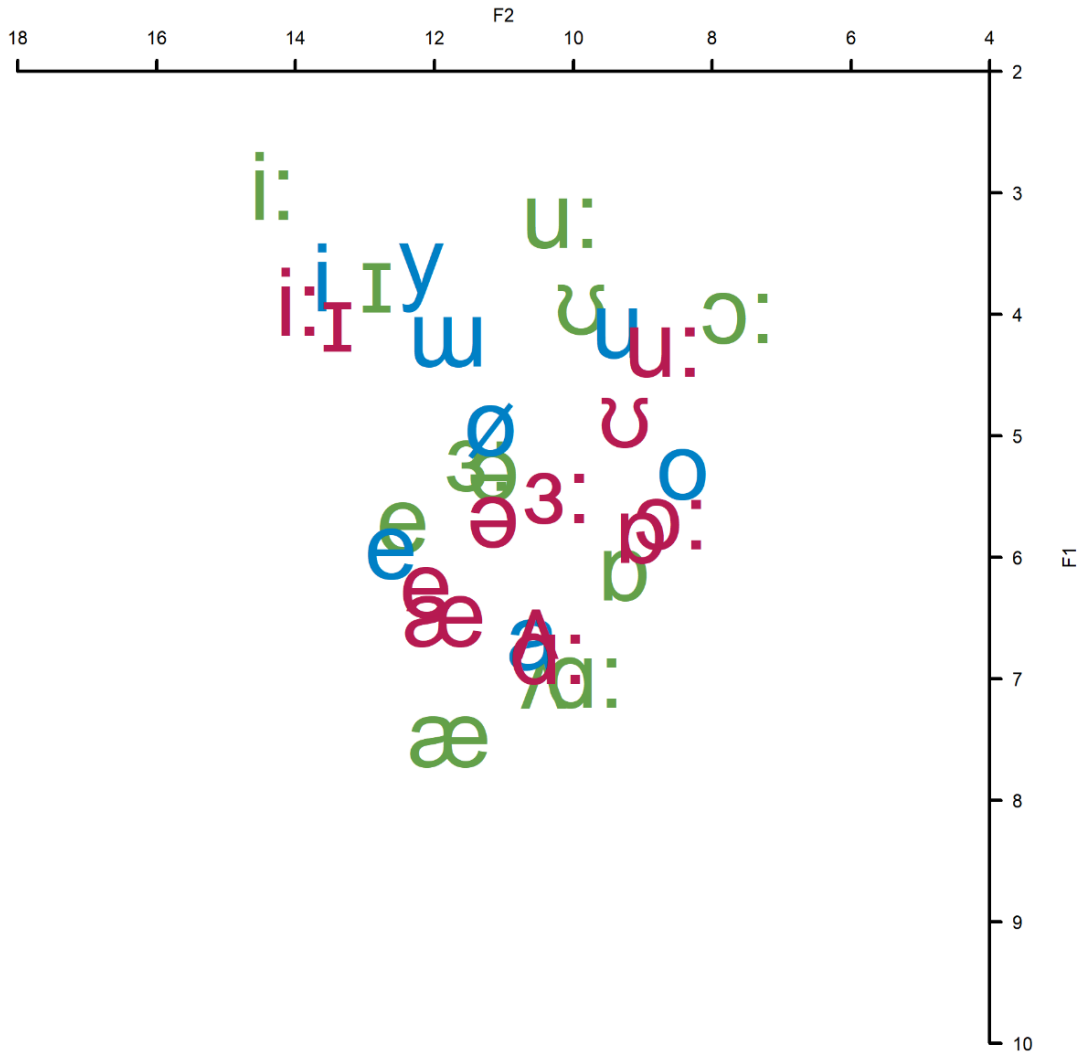


Figure 4.15. Normalized view of the English vowels performed by Turkish participants (red colour), English vowels by British participants (reference values) (green colour) and Turkish vowels for Turkish participants (blue colour) altogether (Bark).

The distribution and positions of vowels exhibit remarkable similarities and groupings (see Figure 4.15). Vowel features that are close to each other, such as Turkish /i/ by Turkish speakers, English /ɪ/ and English /i:/ by Turkish speakers, and English /ɪ/ and English /i:/ by British speakers, form a regional group. Similarly, Turkish /u/ by Turkish speakers, English /ʊ/ and /u:/ by Turkish speakers, English /ʊ/ and /u:/ by British speakers, which are similar to each other in terms of vowel features, form a group; Turkish /a/ by Turkish speakers, English /ʌ/ and /ɑ:/ by Turkish speakers, and English / ʌ/ and /ɑ:/ by British speakers form another group, while Turkish /o/ by Turkish speakers, English /ɔ:/ and /ɒ/ by Turkish speakers, English /ɒ/ by British speakers appear close to each other as a group and English /ɔ:/ has a distant position from this group.

The proximity of Turkish /ø/ by Turkish speakers, English /ɜ:/ and /ə/ by Turkish speakers, and English /ɜ:/ and /ə/ by British speakers is remarkable in the centre region of the table.

On the other hand, it is quite remarkable that Turkish /e/ by Turkish speakers, English /e/ by Turkish speakers and English /e/ by British speakers form a group; English /æ/ by Turkish speakers appears in this group – even overlaps with Turkish /e/ by Turkish speakers – while English /æ/ by British speakers located distant from the group.

Tests of Normality (Smirnov, 1948) (Shapiro & Wilk, 1965) were applied to the coarse data before the analysis process in order to check the distribution of numeric values.

Table 4.11. Tests of Normality for distribution of formant values for vowels

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
En.ɪ.F1	,096	22	,200*	,976	22	,848
En.ɪ.F2	,147	22	,200*	,952	22	,341
En.i:.F1	,133	22	,200*	,935	22	,156
En.i:.F2	,139	22	,200*	,956	22	,420
En.ʊ.F1	,205	22	,017	,889	22	,018
En.ʊ.F2	,106	22	,200*	,944	22	,235
En.u:.F1	,207	22	,015	,936	22	,161
En.u:.F2	,177	22	,070	,829	22	,001
En.e.F1	,112	22	,200*	,948	22	,290
En.e.F2	,143	22	,200*	,951	22	,333
En.ə.F1	,090	22	,200*	,959	22	,462
En.ə.F2	,108	22	,200*	,970	22	,720
En.ɜ:.F1	,133	22	,200*	,928	22	,110
En.ɜ:.F2	,133	22	,200*	,921	22	,081
En.ɔ:.F1	,156	22	,174	,967	22	,636
En.ɔ:.F2	,179	22	,063	,915	22	,060
En.æ.F1	,121	22	,200*	,960	22	,485
En.æ.F2	,087	22	,200*	,981	22	,930
En.ʌ.F1	,156	22	,177	,975	22	,823
En.ʌ.F2	,121	22	,200*	,969	22	,699
En.ɑ:.F1	,084	30	,200*	,975	30	,695
En.ɑ:.F2	,093	20	,200*	,960	20	,542
En.ɒ.F1	,143	20	,200*	,954	20	,431
En.ɒ.F2	,105	20	,200*	,970	20	,760
Tr.a.F1	,071	20	,200*	,976	20	,870
Tr.a.F2	,115	20	,200*	,958	20	,504
Tr.e.F1	,119	20	,200*	,969	20	,735
Tr.e.F2	,137	20	,200*	,961	20	,562
Tr.ɯ.F1	,255	20	,001	,846	20	,005
Tr.ɯ.F2	,119	20	,200*	,964	20	,631
Tr.i.F1	,149	20	,200*	,942	20	,264
Tr.i.F2	,146	20	,200*	,919	20	,097
Tr.o.F1	,224	20	,010	,897	20	,037
Tr.o.F2	,134	20	,200*	,956	20	,476
Tr.ø.F1	,184	20	,076	,884	20	,021
Tr.ø.F2	,131	20	,200*	,967	20	,681
Tr.u.F1	,165	20	,154	,911	20	,066
Tr.u.F2	,115	20	,200*	,922	20	,110
Tr.y.F1	,184	20	,073	,851	20	,006
Tr.y.F2	,177	20	,099	,950	20	,373

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

According to the Tests of Normality results (Table 4.11), En.ʊ.F1 (.018), En.u:.F2 (.001), Tr.ɯ.F1 (.005), Tr.o.F1 (.037), Tr.ø.F1 (.021) and Tr.y.F1 (.006) do not show a normal distribution ($p < .05$).

Table 4.12. Tests of Normality for distribution of formant values on nationalities.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Nationality	,423	30	,000	,597	30	,000

a. Lilliefors Significance Correction

According to the Tests of Normality results (Table 4.12), it is observed that the distributions among the nationalities were not normal (.000 < .05). T-test could be used as an advanced analysis method according to nationalities. Instead, the non-parametric Mann-Whitney U Test (1947) was be applied.

The data analysis was performed through Mann-Whitney U Test based on the significant differences between nationalities.

Table 4.13. Mann-Whitney U Test results of English /ɑ:/ F2 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	10,65	106,5	51,5	0,033
Turkish	20	17,93	358,5		

There was a statistically significant difference in the two groups' pronunciations of the English vowel /ɑ:/ ($U = 51.5$, $p < 0.05$) according to the results of the Mann-Whitney U test, which was applied to determine whether Turkish and English speakers pronounced the vowel differently (Table 4.13).

Table 4.14. Mann-Whitney U Test results of English /i:/ F1 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	6,05	60,5	5,5	0,000
Turkish	20	20,23	404,5		

According to the results of the Mann-Whitney U Test, which was conducted to reveal whether there is a difference between the pronunciation of Turkish and English speakers, it was seen that there was a statistically significant difference in pronunciation of English /i:/ between the two groups ($U = 5.5$, $p < 0.05$) (Table 4.14).

Table 4.15. Mann-Whitney U Test results of English /æ/ F1 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	20,2	202	53	0,039
Turkish	20	13,15	263		

The Mann-Whitney U Test results, which were analysed to determine whether Turkish and English speakers' pronunciations differed from one another, showed that there was a statistically significant difference in pronunciation of English /æ/ between the two groups ($U = 53$, $p < 0.05$) (Table 4.15).

Table 4.16. Mann-Whitney U Test results of English /ɔ:/ F1 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	5,5	55	0,000	0,000
Turkish	20	20,5	410		

The pronunciation of English /ɔ:/ varied between the two groups in a statistically significant way, as indicated by the results of the Mann-Whitney U Test, which was used to determine whether Turkish and English speakers pronounce sounds differently ($U = 0.000$, $p < 0.05$) (Table 4.16).

Table 4.17. Mann-Whitney U Test results of English /ɔ:/ F2 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	6,8	68	13	0,000
Turkish	20	19,85	397		

The pronunciations of Turkish and English speakers were compared using the Mann-Whitney U Test, and the results showed that there was a statistically significant difference between the two groups in English /ɔ:/ ($U = 13$, $p < 0.05$) (Table 4.17).

Table 4.18. Mann-Whitney U Test results of English /ɜ:/ F2 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	22,20	222	33	0,003
Turkish	20	12,15	243		

The Mann-Whitney U Test, which was used to test whether Turkish and English speakers pronounced words differently, showed that there was a statistically significant difference in pronunciation of English /ɜ:/ between the two groups ($U = 33$, $p < 0.05$) (Table 4.18).

Table 4.19. Mann-Whitney U Test results of English /ʊ/ F1 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	6,3	63	8	0,000
Turkish	20	20,1	402		

The Mann-Whitney U Test results, which was performed in order to find out if Turkish and English speakers pronounce words in distinct ways, showed that there was a statistically significant difference in pronunciation of English /ʊ/ between the two groups ($U = 8$, $p < 0.05$) (Table 4.19).

Table 4.20. Mann-Whitney U Test results of English /u:/ F1 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	5,5	55	0,000	0,000
Turkish	20	20,5	410		

According to the results of the Mann-Whitney U Test, which was conducted to reveal whether there is a difference between the pronunciation of Turkish and English speakers, it was seen that there was a statistically significant difference in pronunciation of English /u:/ between the two groups ($U = 0.000$, $p < 0.05$) (Table 4.20).

Table 4.21. Mann-Whitney U Test results of English /u:/ F2 values

Group	N	Mean Rank	Sum of Ranks	U Value	p
British	10	22,35	223,5	31,5	0,003
Turkish	20	12,08	241,5		

A statistically significant difference in pronunciation of English /u:/ was seen between the two groups, based on the findings of the Mann-Whitney U Test ($U = 31.5$, $p < 0.05$), which was performed to determine if there was a difference between the pronunciation of Turkish and English speakers (Table 4.21).

A number of significant findings emerged from the analysis of the numerical data derived from the pronunciation performances of volunteer participants in this study, which investigated three research questions and three hypotheses in accordance with those research topics. Particular vowels differ from native speakers when the acoustic data and characteristics are used to compare the pronunciation of English vowels between Turkish native speakers who are English L2 speakers to indicate these distinctions. As a result of an evaluation in which F1 values are associated with the openness and closedness (height) of the vowels, and F2 values are associated with the backness and frontness of the vowels, it is possible to gather and emphasize the following findings:

- Turkish speakers' pronunciation of the English /a:/ monophthong vowel shows a significant frontness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /i:/ monophthong vowel shows a significant openness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /æ/ monophthong vowel shows a significant closedness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /ɔ:/ monophthong vowel shows a significant openness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /ɔ:/ monophthong vowel shows a significant frontness compared to British speakers' pronunciation.

- Turkish speakers' pronunciation of the English /ɜ:/ monophthong vowel shows a significant backness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /ʊ/ monophthong vowel shows a significant openness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /u:/ monophthong vowel shows a significant openness compared to British speakers' pronunciation.
- Turkish speakers' pronunciation of the English /u:/ monophthong vowel shows a significant backness compared to British speakers' pronunciation.

These findings, which reveal differences at the segmental level, indicate measurable and significant articulation differences. These differences, when considered together with other segmental and suprasegmental factors, are emphasized in the research findings as being included in a series of factors that constitute the accentedness phenomena in total.

In the light of the findings obtained, it will be possible to answer the research questions as follows:

Research Question 1: Are vowels of English Language pronounced differently by native Turkish speaker English L2 learners? If so, which vowels are pronounced in qualities of native language (L2) and which vowels are pronounced out of qualities of native language?

Answer for Research Question 1: Not all vowels – but some (specific) vowels of English language are pronounced differently by native Turkish speaker English L2 learners. According to the research results, it is possible to conclude that the English vowels which are "similar" to the native Turkish vowels in terms of vowel features, namely /ɪ/, /e/, /ə/, /ʌ/, /ɒ/, are pronounced in (or close to) qualities of English language. However, some specific vowels of English, namely /i:/, /ʊ/, /u:/, /ɜ:/, /ɔ:/, /æ/, /ɑ:/, are pronounced out of qualities of native language.

Research Question 2: Is it possible to make generalizations about vowel pronunciations by native Turkish speaker English L2 learners in the target language?

Answer for Research Question 2: The research findings indicate that there are pronunciation differences between native Turkish speaker English L2 learners for English vowels that are the same or similar to Turkish vowels in terms of vowel features, which will have less of an impact on accentedness, and for vowels that have different features, which will have a greater impact for accentedness. Therefore, it is possible to make generalizations about students' vowel pronunciations by regarding the tendencies in their pronunciation performances.

Research Question 3: Can Optimality Theory contribute to a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners?

Answer for Research Question 3: By analysing the similarities and differences in the features and tendencies that Turkish students' pronunciation performances in the target language reveal, as well as by providing a comprehensive explanation of the factors that contribute to these differences and tendencies, it is possible to gain a better understanding of the concept of accentedness. Optimality Theory can contribute in improving our comprehension of the accentedness phenomenon in this particular setting.

The evaluation of the hypotheses that are in line with the research questions and that were tested on the basis of the research can be done as follows in the light of the findings and results:

Hypothesis 1: Some of the vowels of English language are pronounced out of qualities of native language (L2) by Turkish speaker English L2 learners.

According to the findings and results obtained in the research, some of the English vowels are pronounced out of native language quality (L2) by Turkish speaker English L2 learners. In pronunciations in the target language, frontness-backness degrees that were significantly different from native language values were detected in some vowels, whereas openness-closedness (height) degrees that were significantly different from native language values were detected in some vowels. **These results confirm Hypothesis 1**, which forms the basis of the research.

Hypothesis 2: It is possible to make generalizations about vowels' pronunciations by native Turkish speaker English L2 learners in the target language.

The research is based on an examination in terms of vowel features in line with the acoustic data obtained from native Turkish speaker English L2 learners' vowel pronunciation performances in the target language. The results of the analysis reveal that students pronounce some English vowels out of native language quality. The data show that the vowels in the target language are pronounced with values closer to the "similar" ones in the native language, while the vowels that do not exist in the native language are pronounced with values closer to "the closest" (or most similar) ones in the native language. Although there are some individual characteristics in the data, the fact that the tendencies generally focus on certain points allows us to make generalizations about vowel pronunciations, which confirms Hypothesis 2.

Hypothesis 3: Optimality Theory can contribute to a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners.

Optimality Theory (OT) seeks to explain how linguistic patterns form and take shape in natural languages. OT focuses on constraints and interaction rather than rules and derivations, which sets it apart from previous generative theories. The theory explains the mechanism operating in producing the language, by ranking the constraints, generating candidates that satisfy the constraints, and selection of "the optimum" choice between the candidates by minimizing the violations of constrains. Consequently,

by emphasizing how constraints interact to create linguistic outputs, Optimality Theory offers a convincing framework for understanding linguistic patterns and provides insights on both language-specific and universal features of grammar. Confirming Hypothesis 3, the overall process explicated through Optimality Theory contributes a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners.

4.2. Discussion

Every research conducted on the phenomenon of accent and accentedness contributes to the understanding of these phenomena to various degrees with the findings it reveals. It should be stated that accent and accentedness do not depend on a single cause or factor; in fact, it is a multifaceted and complicated process like the language production process itself. The degrees of these reasons and factors may vary depending on the specific conditions and conjuncture. From this perspective, more data and more analysis will always be needed to make healthier generalizations. Therefore, the importance of every data and every finding revealed increases. As a result, each piece of information and each new discovery becomes increasingly significant.

In this study, an investigation was made on the performance differences of participants in the L2 in terms of vowel pronunciation and vowel features, which are among the factors affecting accentedness, and the results were presented with analyses and various demonstrations. While doing this, data was collected with a pre-defined participant profile and a prepared reading task in a specific setting. In this way, the targeted vowels were voiced with a certain number of repetitions, and the effect of environmental factors was aimed to be minimized.

Of course, the data obtained from the speakers' performance in a casual conversation is as important as the data obtained in a specific research design. The parameters of speech sounds produced in a natural environment, in a free speech setting, will help to obtain a broader insight in this process. In this regard, the data pool obtained through research on natural speech can be enriched.

Among the approaches aimed at providing a better understanding of the phenomenon of accentuation, taking its foundations from Chomsky's Universal Grammar (2006), Optimality Theory stands out with its universal dimension in terms of the principles and facts it reveals. The theory, to conclude it very briefly, is the process of constraints, the satisfaction or violation of these constraints, the choice (or winning) of the option that obtains the highest value between "markedness" and "faithfulness" – in short, "optimal" or "optimal" – in situations where constraints compete. In this case, it will be more likely to gravitate towards the pre-existing one as the optimal option given the circumstances and the situation. When this situation is carried over to the phonological process, it should be expected that in the process of pronunciation of a speech sound of the second language - more

specifically, a phoneme- the phoneme that is not in the native language will tend towards the "closest" one among those in the native language and will show "similar" features.

When the findings obtained from the analysis of the data in the research are examined, it is seen that the vowels examined tend in this way, and this situation can be better interpreted when the principles of Optimality Theory are taken into consideration.

Considering that reducing accentuation is a "natural", if not absolute, goal in terms of intelligibility and comprehensibility, it may be recommended to emphasize the phonemes that increase the degree of accentuation in language teaching processes and pronunciation training, and to focus on these phonemes within training programs and modules. In this way, reducing the distance degrees in speech sounds in terms of features can be achieved easier.

The research study of the thesis focused on understanding the influence between L1 and L2 – specifically the influence of L1 on L2. Clearly, the research ground where this effect will be examined more deeply should be the research conducted with multilingual speakers focusing on the effect of L1 on L2, L3 and even L4. In this way, possible variations can be evaluated together with judgments in the context of intelligibility and a multidimensional understanding can be obtained. For more detailed investigations, studies focused on the effects of L2, L3, L4... on each other will be important. In such cases, the determinants such as which language has been acquired before and which language is used more intensively can be evaluated. In such research and in multiple interaction environments, it will be possible to test the principles put forward by OT and other theories and reach more significant results.

On the other hand, the change in the accentedness over time should not be missed out. Comparing the data and findings of a study by repeating the study at certain intervals or after a certain period of time will enrich the perspectives on the phenomenon of accent by evaluating the course of the effect of L1 on L2 over time.

In any case, it is of utmost importance for the world of science, to add new studies to the existing studies on the above-mentioned subjects, to expand and enrich the obtainments with new findings.

CONCLUSION

In this study, which focuses on the factors that cause accentedness in speech sounds, the data obtained were examined by analysing the voice recordings obtained from 20 volunteer participants aged 14-19, who are Turkish native speakers and English L2 learners. Within a pre-defined research design, participants completed a reading task and read aloud 132 English sentences and 56 Turkish sentences presented. By performing spectrographic analysis and segmentation of the voice recordings, the F1 and F2 values of the target vowels were obtained and their distribution was realized by numerical analysis.

Analyses on vowels were carried out on F1 values that are associated with openness-closedness and F2 values that are associated with frontness-backness in the context of the vowel feature. As a result of the analysis of the data, in the L2 pronunciations of Turkish participants, significant openness was observed in English /iː/ monophthong vowel, English /ɔː/ monophthong vowel, English /ʊ/ monophthong vowel, English /uː/ monophthong vowel, significant closedness in English /æ/ monophthong vowel, significant frontness in English /aː/ monophthong vowel, English /ɔː/ monophthong vowel, and significant backness in English /ɜː/ monophthong vowel, English /uː/ monophthong vowel.

Findings and data revealed through the analysis indicate the fact that there are significant pronunciation differences in some vowels of target language. The differences and tendencies of vowel articulations of the participants were in accordance with the principles of Optimality Theory, which made it possible to interpret the effect of L1 on L2 articulations.

Consequently, all of the 3 hypotheses defined in line with the research questions were validated in regard to the results of the study:

Hypothesis 1: Some of the vowels of English language are pronounced out of qualities of native language (L2) by Turkish speaker English L2 learners.

Hypothesis 2: It is possible to make generalizations about vowels' pronunciations by native Turkish speaker English L2 learners in the target language.

Hypothesis 3: Optimality Theory can contribute to a better understanding of the accentedness phenomenon, which is evaluated by comparing the pronunciation of the vowels in the native language and the target language by native Turkish speaker English L2 learners.

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APPENDICES

APPENDIX 1. Certificate of Approval by Research Ethics Committee of Mersin University Social and Humanity Sciences

T.C.
MERSİN ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER ETİK KURULU
ONAY BELGESİ

Mersin Üniversitesi Lisansüstü Öğrencisi Cevdet ÜSTÜN'ün "14-19 Yaş Grubu Yabancı Dil Olarak İngilizce Öğrenen Türkçe Anadili Konuşucularının İkinci Dil Sesletimleri: Ortaklıklar ve Ayrımlar" adlı çalışması kurulumuz tarafından incelenmiş ve;

Etik yönden uygun bulunmuştur.	X
Etik yönden geliştirilmesi gerekmektedir.	
Etik yönden uygun bulunmamıştır.	

Mersin Üniversitesi Sosyal ve Beşeri Bilimler Etik Kurulu Kararı	
Başvuru Formunun Etik Kurula Ulaştığı Tarih	13/05/2022
Etik Kurul Karar Toplantı Tarihi ve Karar No	06/06/2022-248
Yer	Mersin Üniversitesi, Uğur Oral Kültür Merkezi
Katılımcılar	Formda imzası bulunan üyelerimiz toplantıya katılmıştır.

KURUL BAŞKANI VE ÜYELER:

		İMZA
Prof. Dr. F. Ayşe BALCI KARABOĞA	**Başkan**	
Prof. Dr. Arzu AYDIN ACI	**Üye**	
Prof. Dr. Devrim ALICI	**Üye**	
Prof. Dr. Şerife YORULMAZ	**Üye**	
Prof. Dr. Neriman AÇIKALIN	**Üye**	
Prof. Dr. Hürriyet GÖKDAYI	**Üye**	
Prof. Dr. Leyla SARAÇ	**Üye**	

Açıklama:

ASLI GİBİDİR
Av. Tuncay UĞUR CAN
Hukuk Müşaviri

APPENDIX 2. Official Consent for Research by Kahramanmaraş Provincial Directorate of Education

T.C.
KAHRAMANMARAŞ VALİLİĞİ
İl Milli Eğitim Müdürlüğü

Sayı : E-35776031-605.01-54584288 03.08.2022
Konu : Araştırma Talebi (Cevdet ÜSTÜN)

MERSİN ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Yazı İşleri Müdürlüğü)

İlgi : a) 07.07.2022 tarih ve E-15302574 sayılı yazınız.
b) Milli Eğitim Bakanlığının 21.01.2020 tarih ve 8156613-10.06.02-E.1563890 (2020/2) sayılı Genelgesi.

İlgi (a) yazıda belirtilen Üniversiteniz Sosyal Bilimler Enstitüsü İngiliz Dili ve Edebiyatı Anabilim Dalı yüksek lisans öğrencisi Cevdet ÜSTÜN'ün **"14-19 Yaş Grubu Yabancı Dil Olarak İngilizce Öğrenen Türkçe Anadili Konuşucularının İkinci Dil Sesletimleri: Ortaklıklar ve Ayrımlar"** konulu tez çalışmasına veri oluşturmak amacıyla, ilimize bağlı Dulkadiroğlu ve Onikişubat ilçelerinde bulunan lise öğrencilerine yönelik ilgi (a) yazınız ekindeki anket ve ölçeklerinin uygulanabilmesi ile ilgili talebiniz incelenmiştir.

Denetimi ilçe millî eğitim müdürlüğünde ve okul/kurum idarelerinde olmak üzere, gönüllülük esasına göre; onaylı bir örneği Bakanlığımızda muhafaza edilen ve uygulama sırasında da mühürlü ve imzalı örnekten elektronik ortama aktarılmış veri toplama aracının ilgi (b) Genelge doğrultusunda 2022-2023 Eğitim Öğretim döneminde okulların açılması halinde eğitim öğretim aksatılmadan, pandemi kurallarına uygun olarak veya online olarak uygulanmasına izin verilmiştir. Söz konusu veri toplama aracının Bakanlığımız Veri Toplama Modülü üzerinden yayınlanması Müdürlüğümüz görev ve sorumluluğu dahilinde değildir.

Gereğini bilgilerinize arz ederim.

Yusuf KAHRAMAN
İl Milli Eğitim Müdürü

Ek: Veri Toplama Araçları (5 sayfa)

APPENDIX 3. Informed Consent Form for Voluntary Participants

T.C.
MERSİN ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER ARAŞTIRMALARI
BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU (BGOF)

Sayın Katılımcı;

14-19 yaş arası Türkçe anadil konuşucu ve İngilizce ikinci dil öğrenicilerinin ana dillerinde ve hedef dilde yer alan ünlüleri sesletimlerini "ünlü özellikleri" ve "ünlü niteliği" açısından incelemek amacıyla bir araştırma yapmaktayım. Araştırmanın ismi "14-19 Yaş Grubu Yabancı Dil Olarak İngilizce Öğrenen Türkçe Anadili Konuşucularının İkinci Dil Sesletimleri: Ortaklıklar ve Ayrımlar" dır. Sizin de bu çalışmaya katılmanızı diliyorum. Araştırmaya katılım gönüllülük esasına dayalıdır. Kararınızdan önce araştırma hakkında sizi bilgilendirmek istiyorum. Elde edilen bilgiler yalnızca araştırma amacı için kullanılacak, başka bir amaçla kullanılmayacaktır. Araştırmanın sunumunda kurum kimliğine yönelik açıklama yer almayacaktır. Bu araştırmaya katılmanız dahilinde isminiz kullanılmayacak ve kimlik haklarınız korunacaktır. Bu araştırmaya katılmanız için sizden herhangi bir ücret istenmeyecek, katıldığınız için de size ek bir ödeme yapılmayacaktır. Bu araştırmaya katılmayı reddedebilirsiniz. Yine araştırmanın herhangi bir aşamasında onayınızı geri alma hakkına da sahipsiniz.

Katılımınız ve desteğiniz için teşekkürlerimizi sunarız.

Bilgilendirilmiş Gönüllü Olur Formundaki tüm açıklamaları okudum. Bana, yukarıda konusu ve amacı belirtilen araştırma ile ilgili yazılı açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı. Araştırmaya gönüllü olarak katıldığımı, istediğim zaman gerekçeli veya gerekçesiz olarak araştırmadan ayrılabileceğimi biliyorum. Söz konusu araştırmaya, hiçbir baskı ve zorlama olmaksızın kendi rızamla katılmayı kabul ediyorum.

Tarih : …./…./20….
Gönüllünün İmzası :

MEÜ.BA.FR-009/01 Sayfa 1/1 Yayın Tarihi : 23 / 02 / 2018

APPENDIX 4. Parental Consent Form

Ek-1
Sayın Veli;

Çocuğunuzun katılacağı bu çalışma, "14-19 Yaş Grubu Yabancı Dil Olarak İngilizce Öğrenen Türkçe Anadili Konuşucularının İkinci Dil Sesletimleri: Ortaklıklar ve Ayrımlar" adıyla, 25/05/2022 – 31/07/2023 tarihleri arasında yapılacak bir araştırma uygulamasıdır.

Araştırmanın Hedefi: Bu çalışmanın amacı, 14-19 yaş arası Türkçe anadil konuşucu ve İngilizce ikinci dil öğrenicilerinin ana dillerinde ve hedef dilde yer alan ünlüleri sesletimlerini "ünlü özellikleri" ve "ünlü kalitesi" açısından incelemektir.

Araştırma Uygulaması: Görüşme şeklindedir.

Araştırma T.C. Milli Eğitim Bakanlığı'nın ve okul yönetiminin de izni ile gerçekleşmektedir. Araştırma uygulamasına katılım tamamıyla gönüllülük esasına dayalı olmaktadır. Çocuğunuz çalışmaya katılıp katılmamakta özgürdür. Araştırma çocuğunuz için herhangi bir istenmeyen etki ya da risk taşımamaktadır. Çocuğunuzun katılımı **tamamen sizin isteğinize bağlıdır**, reddedebilir ya da herhangi bir aşamasında ayrılabilirsiniz. Araştırmaya katılmamama veya araştırmadan ayrılma durumunda öğrencilerin akademik başarıları, okul ve öğretmenleriyle olan ilişkileri etkilemeyecektir.

Çalışmada öğrencilerden kimlik belirleyici hiçbir bilgi istenmemektedir. Cevaplar tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir.

Uygulamalar, genel olarak kişisel rahatsızlık verecek sorular ve durumlar içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden çocuğunuz kendisini rahatsız hissederse cevaplama işini yarıda bırakıp çıkmakta özgürdür. Bu durumda rahatsızlığın giderilmesi için gereken yardım sağlanacaktır. Çocuğunuz çalışmaya katıldıktan sonra istediği an vazgeçebilir. Böyle bir durumda veri toplama aracını uygulayan kişiye, çalışmayı tamamlamayacağını söylemesi yeterli olacaktır. Anket çalışmasına katılmamak ya da katıldıktan sonra vazgeçmek çocuğunuza hiçbir sorumluluk getirmeyecektir.

Onay vermeden önce sormak istediğiniz herhangi bir konu varsa sormaktan çekinmeyiniz. Çalışma bittikten sonra bizlere telefon veya e-posta ile ulaşarak soru sorabilir, sonuçlar hakkında bilgi isteyebilirsiniz. Saygılarımızla,

Araştırmacı : Cevdet ÜSTÜN

İletişim bilgileri : Nuri Pakdil Bilim ve Sanat Merkezi Yenişehir Mah. 74014 Sokak No:8 Dulkadiroğlu Kahramanmaraş

Velisi bulunduğum ..... sınıfı ..... numaralı öğrencisi .....
.....'in yukarıda açıklanan araştırmaya katılmasına izin veriyorum.
(Lütfen formu imzaladıktan sonra çocuğunuzla okula geri gönderiniz*).

..../...../.....

İsim-Soyisim İmza:

Veli Adı-Soyadı :

Telefon Numarası :

APPENDIX 5. Demographic Information Form

Demografik Bilgi Formu

Adı Soyadı:

Yaş: ……..

Cinsiyet: ……. (E / K)

Okuduğunuz okulun türü: ……

Babanızın eğitim düzeyi:

a. İlkokul / Ortaokul

b. Lise

c. Üniversite

Annenizin eğitim düzeyi:

a. İlkokul / Ortaokul

b. Lise

c. Üniversite

Okul döneminde yaşadığınız yer:

a. Aile ile birlikte

b. Akraba ile birlikte

c. Yurt / Pansiyon

d. Diğer (……)

Okul döneminde yaşadığınız yerde konuşulan dil (*Birden fazla ise öncelik sırasına göre yazınız*):

……

Hangi şehir(ler)de yaşadınız?

…… - ……. yaş arası ……

…… - ……. yaş arası ……

…… - ……. yaş arası ……

Şu an etkisinde olduğunuz bir rahatsızlığınız var mı?

Akciğer ve solunum yolu (*Örn. Astım vb*) ……

Boğaz, gırtlak, yutak (*Örn, Ses telleri, boğaz enfeksiyonu vb*) ……

Ağız ve burun (*Örn. Burun tıkanıklığı, diş vb*) ……

Diğer: ……

APPENDIX 6. 132 Sentences with Minimal Pairs for Vowels of English

132 Sentences with Minimal Pairs for Vowels of English

1. ship sheep /ɪ/ /iː/
We heard **sheep** bleating in the field.
The **ship** sank slowly to the depths of the ocean.

2. bill bull /ɪ/ /ʊ/
They asked the waitress for the **bill**.
The **bull** tossed him up into the air.

3. fill fool /ɪ/ /uː/
Before painting, **fill** all the cracks in the plaster.
He's a **fool** to think she still loves him.

4. mess miss /ɪ/ /e/
Jem's house is always in a **mess**.
You should leave early if you want to **miss** the rush hour.

5. precede proceed /ɪ/ /ə/
It would be helpful if you were to **precede** the report with an introduction.
His lawyers have decided not to **proceed** with the case.

6. bid bird /ɪ/ /ɜː/
She knew she couldn't afford it, so she didn't **bid**.
The poor **bird** couldn't fly because it had a broken wing.

7. bill ball /ɪ/ /ɔː/
Could we have the **bill**, please?
The **ball** bounced off the post and into the net.

8. bid bad /ɪ/ /æ/
How much did you **bid** for that antique vase?
Our holiday was spoiled by **bad** weather.

9. bitter butter /ɪ/ /ʌ/
The coffee was **bitter**.
Have some bread and **butter**.

10. list last /ɪ/ /ɑː/
Is your name on the **list**?
I hate being the **last** one to arrive at a meeting.

11. ship shop /ɪ/ /ɒ/
The **ship** was flying the Spanish flag.
The **shop** was closed.

12.feet foot /i:/ /ʊ/
A short time from now, it has become two **feet** long.
I've got a blister on my left **foot**.

13.teeth tooth /i:/ /u:/
Brush your **teeth** thoroughly morning and night.
Look, I've got a wobbly **tooth**.

14.neat net /i:/ /e/
She likes everything **neat** and tidy.
His penalty kick placed the ball decisively in the back of the **net**.

15.seaport support /i:/ /ə/
My constituency is a **seaport** and fishing port.
The majority of people in the town strongly **support** the plans to build a new school.

16.bead bird /i:/ /ɜ:/
A **bead** of sweat stood out on his forehead.
He's a tough old **bird**.

17.weak walk /i:/ /ɔ:/
I can't stand **weak** coffee.
The baby has just learned to **walk**.

18.feet fat /i:/ /æ/
Their **feet** and hands, however, are remarkably small.
He eats all the time but he never gets **fat**.

19.teach touch /i:/ /ʌ/
We **teach** English to foreign students.
That paint is wet - don't **touch** it.

20.least last /i:/ /ɑ:/
It was the answer she **least** wanted to hear.
Our house is the **last** one on the left before the traffic lights.

21.least lost /i:/ /ɒ/
He's the relative I like the **least**.
You look **lost** - can I help you?

22.full fool /ʊ/ /u:/
My plate was already **full**.
You **fool**, you missed your chance!

23.pet put /ʊ/ /e/
Doctors have discovered that keeping a **pet** can do wonders for your health.
She **put** her bag on the table.

24.backwoods backwards /ʊ/ /ə/
I grew up in the **backwoods**, with no cable TV and no Internet access.
I walked **backwards** towards the door.

25.pull pearl /ʊ/ /ɜ:/
Pull your chair over here so you can see the screen.
He gave her a **pearl** necklace for her birthday.

26.port put /ʊ/ /ɔ:/
We had a good view of all the ships leaving **port**.
She **put** her hands over her eyes.

27.pat put /ʊ/ /æ/
I bent down to **pat** the little puppy.
He **put** salt into the sugar bowl by mistake.

28.look luck /ʊ/ /ʌ/
Look over there - there's a rainbow!
So your interview's tomorrow? Good **luck**!

29.part put /ʊ/ /ɑ:/
Exercise has become **part** of my daily routine.
We always **put** the cat out at night.

30.pot put /ʊ/ /ɒ/
Fill a large **pot** with salted water and bring it to the boil.
If you **put** together yellow and blue paint you get green.

31.fell fool /u:/ /e/
We went **fell** walking last weekend.
I felt like a **fool** when I dropped my phone in the toilet.

32.boot but /u:/ /ə/
He lent down and struck a match on the sole of his **boot**.
She's not a painter **but** a writer.

33.pool pearl /u:/ /ɜ:/
I spent most of my holiday lying by the **pool**.
You are holding a **pearl** necklace in your hands.

34.fall fool /u:/ /ɔ:/
The water's deep here, so don't **fall** in!
He said he would pay me back and like a **fool**, I believed him.

35.man moon /u:/ /æ/
My **man** will show you to the door.
What time does the **moon** rise?

36.shoot shut /u:/ /ʌ/
If he's not armed, don't **shoot**.
Please **shut** the gate.

37.bath booth /u:/ /ɑ:/
I took a **bath** this morning.
There was a line of people waiting for the phone **booth**.

38.poll pool /u:/ /ʊ/
We're carrying out a **poll** to find out what people think about abortion.
She looked at her reflection in the deep green **pool** of water.

39.essay assay /e/ /ə/
Mr Jones thought my history **essay** was terrific.
They compared technical ease of the **assay** and cost.

40.bed bird /e/ /ɜ:/
She didn't get out of **bed** till lunchtime today.
Is that Lee's new **bird**?

41.fell fall /e/ /ɔ:/
The horse **fell** at the first fence.
Athletes have to learn how to **fall** without hurting themselves.

42.bad bed /e/ /æ/
We've just had some very **bad** news.
I'm exhausted - I'm going to **bed**.

43.better butter /e/ /ʌ/
She is much **better** at tennis than I am.
Cream the **butter** and sugar together.

44.pet part /e/ /ɑ:/
She has **pet** snake.
Unfortunately, accidents are **part** of life.

45.less loss /e/ /ʊ/
Exercise more and eat **less**.
He suffered a gradual **loss** of memory.

46.foreword forward /ə/ /ɜ:/
However, there is a passage in the **foreword** that is much more significant for present concerns.
You will run **forward** at my command.

47.audition addition /ə/ /ɔ:/
His **audition** went well and he's fairly hopeful about getting the part.
In **addition** to being a politician, he still works as a lawyer.

48. objection abjection /ə/ /æ/

A couple of people raised **objections** to the proposal.
It was almost **abjection** in his respect for his boss.

49. discus discuss /ə/ /ʌ/

It is a sport in which a **discus** is thrown as far as possible.
The later chapters **discuss** the effects on the environment.

50. radar raider /ə/ /ɑ:/

Other vessels in the area show up on the ship's **radar**.
An armed **raider** forced their way into the couple's home.

51. on an /ə/ /ɒ/

I got **on** my bike and left.
He applied to become **an** American citizen.

52. walk work /ɜ:/ /ɔ:/

He offered to **walk** to the station.
I've got so much **work** to do.

53. bad bird /ɜ:/ /æ/

He has some very **bad** habits.
A penguin is a flightless **bird**.

54. bud bird /ɜ:/ /ʌ/

It was springtime and the fruit trees were in **bud**.
We were woken early by the sound of a **bird** singing.

55. dart dirt /ɜ:/ /ɑ:/

We made a **dart** for the exit.
His coat was covered with **dirt**.

56. poll pearl /ɜ:/ /ɒ/

A **poll** was conducted to gauge consumers' attitudes.
There is a **pearl** of dew on the grass.

57. pat port /ɔ:/ /æ/

I gave the little boy a **pat** on the head.
At the **port** she managed to get a passage on an outward-bound ship.

58. torch touch /ɔ:/ /ʌ/

She flashed the **torch** into the dark room.
Don't **touch** the machine when it's in use.

59. part port /ɔ:/ /ɑ:/

Part of my steak isn't cooked properly.
During the 20th century the village was a bustling river **port**.

60. pot port /ɔ:/ /ɒ/

I've just drunk a whole **pot** of tea!

The Estonian **port** of Tallinn was blockaded for a time by Soviet warships.

61. cat cut /æ/ /ʌ/

My **cat** likes dozing in front of the fire.

This knife doesn't **cut** very well.

62. pat part /æ/ /ɑ:/

Pat the vegetables dry with a paper towel.

Part of this form seems to be missing.

63. pat pot /æ/ /ɒ/

The spokesman came out with a **pat** response.

She'd made a large **pot** of chicken soup.

64. butter barter /ʌ/ /ɑ:/

Fry the mushrooms in a little **butter**.

Earlier economies worked on a **barter** system.

65. lock luck /ʌ/ /ɒ/

I heard someone turn a key in the **lock**.

The best of **luck** with your exams!

66. part pot /ɑ:/ /ɒ/

He was, for the most **part**, quite helpful.

He made a new **pot** of coffee.

Vowel	Lexical Items
/ɪ/	ship, bill, fill, miss, precede, bid, bitter, list
/i:/	feet, teeth, neat, seaport, bead, weak, teach, least, sheep
/ʊ/	full, put, backwoods, pull, look, bull, foot
/u:/	fool, boot, pool, moon, shoot, booth, tooth
/e/	essay, bed, fell, bed, better, pet, less, mess, net
/ə/	forward, addition, objection, discus, raider, an, precede, support, backwards, but, assay
/ɜ:/	work, bird, dirt, pearl, foreword
/ɔ:/	port, torch, ball, walk, fall, audition
/æ/	cat, pat, bad, fat, man, abjection
/ʌ/	butter, luck, touch, shut, discuss, bud, cut
/ɑ:/	part, last, bath, radar, dart, barter
/ɒ/	shop, lost, pot, poll, loss, on, lock

Sentences were retrieved from Cambridge Dictionary (https://dictionary.cambridge.org/) on 03/07/2022

APPENDIX 7. 56 Sentences with Minimal Pairs for Vowels of Turkish

56 Sentences with Minimal Pairs for Vowels of Turkish

1. baş beş **/ a/ /e/**
Reklamların **baş** döndürücü çekiciliğine kapılmamalıyız.
Dört ya da **beş** kişi.

2. kaz kız **/a/ /ɯ/**
Komşunun tavuğu komşuya **kaz** görünür.
Hatice gelin, küçük bir **kız** gibi telaşlıydı.

3. kan kin **/a/ /i/**
Beyne giden damarların daralması beyne **kan** akışını azaltır.
Biz kimseye **kin** tutmayız.

4. baş boş **/a/ /o/**
Eski günlerin **baş** döndürücü mutluluğu ikimizi de kucaklamıştı.
Yarısı **boş** bir bardak görüyorum.

5. köle kale **/ø/ /a/**
Üçüncü gün aynı saatlerde bir **köle** gelerek yiyecek istedi.
Bu defa, yaşayan bir **kale** gördüm.

6. az uz **/a/ /u/**
Kim olduğunu da anlayabiliyordu **az** çok.
Az gitmiş, **uz** gitmiş, dere tepe düz gitmiş.

7. tam tüm **/a/ /y/**
Biz niyetimizi **tam** anlatamadık, onlar da anlatamadılar.
Paris'te büyük bir şirkette görevliydi ve görevi gereği **tüm** dünyayı dolaşıyordu.

8. kez kız **/e/ /ɯ/**
İlk **kez** mi izliyorsun bunu?
Türkiye'nin dört bir yanında **kız** çocuklarının eğitim problemi olduğunu biliyorduk.

9. kel kil **/e/ /i/**
Sonra takke düştü, **kel** göründü.
Daha önce de tamamen bitkisel bir **kil** maskesi almıştım.

10.ten ton **/e/ /o/**
Hafif bronz bir **ten**, çikolata kahvesi dalgalı saçlar, ve bu renklerin uyumu.
Sanki sırtında milyonlarca **ton** yük taşıyor gibiydi.

11.gez göz **/e/ /ø/**
Gez dünyayı gör Konya'yı!
Etrafıma **göz** attım.

12.kem kum **/e/ /u/**
Allah **kem** gözlerden saklasın.
Şu akıp giden **kum** seline bak.

13.gel gül **/e/ /y/**
Yeter ki, sen benimle **gel** ve bana yardım et!
Renkleri sarı bir **gül** gibiydi.

14.dış diş **/ɯ/ /i/**
Beklenen oranda bir **dış** kaynak girişi olmazsa ne olur?
Gülerken **diş** etleri görünüyordu.

15.kır kor **/ɯ/ /o/**
Küçük otlara, minik **kır** çiçeklerine, çalışkan karıncalara baktı.
Çam kütüğü **kor** gibi olmuştu.

16. kır kör **/ɯ/ /ø/**
İçeride elli yaşlarında, **kır** saçlı bir adam görüyorum.
Şiddetin **kör** bir kuyu olduğunu anlatmaya çalıştım.

17.kıl kul **/ɯ/ /u/**
Birkaç kez **kıl** payı yakayı kurtardım.
Ben **kul** hakkından çok korkarım.

18.dış düş **/ɯ/ /y/**
Merdiven basamaklarını bitirip **dış** kapının kilidine anahtarımı soktum.
Bazen başarılar böyle **düş** kırıklıklarına yol açabiliyordu.

19.kol kil **/o/ /i/**
Aradaki bir **kol** uzunluğundan fazla açıklık da değişmez.
Bu maddelerin yapımında topraktaki **kil** tipinin önemli rolü bulunmaktadır.

20.kör kir **/ø/ /i/**
Annesi sabahın **kör** karanlığında işe gitmişti.
Eli yüzü **kir** içinde, ayağına giyecek ayakkabısı yok.

21.pil pul **/i/ /u/**
Performans testinin yanı sıra **pil** ömürleri de ölçüldü.
Lakin şehir yeri para **pul** dayanmaz olmuş.

22.süren siren **/y/ /i/**
Onlarla üç sene **süren** birlikteliğim, hep imtihanlarla geçti.
Tam yatıyoruz, **siren** sesleri gelmeye başlıyor.

23.kor kör **/o/ /ø/**
Olabilir mi, her şeye **kör** ve sağır kalınabilir mi?
Acı ve kahır bir **kor** gibi dolanır içimizde.

24. buz boz /u/ /o/

Ellerimiz **buz** kesti, yüzümüz kireç gibi.
Biri siyah, öteki **boz** renkliydi.

25. dün don /y/ /o/

Gittiğimiz yerler, sinemalar, parklar **dün** gibi aklımda hala..
Ancak **don** tehlikeli gecelerde sobalar yakılır.

26. köle kule /ø/ /u/

Eğer bunları daimi olarak yaparlarsa o zaman efendi ile **köle** arasında fark kalmaz.
Beyaz **kule** çevresinde Yahudi mahalleleri yoğunlaşmıştı.

27. güz göz /y/ /ø/

Sıradan sayılacak bir **güz** sabahıydı.
Üstüme çöken bu ölü ağırlığı **göz** kapaklarımı açmamı zorlaştırıyordu.

28. tür tur /y/ /u/

Zaman zaman da bu **tür** grupların oluşturulabilmesine imkan tanınabilir.
Yeni yatımla bir **tur** atıp geleceğim.

Vowel	Lexical Items
/a/	baş, kaz, kan, kale, az, tam
/e/	beş, kez, kel, ten, gez, kem, gel
/ɯ/	kız, dış, kır, kıl
/i/	kin, kil, diş, kir, pil, siren
/o/	boş, ton, kor, kol, boz, don
/ø/	köle, göz, kör, köle
/u/	uz, kum, kul, pul, buz, kule, tur
/y/	tüm, gül, düş, süren, dün, güz, tür

Queries were made on Turkish National Corpus (https://v3.tnc.org.tr/) on 03/07/2022.

APPENDIX 8. List of English Sentences for Reading Task for Participants

Dear participant, please read the following sentences aloud:

- ✓ We heard sheep bleating in the field.
- ✓ They asked the waitress for the bill.
- ✓ The ship sank slowly to the depths of the ocean.
- ✓ The bull tossed him up into the air.
- ✓ Before painting, fill all the cracks in the plaster.
- ✓ Jem's house is always in a mess.
- ✓ He's a fool to think she still loves him.
- ✓ You should leave early if you want to miss the rush hour.
- ✓ It would be helpful if you were to precede the report with an introduction.
- ✓ She knew she couldn't afford it, so she didn't bid.
- ✓ His lawyers have decided not to proceed with the case.
- ✓ The poor bird couldn't fly because it had a broken wing.
- ✓ Could we have the bill, please?
- ✓ How much did you bid for that antique vase?
- ✓ The ball bounced off the post and into the net.
- ✓ Our holiday was spoiled by bad weather.
- ✓ The coffee was bitter.
- ✓ Is your name on the list?
- ✓ Have some bread and butter.
- ✓ I hate being the last one to arrive at a meeting.
- ✓ The ship was flying the Spanish flag.
- ✓ A short time from now, it has become two feet long.
- ✓ The shop was closed.
- ✓ I've got a blister on my left foot.
- ✓ Brush your teeth thoroughly morning and night.
- ✓ She likes everything neat and tidy.
- ✓ Look, I've got a wobbly tooth.
- ✓ His penalty kick placed the ball decisively in the back of the net.
- ✓ My constituency is a seaport and fishing port.
- ✓ A bead of sweat stood out on his forehead.
- ✓ The majority of people in the town strongly support the plans to build a new school.
- ✓ He's a tough old bird.

1

- ✓ I can't stand weak coffee.
- ✓ Their feet and hands, however, are remarkably small.
- ✓ The baby has just learned to walk.
- ✓ He eats all the time but he never gets fat.
- ✓ We teach English to foreign students.
- ✓ It was the answer she least wanted to hear.
- ✓ That paint is wet - don't touch it.
- ✓ Our house is the last one on the left before the traffic lights.
- ✓ He's the relative I like the least.
- ✓ My plate was already full.
- ✓ You look lost - can I help you?
- ✓ You fool, you missed your chance!
- ✓ Doctors have discovered that keeping a pet can do wonders for your health.
- ✓ I grew up in the backwoods, with no cable TV and no Internet access.
- ✓ She put her bag on the table.
- ✓ I walked backwards towards the door.
- ✓ Pull your chair over here so you can see the screen.
- ✓ We had a good view of all the ships leaving port.
- ✓ He gave her a pearl necklace for her birthday.
- ✓ She put her hands over her eyes.
- ✓ I bent down to pat the little puppy.
- ✓ Look over there - there's a rainbow!
- ✓ He put salt into the sugar bowl by mistake.
- ✓ So your interview's tomorrow? Good luck!
- ✓ Exercise has become part of my daily routine.
- ✓ Fill a large pot with salted water and bring it to the boil.
- ✓ We always put the cat out at night.
- ✓ If you put together yellow and blue paint you get green.
- ✓ We went fell walking last weekend.
- ✓ He lent down and struck a match on the sole of his boot.
- ✓ I felt like a fool when I dropped my phone in the toilet.
- ✓ She's not a painter but a writer.
- ✓ I spent most of my holiday lying by the pool.
- ✓ The water's deep here, so don't fall in!

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- ✓ You are holding a pearl necklace in your hands.
- ✓ He said he would pay me back and like a fool, I believed him.
- ✓ My man will show you to the door.
- ✓ If he's not armed, don't shoot.
- ✓ What time does the moon rise?
- ✓ Please shut the gate.
- ✓ I took a bath this morning.
- ✓ We're carrying out a poll to find out what people think about abortion.
- ✓ There was a line of people waiting for the phone booth.
- ✓ She looked at her reflection in the deep green pool of water.
- ✓ Mr Jones thought my history essay was terrific.
- ✓ She didn't get out of bed till lunchtime today.
- ✓ They compared technical ease of the assay and cost.
- ✓ Is that Lee's new bird?
- ✓ The horse fell at the first fence.
- ✓ We've just had some very bad news.
- ✓ Athletes have to learn how to fall without hurting themselves.
- ✓ I'm exhausted - I'm going to bed.
- ✓ She is much better at tennis than I am.
- ✓ She has pet snake.
- ✓ Cream the butter and sugar together.
- ✓ Unfortunately, accidents are part of life.
- ✓ Exercise more and eat less.
- ✓ However, there is a passage in the foreword that is much more significant for present concerns.
- ✓ He suffered a gradual loss of memory.
- ✓ You will run forward at my command.
- ✓ His audition went well and he's fairly hopeful about getting the part.
- ✓ A couple of people raised objections to the proposal.
- ✓ In addition to being a politician, he still works as a lawyer.
- ✓ It was almost abjection in his respect for his boss.
- ✓ It is a sport in which a discus is thrown as far as possible.
- ✓ Other vessels in the area show up on the ship's radar.
- ✓ The later chapters discuss the effects on the environment.
- ✓ An armed raider forced their way into the couple's home.

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- ✓ I got on my bike and left.
- ✓ He offered to walk to the station.
- ✓ He applied to become an American citizen.
- ✓ I've got so much work to do.
- ✓ He has some very bad habits.
- ✓ It was springtime and the fruit trees were in bud.
- ✓ A penguin is a flightless bird.
- ✓ We were woken early by the sound of a bird singing.
- ✓ We made a dart for the exit.
- ✓ A poll was conducted to gauge consumers' attitudes.
- ✓ His coat was covered with dirt.
- ✓ There is a pearl of dew on the grass.
- ✓ I gave the little boy a pat on the head.
- ✓ She flashed the torch into the dark room.
- ✓ At the port she managed to get a passage on an outward-bound ship.
- ✓ Don't touch the machine when it's in use.
- ✓ Part of my steak isn't cooked properly.
- ✓ I've just drunk a whole pot of tea!
- ✓ During the 20th century the village was a bustling river port.
- ✓ The Estonian port of Tallinn was blockaded for a time by Soviet warships.
- ✓ My cat likes dozing in front of the fire.
- ✓ Pat the vegetables dry with a paper towel.
- ✓ This knife doesn't cut very well.
- ✓ Part of this form seems to be missing.
- ✓ The spokesman came out with a pat response.
- ✓ Fry the mushrooms in a little butter.
- ✓ She'd made a large pot of chicken soup.
- ✓ Earlier economies worked on a barter system.
- ✓ I heard someone turn a key in the lock.
- ✓ He was, for the most part, quite helpful.
- ✓ The best of luck with your exams!
- ✓ He made a new pot of coffee.

Thank you for your participation.

4

APPENDIX 9. List of Turkish Sentences for Reading Task for Participants

Dear participant, please read the following sentences aloud:

- ✓ Reklamların baş döndürücü çekiciliğine kapılmamalıyız.
- ✓ Komşunun tavuğu komşuya kaz görünür.
- ✓ Dört ya da beş kişi.
- ✓ Hatice gelin, küçük bir kız gibi telaşlıydı.
- ✓ Beyne giden damarların daralması beyne kan akışını azaltır.
- ✓ Eski günlerin baş döndürücü mutluluğu ikimizi de kucaklamıştı.
- ✓ Biz kimseye kin tutmayız.
- ✓ Yarısı boş bir bardak görüyorum.
- ✓ Üçüncü gün aynı saatlerde bir köle gelerek yiyecek istedi.
- ✓ Kim olduğunu da anlayabiliyordu az çok.
- ✓ Bu defa, yaşayan bir kale gördüm.
- ✓ Az gitmiş, uz gitmiş, dere tepe düz gitmiş.
- ✓ Biz niyetimizi tam anlatamadık, onlar da anlatamadılar.
- ✓ İlk kez mi izliyorsun bunu?
- ✓ Paris'te büyük bir şirkette görevliydi ve görevi gereği tüm dünyayı dolaşıyordu.
- ✓ Türkiye'nin dört bir yanında kız çocuklarının eğitim problemi olduğunu biliyorduk.
- ✓ Sonra takke düştü, kel göründü.
- ✓ Hafif bronz bir ten, çikolata kahvesi dalgalı saçlar, ve bu renklerin uyumu.
- ✓ Daha önce de tamamen bitkisel bir kil maskesi almıştım.
- ✓ Sanki sırtında milyonlarca ton yük taşıyor gibiydi.
- ✓ Gez dünyayı gör Konya'yı!
- ✓ Allah kem gözlerden saklasın.
- ✓ Etrafıma göz attım.
- ✓ Şu akıp giden kum seline bak.
- ✓ Yeter ki, sen benimle gel ve bana yardım et!
- ✓ Beklenen oranda bir dış kaynak girişi olmazsa ne olur?
- ✓ Renkleri sarı bir gül gibiydi.
- ✓ Gülerken diş etleri görünüyordu.

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- ✓ Küçük otlara, minik kır çiçeklerine, çalışkan karıncalara baktı.
- ✓ İçeride elli yaşlarında, kır saçlı bir adam görüyorum.
- ✓ Çam kütüğü kor gibi olmuştu.
- ✓ Şiddetin kör bir kuyu olduğunu anlatmaya çalıştım.
- ✓ Birkaç kez kıl payı yakayı kurtardım.
- ✓ Merdiven basamaklarını bitirip dış kapının kilidine anahtarımı soktum.
- ✓ Ben kul hakkından çok korkarım.
- ✓ Bazen başarılar böyle düş kırıklıklarına yol açabiliyordu.
- ✓ Aradaki bir kol uzunluğundan fazla açıklık da değişmez.
- ✓ Annesi sabahın kör karanlığında işe gitmişti.
- ✓ Bu maddelerin yapımında topraktaki kil tipinin önemli rolü bulunmaktadır.
- ✓ Eli yüzü kir içinde, ayağına giyecek ayakkabısı yok.
- ✓ Performans testinin yanı sıra pil ömürleri de ölçüldü.
- ✓ Onlarla üç sene süren birlikteliğim, hep imtihanlarla geçti.
- ✓ Lakin şehir yeri para pul dayanmaz olmuş.
- ✓ Tam yatıyoruz, siren sesleri gelmeye başlıyor.
- ✓ Olabilir mi, her şeye kör ve sağır kalınabilir mi?
- ✓ Ellerimiz buz kesti, yüzümüz kireç gibi.
- ✓ Acı ve kahır bir kor gibi dolanır içimizde.
- ✓ Biri siyah, öteki boz renkliydi.
- ✓ Gittiğimiz yerler, sinemalar, parklar dün gibi aklımda hala..
- ✓ Eğer bunları daimi olarak yaparlarsa o zaman efendi ile köle arasında fark kalmaz.
- ✓ Ancak don tehlikeli gecelerde sobalar yakılır.
- ✓ Beyaz kule çevresinde Yahudi mahalleleri yoğunlaşmıştı.
- ✓ Sıradan sayılacak bir güz sabahıydı.
- ✓ Zaman zaman da bu tür grupların oluşturulabilmesine imkan tanınabilir.
- ✓ Üstüme çöken bu ölü ağırlığı göz kapaklarımı açmamı zorlaştırıyordu.
- ✓ Yeni yatımla bir tur atıp geleceğim.

Thank you for your participation.

2

BENZERLİK RAPORU ÖZET SAYFASI

Second Language Articulations of Native Turkish Speakers Learning English as a Foreign Language in the 14-19 Age Group: Shared and Distinct Features

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