Dirasat: Human and Social Sciences, Volume 52, No. 6, Supplement 1, 2025, 5447

Deanship of Scientific Research

Investigation of the Pronunciation of the Voiceless Fricative Non-Sibilant Phoneme /θ/ in Arabic: An Acoustic Phonetics Comparative Analysis

Mohamad Zaka Al Farisi[1]*, *Mad Ali*[1], *Zawawi Ismail*[2], *Hikmah Maulani*[1], *Nalahuddin Saleh*[1], *Shofa Musthofa Khalid*[1]

[1] Department of Arabic Language Education, Faculty of Languages and Literature Education, Universitas Pendidikan Indonesia, Indonesia

[2] Department of Language and Literacy Education, Faculty of Education, Universiti Malaya, Kuala Lumpur, Malaysia.

Received: 10/8/2023
Revised: 5/3/2024
Accepted: 7/8/2024
Published online: 1/7/2025

* *Corresponding author:*
zaka@upi.edu

Citation: Al Farisi, M. Z., Ali, M., Ismail, Z., Maulani, H., Saleh, N., & Khalid, S. M. (2025). Investigation of the Pronunciation of the Voiceless Fricative Non-Sibilant Phoneme /θ/ in Arabic: An Acoustic Phonetics Comparative Analysis. *Dirasat: Human and Social Sciences*, 52(6), 5447.
https://doi.org/10.35516/Hum.2025.5447

Abstract

Objectives: This research aims to investigate phonological interference experienced by Sundanese, Javanese, and Bataknese speakers (from now on referred to as SS, JS, and BS, respectively) in pronouncing the voiceless fricative non-sibilant /θ/ in Arabic. The phoneme /θ/ is selected by considering its absence in the languages aboves.

Methods: This is descriptive-evaluative-comparative research with content analysis design whose goal is to predict and assess the pronunciation of the phoneme /θ/ by the SS, JS, and BS - while comparing it with the model speaker (starting now would be referred to as MS). The participants are selected purposively based on criteria which suit the aim of this research. Meanwhile the MS is a reciter who won first place in the National Musabaqah Tilawatil Quran. The research data are nine verses of the Qur'an, which contain the phoneme /θ/. The data are collected through the listen-record-note technique is compared to the MS and analyzed acoustically through the Praat application.

Results: The results indicate that only the BS experience phonologic interference when pronuncing the phoneme /θ/ located at the beginning of a word, as well as the JS when pronuncing the phoneme /θ/ situated at the end of a word.

Conclusions: The phonologic interference they experience is apparent by the change of the /θ/ sound to the /s/ sound. Meanwhile SS does not undergo phonologic interference in producing the phoneme /θ/ in Arabic, whether it is located at the beginning, in the middle, or at the end of a word.

Keywords: Arabic; Bataknese; Fricative; Phonetic Interference; Javanese; Sundanese; Voiceless.

التحقيق في نطق الفونيم /θ/المهموس الاحتكاكي غير الصفيري في العربية: تحليل مقارن في علم الأصوات الفيزيائي

محمد زكى الفارسي[1]*، *مد علي*[1]، *زواوي إسماعيل*[2]، *حكمة مولاني*[1]، *ناله الدين صالح*[1]، *صافى مصطفى خالد*[1]

[1] قسم تربية اللغة العربية، جامعة إندونيسيا التربوية، باندونج، إندونيسيا.

[2] قسم تعليم اللغة ومحو الأمية، التربية، جامعة مالايا، كوالالمبور، ماليزيا.

ملخّص

الأهداف: يهدف هذا البحث إلى دراسة التداخل الصوتي الذي تعاني منه المتحدثات باللغة السودانية والجاوية والباتاكية - يشار إليهم فيما بعد بـ SS وJS وBS على التوالي - في نطق الصوت المهموس الاحتكاكي غير الصفيري /θ/ باللغة العربية. يتم اختيار الصوت /θ/ مع الأخذ في الاعتبار أنه غير موجود في تلك اللغات المحلية.

المنهجية: هذا بحث وصفي تقييمي مقارن مع تصميم تحليل المحتوى هدفه وصف نطق الصوت /θ/ وتقييمه بواسطة SS وJS و BS، مع مقارنته بالمتحدثة النموذجية - البداية الآن سيشار إليها باسم .(MS) وقد تم اختيار المشاركات بشكل هادف بناءً على معايير تتناسب مع هدف هذا البحث. فقد حصلت MS على الجائزة الأولى في المسابقة الوطنية لتلاوة القرآن الكريم. وكانت بيانات البحث تسع آيات قرآنية تحتوي على الصوت /θ/ وتمت مقارنة البيانات التي جُمعت من خلال تقنية الاستماع والتسجيل والملاحظة مع MS وتم تحليلها صوتيًا من خلال تطبيق Praat.

النتائج: تشير النتائج إلى أن BS فقط هي التي تتعرض للتداخل الصوتي عند نطق الصوت /θ/ الواقع في بداية الكلمة، وكذلك JS عند نطق الصوت /θ/ الواقع في نهاية الكلمة.

الخلاصة: يظهر التداخل الصوتي الذي تتعرض له BS و JS من خلال تغيير الصوت /θ/ إلى الصوت /s/ في حين أن SS لا تتعرض لتداخل صوتي في إنتاج الصوت /θ/ في اللغة العربية، سواء أكان يقع في بداية الكلمة أو في وسطها أو في نهايتها.

الكلمات الدالة: العربية، الباتاكية، الاحتكاكية، التداخل الصوتي، الجاوية، السوناوية، المهموس.

Introduction

Phonological interference occurs when bilingual or multilingual speakers pronounce second-language phonemes differently due to their native phonological system. Rahmatia, Darwis, & Lukman (2021) argue that this interference affects students' reading skills in Arabic and in translation as well (Al Farisi, 2023). Arabic has 34 phonemes, including 6 vowels and 28 consonants, classified into categories like short and long vowels. Arabic word structure involves syllables with at least one vowel, while its 28 consonants are further categorized by Elfahm et al. (2022) based on articulation.

When using a second language, speakers may be influenced by their first language, leading to phonological interference. Adityarini, Pastika & Sedeng (2020) found that European BIPA students in Bali experience such interference, affecting vowel and consonant sounds. Similarly, Muzaki & Darmawan (2022) observed phonological interference among MS on the Fouly Youtube Channel, with Indonesian phonemes altering their speech. Therefore, speakers of Sundanese, Javanese, and Bataknese may also experience interference when pronouncing the voiceless fricative non-sibilant interdental phoneme /θ/ in Arabic, as these consonants are absent in their native languages. Sundanese, Javanese, and Bataknese, being the most-spoken languages in Indonesia, have distinct phonetic features, including /θ/, which differs from Arabic.

The differences between phonemes in the first and second languages can hinder listening and speaking skills due to inaccurate pronunciation caused by phonological interference. This interference, particularly with the phoneme /θ/, can significantly alter the meaning of words or sentences. Therefore, recognizing distinctive phonetic features is crucial for identifying foreign language phonemes, as emphasized by Ibrahim et al. (2020). Various researchers have investigated voiceless fricative non-sibilant phonemes in different languages, such as Arabic, English, Russian, Romanian, and Greek (Al-Khairy, 2005; Maniwa, Jongman & Wade, 2009; Nirgianaki, 2014; Kong et al., 2014; Spinu & Lilley, 2016; Kochetov, 2017; Lilley, Spinu & Athanasopoulou, 2021).

Understanding phonological interference is crucial for fostering cross-cultural communication as it enhances listening, speaking, and examination skills. Additionally, Arabic holds significance in various domains such as business, culture, education, international relations, and religion. Many Muslims in Indonesia, including speakers of Sundanese, Javanese, and Bataknese, study Arabic to explore the Al-Qur'an. Unfortunately, there are still many Muslims who cannot speak Arabic. Because of this, many Muslims need a translation of the Qur’an. Translation of the Qur’an is an obligation in view of many Muslims who do not comprehend the Arabic (Al Farisi, 2018). In verbal communication, speakers must select words that accurately convey their intended meaning from their vast knowledge base, considering various phonetic similarities, as highlighted by Hameau et al. (2021).

This research can enhance the development of Arabic teaching materials tailored to the needs of non-Arabic speakers with diverse regional languages by addressing phonological interference. Understanding this phenomenon enables students to create materials that address the challenges in pronouncing Arabic phonemes, which possess unique characteristics. Phonological interference occurs when speakers of Sundanese, Javanese, and Bataknese struggle to articulate voiceless fricative non-syllable phonemes in Arabic, influenced by their first-language phonological system. Carmitha et al. (2023) note similar challenges faced by students from Egypt and Uzbekistan in the BIPA class, leading to phonological errors that alter word meanings. To address this, speakers may substitute these Arabic phonemes with others from their native languages. However, phonological interference poses a significant challenge in Arabic learning, as incorrect pronunciation can lead to misunderstandings and communication breakdowns in cross-cultural contexts. Therefore, understanding phonological aspects is crucial for effective oral communication, as emphasized by Garn-Nunn & Sotto (2018) and Hameau et al. (2021)

Research on phonological interference is essential as it enhances understanding of speaking, listening, and second-language examination. This research aims to improve Arabic learning for non-Arabic speakers with diverse regional languages by addressing phonological interference. Additionally, it provides insight into how first-language phonological systems influence the production of second-language phonemes. Muhtar et al. (2022) and Marlina, Hermawan & Budi (2023) highlight phonetic errors made by students due to the absence of equivalent phonemes in their first languages, altering word meanings. This study focuses on examining phonological interference experienced by Sundanese Speaker

(SS), Javanese Speaker (JS), Bataknese Speaker (BS), and Model Speaker (MS) towards the voiceless fricative non-sibilant interdental phoneme /θ/, comparing it with MS pronunciation.

This research presents research questions; How do speakers from diverse linguistic backgrounds, particularly non-Arabic speakers, pronounce the voiceless fricative non-sibilant phoneme /θ/ in Arabic, and what are the underlying factors influencing their pronunciation?

To answer the research question, the study focuses on improving Arabic learning for non-Arabic speakers with diverse regional languages by addressing phonological interference. Unlike previous studies, it targets Arabic learners from various linguistic backgrounds, such as Sundanese, Javanese, and Bataknese speakers in Indonesia. This situation indicates that tools designed for other languages are not easily adaptable to Arabic because of its complexity (Syihabuddin, et al., 2024). By identifying and addressing the challenges these learners face in pronouncing the voiceless fricative non-sibilant phoneme /θ/ in Arabic, this study provides valuable insights into phonetics, language acquisition, and cross-cultural communication. At least this is based on the fact that the influence of the first language (L1) on learning a second language (L2), especially in grasping lexical meanings, is eviden (Al Farisi, et al., 2024). Additionally, the research methodology integrates acoustic phonetics comparative analysis, offering a fresh approach to understanding the articulatory characteristics of the target phoneme across different Arabic dialects. This research significantly contributes to uncovering the articulatory characteristics of /θ/ in different Arabic dialects through acoustic analysis, including spectrographic and other measurements. This method offers a precise and measurable understanding of the pronunciation of this phoneme. By utilizing acoustic phonetic analysis, this research can identify common error patterns and provide more targeted solutions to enhance pronunciation and comprehension abilities of the phoneme.

Theoretical framework

The theoretical foundation of this research is constructed upon several fundamental principles:

This framework encompasses the influence of speakers' native phonological systems on their pronunciation of second-language phonemes (Eckman, et al., 2003; Davidson, 2011; Reinisch and Llompart, 2020), particularly focusing on the challenges encountered when attempting to produce the voiceless fricative non-sibilant phoneme /θ/ in Arabic.

Acoustic analysis serves as the primary methodology for this research, focusing on spectrographic measurements (Melluzi, 2021) and other acoustic parameters (Singh and Ghosh, 2020) to capture the articulatory characteristics of the phoneme /θ/ across various Arabic dialects. This framework allows for a precise and measurable examination of phonetic features.

This framework involves comparing the articulation of /θ/ in Arabic with other languages or dialects (Cotter, 2020), potentially including languages with similar phonemes (Maghrabi, 2020) as well as those without, to highlight distinctive pronunciation patterns and potential areas of phonological interference.

Considering the diversity of Arabic dialects, this framework acknowledges linguistic variation in pronunciation (Al-Essa, 2020; Benítez Fernández, 2023) which may influence the articulation of /θ/ across different regions and communities. Understanding these variations is essential for a comprehensive analysis of the phoneme's pronunciation.

The theoretical framework also emphasizes the relevance of accurate pronunciation in facilitating effective cross-cultural communication. By investigating the pronunciation of /θ/ in Arabic, this research aims to contribute to improved communication between Arabic speakers and learners of the language.

Research Method

This study employs a qualitative approach utilizing descriptive analysis methods (Ritchie and O'Connor, 2003; Belotto, 2018). This study investigates phonological interference encountered by speakers from diverse regional languages when pronouncing the voiceless fricative non-sibilant interdental phoneme /θ/ in Arabic. Employing a descriptive-evaluative-comparative approach with a content analysis design, the research examines the pronunciation of /θ/ by SS, JS, and BS, contrasting it with the pronunciation by native Arabic speakers (MS).

1. Research participant

The research participants are selected purposively under the criteria of "first-semester students of the Public University-Arabic study program, who can read the Qur'an and speak Sundanese, Javanese, and Bataknese (as their first language)". Those languages are chosen because they are the most-spoken regional languages in Indonesia. The MS is Fathma Muthi'ah, a reciter who won first place in the 2019 National Musabaqah Tilawatil Qur'an in Pontianak, West Kalimantan, Indonesia.

The participants' characteristics are outlined in Table 1 regarding the demographic of the research sample.

Table 1. Demographic of the research sample

Characteristic	N
Etnis	
Javanese	1
Sundanese	1
Bataknese	1
Gender	
Male	0
Female	1
Data Source	*Phonetics in reading the Quran.*

2. Data collection technique

The research data are in the form of nine verses of the Qur'an contained in the 30th *juz*, which have the phoneme /θ/ at the beginning, in the middle, and at the end of words. The phoneme /θ/ is chosen because of its absence in Sundanese, Javanese, and Bataknese; therefore, it may cause phonologic interference when the SS, JS, or BS read the Qur'an. The research data are collected by listening-recording-noting the pronunciation of the phoneme /θ/ by the SS, JS, and BS. The analyzed data are then recorded through phonetic transcription based on IPA (International Phonetic Alphabet) symbols (Brierley and Heselwood, 2022). The focus of the data is on the pronunciation of /θ/ at the beginning, middle, and end of words.

3. Data analysis

This research examines the pronunciation of the phoneme /θ/ by SS, JS, and BS. To identify and reveal the inaccuracy of the pronunciation of the phoneme, the recording results are compared with the pronunciation of the phoneme /θ/ done by the MS. The data analysis mainly focuses on the pronunciation of voiceless fricative non-sibilant interdental phoneme /θ/ in Arabic - which are located at the beginning, in the middle, and at the end of a word, with a focus on examining the points of articulation and means of stopping them. The data are analyzed with the help of the Praat application version 6.2.09 (Teearanon, 2020). Furthermore, using spectrogram and sound waveforms generated by the application as mentioned earlier, the researcher also examines the potential phonologic interference.

4. Acoustic analysis

The Praat application allows the researcher to visualize sound data in the form of spectrograms and waveforms, which helps the researcher identify the frequency spectrum of the pronunciation of the phoneme /θ/ done by the SS, JS, BS, and MS.

By analyzing the shape of the frequency spectrum, the researcher can find the differences in intensity and frequency distribution in the range of sounds spoken. Moreover, the application also allows the researcher to visually compare the sound spectrum differences between the SS, JS, BS, and MS. At the same time, also helping to identify the acoustic characteristics which underlie the phonologic interference.

Praat helps the researcher identify the formants formed in the pronunciation of the phoneme /θ/. These formants reflect

the frequency intensity peaks, as seen in the spectrogram. By comparing the formants produced by the SS, JS, BS, and MS. The researcher can find differences in the position and intensity of the formants, which indicate phonologic interference. Moreover, the researcher can also analyze the duration of the pronunciation of the phoneme /θ/. This duration suggests differences in the articulation processes between the SS, JS, and BS. Furthermore, the resulting difference in duration and articulation means phonologic interference.

Discussion

In examining the spectrogram, the researcher observes several phonetic parameters such as duration, fundamental frequency, intensity, and waveform. The acoustic analysis is intended to compare the pronunciation of the SS, JS, BS, and MS; to identify whether there are significant differences in the pronunciation of voiceless fricative non-sibilant interdental phoneme /θ/ in Arabic. Furthermore, the analysis also examines the possibility of using different points of articulation in producing these phonemes. The researcher also considers other phonological factors, such as differences in phonological systems, phoneme position in a word, and similarities with different phonemes with the possibility of phonologic interference in pronuncing the phoneme /θ/.

The possibility of phonologic interference experienced by the SS, JS, and BS when pronuncing the phoneme /θ/ is an interesting phenomenon to be studied. In this research, the researcher uses an acoustic-investigative-comparative analysis of speech data obtained from the SS, JS, BS, and MS. The acoustic analysis examines the spectrogram generated from the Praat application. The use of Praat in this research is to find thorough and accurate results, which can explain the interference experienced by the SS, JS, and BS when pronouncing the phoneme /θ/, whether located at the beginning, in the middle, or at the end of a word.

Table 1. Phoneme /θ/ pronunciation interference

Word	IPA	MS	SS	JS	BS	Description
ثُمَّ	/θumma/	/θumma/	/θumma/	/θumma/	/summa/	θ at the beginning of a word
اَنتَثَرَت	/intaθarat/	/intaθarat/	/intaθarat/	/intaθarat/	/intaθarat/	θ in the middle of a word
التُّرَاثَ	/al-tura:θa/	/al-tura:θa/	/al-tura:θa/	/al-tura:sa/	/al-tura:θa/	θ at the end of a word

Description:
IPA-: International Phonetic Alphabet
MS-: Model Speaker
SS-: Sundanese Speaker
JS-: Javanese Speaker
BS-: Bataknese Speaker

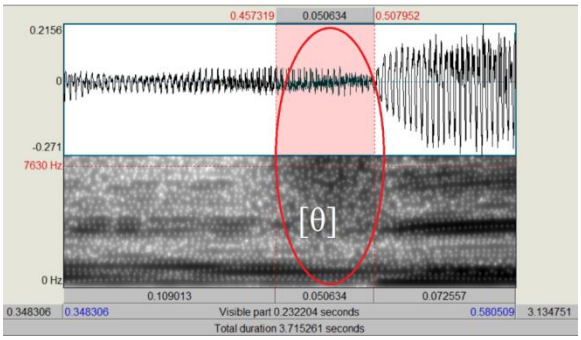
1. The characteristics of the phoneme /θ/ in Arabic

Apart from Arabic, the phoneme /θ/ is also found in several languages such as English (in the word "thin" /θɪn/), which means 'thin'; the Spanish (for "zorro" /ˈθo.ɾo/), which means 'fox'; and Greek (for "θάλασσα" /ˈθalasa/), which means 'sea'. The phoneme /θ/, in contrast, cannot be found in the Sundanese, Javanese, and Bataknese phonological systems. In Arabic, the phoneme /θ/ is an interdental phoneme (see Nasution, 2018; Elfahm et al., 2022; Ameen & Kadhim, 2023), which means that the production of this phoneme involves the tip of the tongue and the upper front teeth. The phoneme /θ/ is included in the fricative category since it is produced by flowing air through a narrow slit, which creates a hissing sound. The tip of the tongue, which is placed between the upper front teeth, inhibits the flow of air coming from the lungs with less resistance - so that air comes out of the gap between them. Air flowing through the narrow gap creates a frictional sound known as a fricative sound. According to Elfahm et al. (2022), fricative phonemes are formed by a shallow narrowing in the vocal cavity, which causes the airflow to experience turbulence continuously. Therefore, this sound is produced by creating

turbulence in the airflow through the gap between the tongue and teeth to make a grinding sound. The phoneme /θ/ is also a voiceless phoneme, which means no vibration of the vocal cords occurs when pronouncing it. Al-Qursy (2012) mentions the characteristics of the phoneme /θ/ as *mahmūs* (voiceless), *rakhāwah* (soft), *iṣmāt* (stable), *infitah* (open), and *istifāl* (closed). In this research, the phoneme /θ/ is analyzed by considering its position - at the beginning, in the middle, or at the end of a word.

2. The pronunciation interference of the phoneme /θ/ at the beginning of a word

Theoretically, phonologic interference can be caused by differences in the speaker's second and first languages' phonological systems. Supriadi (2014) states that mistakes in pronouncing Mandarin can happen because of the differences in the Mandarin phonological system with the respondents' first-language phonological system (such as Indonesian or Javanese). In Arabic, the production of /θ/ involves contact between the tip of the tongue and the upper front teeth. However, in Sundanese, Javanese, and Bataknese, there are no phonemes with a similar point of articulation. Therefore, SS, JS, and BS potentially change the sound to adapt this unusual point of articulation. Wulandari's research (2020) mentions three forms of phoneme pronunciation errors, one of which is a shift. It is one of the realizations of phonologic interference which occurs relatively often, such as a shift in the pronunciation of the phoneme /θ/ to phoneme /s/. Praat helps the researcher to visualize and analyze the phoneme /θ/ while comparing the acoustic differences which may arise when the SS, JS, BS, and MS pronounce it. Through the use of Praat, the researcher can do a comprehensive phonetic analysis to comprehend phonologic interference experienced by the SS, JS, and BS when pronouncing the phoneme /θ/. The following is a visualization of the pronunciation of the phoneme /θ/ at the beginning of a word (/θumma/ (ثُمَّ)).



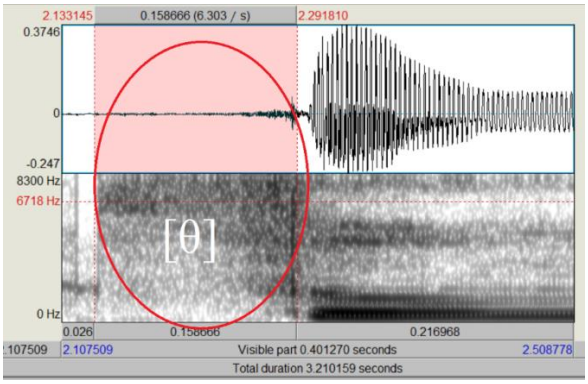
Spectrogram 1. The pronunciation of /θ/ at the beginning of a word by the MS

Spectrogram 1 is a visualization of the production of the phoneme /θ/ spoken by the MS. It shows an aperiodic wave, which means it does not have a regular repetition pattern like vowel sounds since the frequency and amplitude of the sound varies. This following Roach's (2004) explanation which states that voiceless fricatives are in the category of aperiodic sounds and do not have formants like vowels. This can be identified by the noise in the frequency pattern on the spectrogram. Spectrogram 1 also shows random noise caused by turbulence, which happens as a result of pronouncing the /θ/ fricative consonant at the beginning of a word (/θumma/). The fricative sound is formed because of the pressure of air flowing through the narrow channel between the passive and active articulators, which can cause aperiodic vibrations (turbulence) at higher frequencies (see Bannar & Aronow, 2023).

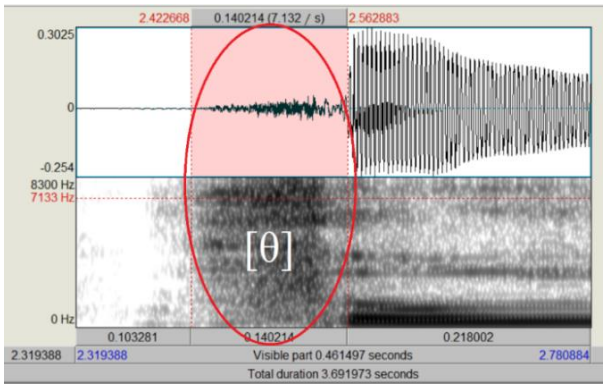
The colour density on the spectrogram shows the intensity of the sound produced. The greater the sound intensity, the darker the colour in the spectrogram will be. Intensity is the main factor which determines the loudness of sound. The latter may also be affected by sound spectral characteristics, duration and fundamental frequency. Spectrogram 1 does not show intense colour when the MS produces the sound /θ/. This indifference is one of the characteristics of /θ/, which is a non-sibilant consonant. Al-Khairy (2005) states that non-sibilant consonants (such as /f/, /v/, /θ/, and /ð/) possess lower amplitude than sibilant consonants, which causes the sound intensity to be weaker; thus, the black colour on the spectrogram gradually vanishes. When the MS makes the /θ/ sound, the energy gathering point becomes higher, namely above 7600 Hz,

and it will also become blurry.

Typically, the SS and JS do not experience phonologic interference when pronouncing the phoneme /θ/, even though it is not in their phonological systems. This result indicates that cross-language influences (first-language) in producing speech sounds (second-language) are not certainly the cause of phonologic interference, especially when the speakers often utter second-language-specific phonemes. That being said, the differences in the speaker's first and second-languages' phonological systems will not always serve as the cause of phonologic interference when pronouncing a typical second-language phoneme, including the phoneme /θ/ in Arabic, as shown in Spectrograms 2 and 3.



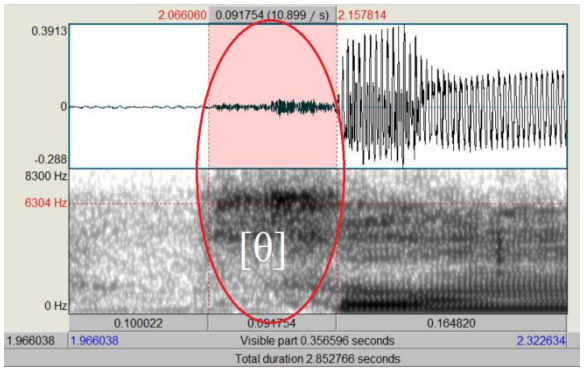
Spectrogram 2. The pronunciation of /θ/ at the beginning of a word by the SS



Spectrogram 3. The pronunciation of /θ/ at the beginning of a word by the JS

The research results show that the SS and JS pronunciations of the phoneme /θ/ located at the beginning of a word (/θumma/) in Arabic are in accordance with the pronunciation of the MS, in which they do not shift to another consonant sound. The horizontal axis of Spectrograms 2 and 3 each show that aperiodic waves, fricative random noise, and relatively weak energy intensity have the same characteristics as the MS pronunciation. Other than the blurry energy gathering points, the /θ/ sound produced by the SS also has a frequency above 6700 Hz, while for the JS, it is above 7100 Hz (as seen on the vertical axis of Spectrograms 2 and 3). The results of this comparative investigation signify that the SS and JS do not experience phonologic interference when producing voiceless fricative non-sibilant /θ/ at the beginning of a word (in Arabic).

However, it is different for the BS. The results of Praat's analysis show a significant difference between the /θ/ sound that they produce compared to the MS. They tend to have different formants and acoustic parameters in the spectrogram when making the /θ/ sound. In this case, the form produced by the Bataknese is far different from that created by the MS.



Spectrogram 4. The pronunciation of /θumma/ by the BS

Spectrogram 4 shows the pronunciation of the /θ/ sound done by the BS. When pronouncing a word (/θumma/), they change the pronunciation of the /θ/ sound to the /s/ sound. It is understandable, considering that the phoneme /θ/ does not

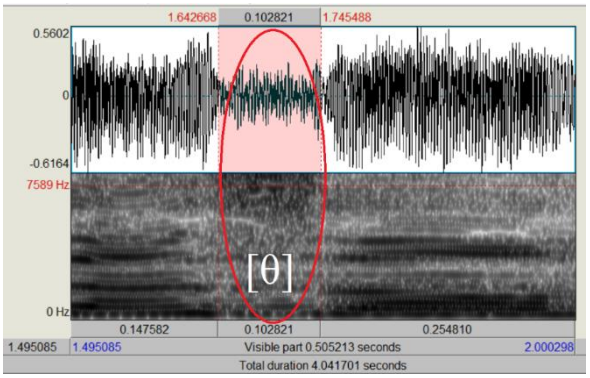
exist in their phonological system, while the phoneme /s/ does exist. Sangkala, Syamsuddin & Anwar's (2023) research results show that the Eleventh-Graders at SMA IT Al Fatih Makassar find it hard to pronounce the phoneme /θ/ in Arabic and change their pronunciation to the /s/ sound. The same thing happens to Arabic speakers who learn to speak Indonesian. In their phonological system, there is no phoneme /p/. The Arabic speakers at the Center for Indonesian Studies at the Suez Canal University in Egypt also make many mistakes when pronouncing the Indonesian phoneme /p/ since it does not exist in their phonological system (see Rafkahanun, 2021).

The BS has the phoneme /s/ instead of the phoneme /θ/, which does not exist in their phonological system. This means that the phonologic interference experienced by the BS is a change of the /θ/ sound to the /s/ sound. These two have different places of articulation – where the former belongs to the apico-interdental group. In contrast, while the latter belongs to the apico-alveolar group (see Elfahm et al., 2022) or dental-alveolar (see Ameen & Kadhim, 2023). The phoneme /s/ is produced by flowing air through the gap between the tongue and hard palate, not between the tongue and the upper front teeth, as in the phoneme /θ/. The /θ/ sound is included in the sound category non-sibilant, while the /s/ sound is sibilant. However, apart from being both a fricative sound, these two are both voiceless consonants since the vocal cords do not vibrate when pronouncing it. This similarity in characteristics may cause the BS to change the pronunciation of /θ/ to the /s/ sound.

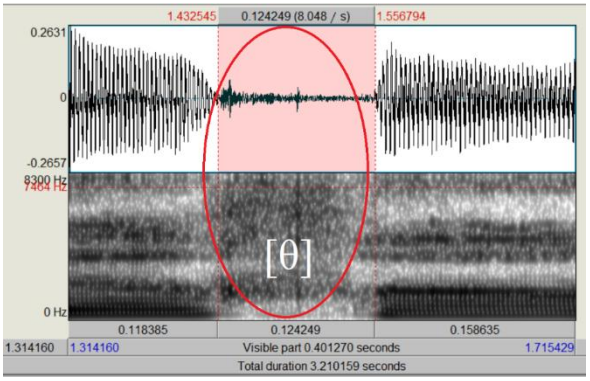
Phonologic interference in the pronunciation of the phoneme /θ/ could be identified through the noise in the spectrogram. The identification could also be done on the /θ/ sound waveform, which belongs to the aperiodic group. According to Roach (2004), voiceless fricative consonants belong to the category of aperiodic sounds and do not have formants like vowels. Aperiodic waves do not have a regular repeating pattern because of the varying frequency and amplitude of the sound. The horizontal axis of Spectrogram 4 shows a denser wave intensity (than the one belonging to the MS) when the BS pronounces the phoneme /θ/ situated at the beginning of a word (/θumma/). This intensity of a wave is an indication that the intensity coming out is stronger. That particular state indicates that the sound coming out is not /θ/ but /s/. This is in accordance with Elfahm et al. (2022), which mentions that the frequency of the fricative sibilant /s/ is higher than the non-fricative /θ/ sound. Moreover, the energy gathering point is around 6300 Hz, which is much lower than the one belongs to the MS (which reaches approximately 7600 Hz).

3. The pronunciation interference of the phoneme /θ/ in the middle of a word

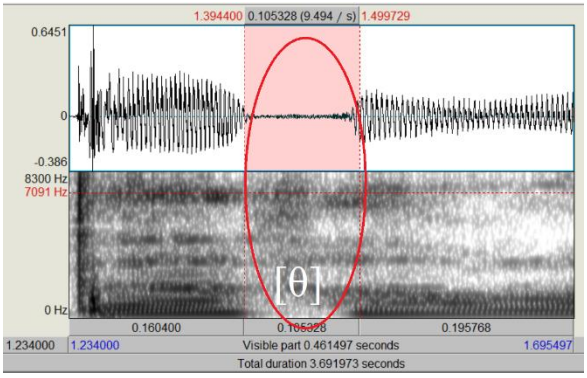
In general, the results of the spectrogram analysis show that the pronunciation of the phoneme /θ/ in the middle of an Arabic word by the SS, JS, and BS is almost in accordance with the MS pronunciation. That means they do not experience phonologic interference when pronouncing the phoneme /θ/ located in the middle of a word (/intaθarat/ (اَنتَثَرَت). This is plausible because the SS, JS, and BS are Arabic language study program students who have often read the Qur'an. According to Ali, Mnasri & Lachiri (2020), pronouncing Arabic phonemes is relatively easy and straightforward - since each letter only corresponds to one phoneme. Therefore, the SS, JS, and BS have no problems in pronouncing the phoneme /θ/ located in the middle of an Arabic word, as shown in the following spectrogram:



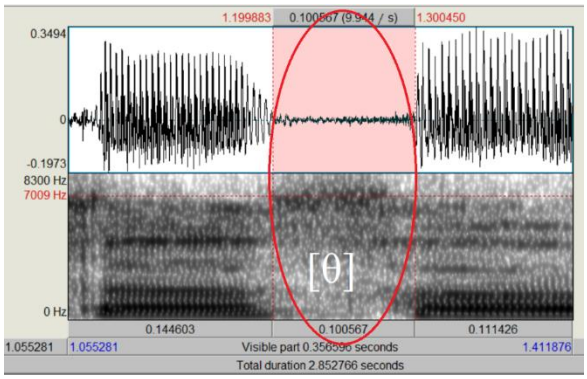
Spectrogram 5. The pronunciation of /θ/ in the middle of a word by the MS



Spectrogram 6. The pronunciation of /θ/ in the middle of a word by the SS



Spectrogram 7. The pronunciation of /θ/ in the middle of a word by the JS

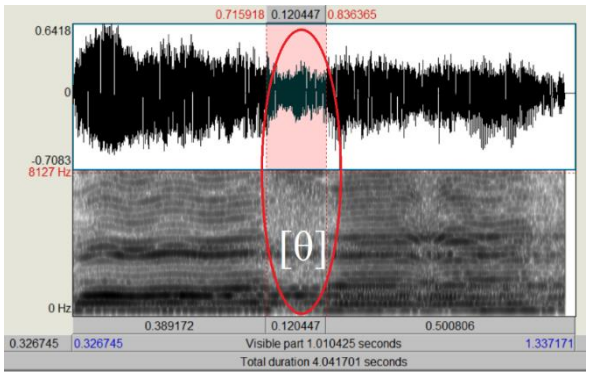


Spectrogram 8. The pronunciation of /θ/ in the middle of a word by the BS

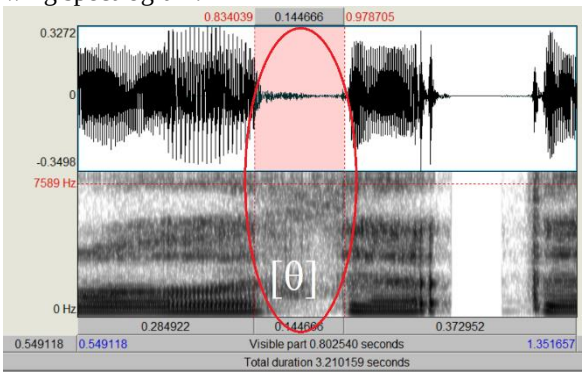
Based on the spectrogram analysis, which visualizes the pronunciation of the phoneme /θ/ located in the middle of a word done by the MS, SS, JS, and BS, the following results are found. First, the visualization of the pronunciation of the phoneme /θ/ in the middle of a word shows aperiodic waves without a regular repetition pattern since the frequency and amplitude of the sound produced varies. Voiceless fricative sounds, including the phoneme /θ/, are aperiodic sounds – and they do not have the same formants as vowels (see Roach, 2004). When compared, the analysis of Spectrogram 5 (MS), Spectrogram 6 (SS), Spectrogram 7 (JS), and Spectrogram 8 (BS) shows that all of them share one thing in common, namely the appearance of random noise due to turbulence which arises when they pronounce the /θ/ fricative consonant in the middle of a word (/intaθarat/). According to Bannar & Aronow (2023), aperiodic fricative sound waves appear because of the push of air flowing through the narrow channel between passive and active articulators at higher frequencies. The second result is that Spectrogram 5, Spectrogram 6, Spectrogram 7, and Spectrogram 8 show colours which are not intense since the phoneme /θ/ is a non-sibilant sound. According to Al-Khairy (2005), non-sibilant consonants (including /θ/) have a lower amplitude than the sibilant ones, which in turn causes the intensity of the /θ/ sound to weaken; that is usually shown by the fading of the black colour in the spectrograms. As for the third result, the /θ/ sound made by the MS, SS, JS, and BS all have blurry energy gathering points and high frequency, namely above 7500 Hz, above 7400 Hz, above 7000 Hz, and above 7000 Hz respectively.

4. The pronunciation interference of the phoneme /θ/ at the end of a word

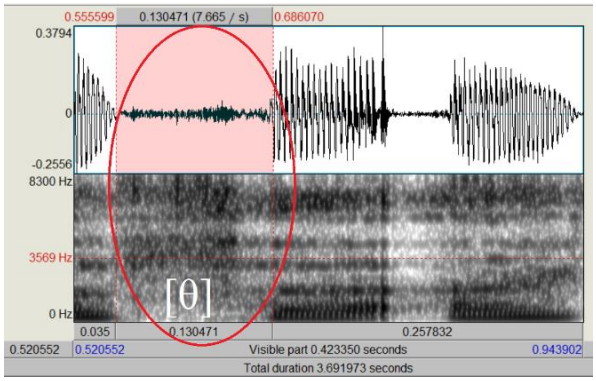
In previous sections, it is shown that the SS and JS do not experience phonologic interference when pronouncing the phoneme /θ/ located at the beginning of a word (/θumma/), yet the BS experience interference when pronouncing it. Meanwhile, they do not experience phonologic interference when pronouncing the phoneme /θ/ situated in the middle of a word (/intaθarat/). Now, when pronouncing the phoneme /θ/ located at the end of a word (/al-tura:θa/), only the JS experiences phonologic interference - as shown in the following spectrogram.



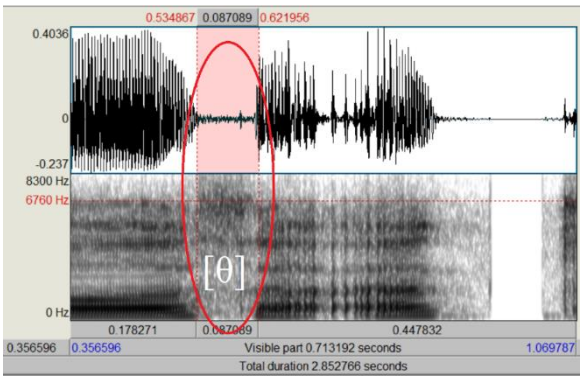
Spectrogram 9. The pronunciation of /θ/ at the end of a word by the MS



Spectrogram 10. The pronunciation of /θ/ at the end of a word by the SS



Spectrogram 11. The pronunciation of /θ/ at the end of a word by the JS



Spectrogram 12. The pronunciation of /θ/ at the end of a word by the BS

Based on Spectrograms 10 and 12, it can be said that the SS and BS do not experience phonologic interference when pronouncing the phoneme /θ/ located at the end of a word (/al-tura:θa/). In this case, only the JS experiences it. The reason is that they change the pronunciation of the phoneme /θ/ situated at the end of a word (/al-tura:θa/) to the /s/ sound. Apart from being used to read part 30 of the Qur'an, where this research sample is taken, the JS are also Arabic language study program students who have completed semester I. This kind of phonologic interference also happens in the Seventh-Graders of MTs Al-Wasliyah Sigambal when pronouncing Arabic words which have the phoneme /θ/. The students change the pronunciation of the /θ/ sound to the /s/ sound (see Nurshafnita & Zainuddin, 2023). In contrast the phoneme /θ/ is not found in the Javanese phonological system. The phoneme /s/ is a voiceless fricative sibilant (Halpern et al., 2022), whereas the phoneme /θ/ is a voiceless fricative non-sibilant (Elfahm et al., 2022). In other words, both the phonemes /θ/ and /s/ are voiceless fricative sounds (see also Alotaibi, 2017). Based on these results, it can be concluded that JS do not always undergo phonologic interference when pronouncing Arabic phonemes which are not contained in their phonological system. Thus, the differences in the phonological systems of the first and second languages are not always the cause of phonologic interference. There may be other factors, such as lack of training (which can cause phonologic interference when a speaker is pronouncing phonemes that are not in their first-language phonological system).

The phoneme /θ/ is a voiceless fricative. The pronunciation spectrogram of the phoneme /θ/ at the end of a word done by the SS and BS each presents a pronunciation visualization which is relatively following the MS pronunciation. Their visualization of the pronunciation of the phoneme /θ/ both have aperiodic waves without regular repetition patterns since the frequency and amplitude of the sound they produce varies. Aperiodic waves of fricative sound are caused by air pushing through the narrow channel between the passive articulators (upper teeth) and active articulators (tongue) at higher frequencies. The SS, BS, and MS spectrograms visualize the appearance of random noise due to turbulence which arises when they pronounce the fricative non-sibilant /θ/ at the end of a word. Their spectrograms also visualize dull colours, which indicate the phoneme /θ/ as a non-sibilant sound. Fricative non-sibilant consonant sounds, as Al-Manie et al. (2019) state, has a low amplitude, which in turn causes the intensity of the /θ/ sound to weaken - indicated by the fading of the black colour in the SS, BS, and MS spectrograms. Moreover, the SS, BS, and MS pronunciation of the phoneme /θ/ has blurry energy gathering points and high frequencies, namely above 7000 Hz, above 6700 Hz, and above 8100 Hz, respectively.

As a result, only the SS and BS are free from phonologic interference when pronouncing the phoneme /θ/ located at the end of a word (/al-tura:θa/). As for the JS, they face problems when pronouncing it. The reason is that they change the pronunciation of the phoneme /θ/ in a word (/al-tura:θa/) to the /s/ sound. Similarly, it also happens when the BS pronounce the phoneme /θ/ at the beginning of a word. In this case, they experience phonologic interference when pronouncing a word (/θumma/). The JS pronunciation of the phoneme /θ/ at the end of a word changes to the /s/ sound because the phoneme /θ/ is a non-sibilant apico-dental sound, which does not exist in the Javanese phonological system. In contrast, the phoneme /s/

is a sibilant apico-alveolar sound that does exist in the Javanese phonological system. The /s/ sound is produced by the tip of the tongue and the gums, which block air flow from the lungs with weak resistance; therefore, air comes out of the gap without experiencing vibration on the vocal cords (see Nasution, 2018). Asih, Miftahuddin & Elmubarok's research (2020) report that phonologic interference also happens to the Eleventh-Graders of Sultan Agung 1 Islamic High School, Semarang when reading Arabic texts with group consonant tongues (such as /θ/, /s/, etc.).

The phoneme /θ/ has similarities with the phoneme /s/, in which both are voiceless fricative sounds (see Nasution, 2018). Maybe this similarity is the cause of phonologic interference experienced by the JS when pronouncing the phoneme /θ/ at the end of a word (/al-turaːθa/). This indicates that cross-language influences (in this case, between the first and second-languages) do not necessarily cause phonologic interference. In other words, the difference in the speaker's first-language phonological system is not undoubtedly the cause of phonologic interference that happens when pronouncing the typical second-language phonemes. The interesting fact is that the SS has no negative interference when pronouncing the phoneme /θ/, whether it is located at the beginning of a word (/θumma/), in the middle of a word (/intaθarat/), or at the end of a word (/al-turaːθa/). Based on a contrastive analysis, there are 14 Arabic consonants which Sundanese does not have that are dominated by fricative sounds, one of which is the phoneme /θ/. Arabic has more fricative sounds than Sundanese. However, this difference in phonological systems does not cause the SS to undergo phonologic interference in articulating these phonemes. The differences in the phonological systems of the first and second languages may not significantly affect the emergence of phonologic interference in the pronunciation of typical Arabic phonemes for the SS, JS, and BS. Therefore, it is also plausible that there are other factors (such as the speaker's variability, which includes speech tempo, age, gender, etc.) that influence the change of a sound (see Ibrahim et al., 2020).

Conclusion

Research on phonologic interference is crucial, even though contransitively, the differences in the phonological systems of the first and second languages do not necessarily affect the shift in the pronunciation of distinctive phonemes that differ between the two languages. This research results can serve as a theoretical foundation in Arabic learning, especially regarding the pronunciation of typical second-language phonemes and the factors which cause phonologic interference to occur to speakers with diverse regional languages. This comprehension has essential implications in second-language learning, especially Arabic. With a better understanding of phonologic interference, it is hoped that Arabic learning can be more effective and efficient, especially in improving one’s listening, speaking and examining skills.

Phonologic interference is an obstacle in Arabic learning, especially for students with diverse regional languages. A better comprehension of it will enable them to identify the difficulty in pronouncing distinctive phonemes, especially those which do not exist in their first-language phonological system. The learning process can focus on several different phonemes, identification of phoneme articulations, pronunciation exercises, correction of mispronunciations, and constructive feedback from competent learners. Inaccurate pronunciation can lead to errors and failures in cross-cultural communication. It is vital for anyone, especially students who want to master a second-language, to pay attention to the differences in their first and second languages' phonological systems. Although the differences themselves may not be much of an obstacle, there are still other factors (such as cultural background, level of mastery of the second language, and even sociolinguistic variables like gender, ethnicity, age, and educational background) worthy of consideration.

Acknowledgment

The authors are grateful to MOECRT (The Ministry of Education, Culture, Research, and Technology) of the Republic of Indonesia for their support in implementing this fundamental research, in accordance with the regulations of Article 5 No. 3 of 2020.

REFERENCES

Adityarini, I.A.P., Pastika, I.W. & Sedeng, I. Ny. (2020). Interferensi fonologi pada pembelajar BIPA asal Eropa di Bali. *Aksara*, 32(1), pp. 167–186. 10.29255/aksara.v32i1.409.167–186

Al-Essa, A. (2020). Arabic Interdentals: Variation and Linguistic Change. *Semitic Dialects And Dialectology*, 45.

Al Farisi, M.Z., Maulani, H., Hardoyo, A.B., Khalid, S.M. and Saleh, N. (2024). Investigating Arabic language teaching materials based on Indonesian folklore: an ethnographic study on the folktale of "Bandung", *Asian Education and Development Studies*, 13(2), 134–149. https://doi.org/10.1108/AEDS-07-2023-0082

Al Farisi, M.Z. (2023). Acceptability of the Quran translation. *Al-Jami'ah: Journal of Islamic Studies*, 61(2), 329–363. https://doi.org/10.14421/ajis.2023.612.329-363

Al Farisi, M.Z. (2018). The impact of techniques and translation ideology on the clarity of pragmatic meanings translation of the qur'anic imperative verses. *Indonesian Journal of Applied Linguistics*, 7(3), 676–686. https://doi.org/10.17509/ijal.v7i3.9818

Al-Khairy, M.A. (2005). *Acoustic characteristics of Arabic fricatives*. Ph.D. dissertation, University of Florida.

Alotaibi, Y., Seddiq, Y., Meftah, A., Selouani, S-A. & Yakoub, M.S. (2017). A new look at the automatic mapping between arabic distinctive phonetic features and acoustic cues. *IEEE*, 368–371.

Ali, I.H., Mnasri, Z. & Lachiri, Z. (2020). DNN-based grapheme-to-phoneme conversion for Arabic text-to-speech synthesis. *International Journal of Speech Technology*, 23, 569–584, https://doi.org/10.1007/s10772-020-09750-7

Al-Manie, M.A., Alkanhal, M.I. & Al-Ghamadi, M.M. (2019). Automatic speech segmentaion using the Arabic phonetic database. *Computer and Electronics Research Institute*, 76–79.

Al-Qursy, J.I. (2012). *Dirāsah al-makhārij wa al-ṣifāt*. Maktabah Ṭālib Al-'Ilm.

Ameen, Z.J.M. & Kadhim, A.A (2023). Machine learning for Arabic phonemes recognition using electrolarynx speech. *International Journal of Electrical and Computer Engineering (IJECE)*, 13(1), 400–412. doi: 10.11591/ijece.v13i1

Asih, R., Miftahuddin, A., & Elmubarok, Z. (2020). Analisis kesalahan fonologi dalam keterampilan membaca teks berbahasa Arab siswa kelas XI SMA Islam Sultan Agung 1 Semarang. *Lisanul Arab: Journal of Arabic Learning and Teaching*, 9(2), 123–137. https://doi.org/10.15294/la.v9i2.42655

Bannar, K. & Aronow, R. (2023). *Phonetics: The basics about acoustic features of consonants in standard English*. Available online: https://www.linguisticsnetwork.com/phonetics-the-basics-about-acoustic-features-of-consonants-in-standard-english/. Accessed: June 01, 2023.

Belotto, M. J. (2018). Data analysis methods for qualitative research: Managing the challenges of coding, interrater reliability, and thematic analysis. *The qualitative report*, 23(11), 2622–2633.

Benítez Fernández, M. (2023). Linguistic variation, social meaning and covert prestige in a Northern Moroccan Arabic variety. *Languages*, 8(1), 89.

Brierley, C., & Heselwood, B. (2022). *Phonetic transcription and the International Phonetic Alphabet*. In Oxford Research Encyclopedia of Linguistics.

Carmitha, I.C.W., Wurianto, A.B., Sudjalil & Hakimi, A.A.Q. (2023). Analisis kesalahan perubahan bunyi bahasa Indonesia pada tuturan mahasiswa BIPA tingkat pemula di Universitas Muhammadiyah Malang. *Ghāncaran: Jurnal Pendidikan Bahasa dan Sastra Indonesia*, 4(2), 242–261. DOI 10.19105/ghancaran.v4i2.6943

Cotter, W. M. (2020). Dialect contact and phonological change. Arabic and contact-induced change, 567.

Davidson, L. (2011). Phonetic and phonological factors in the second language production of phonemes and phonotactics. *Language and Linguistics Compass*, 5(3), 126–139.

Eckman, F. R., Elreyes, A., & Iverson, G. K. (2003). Some principles of second language phonology. *Second Language Research*, 19(3), 169–208.

Elfahm, Y., Elfahm, Y., Abajaddi, N., Mounir, B., Elmaazouzi, L., Mounir, I. & Farchi A. (2022). Classification of Arabic fricative consonants according to their places of articulation. *International Journal of Electrical and Computer Engineering (IJECE)*. 12(1), 936–945. DOI: 10.11591/ijece.v12i1.pp936-945

Garn-Nunn, P. & Sotto, C. (2018). Phonology. In encyclopedia of clinical neuropsychology (pp. 2678–2679). *Springer International Publishing*. https://doi.org/10.1007/978-3-319-57111-9_912

Halpern, B.M., Feng, S., van Son, R., van den Brekel, M. & Scharenborg, O. (2022). Low-resource automatic speech recognition and error analyses of oral cancer Speech. *Speech Communication*, 141, 14–27, https://doi.org/10.1016/j.specom.2022.04.006

Hameau, S., Biedermann, B., Robidoux, S. & Nickels, L. (2021). Effects of phonological neighbourhood density and frequency in picture naming. *Journal of Memory and Language*, 120. https://doi.org/10.1016/j.jml.2021.104248

Ibrahim, B.I, Seddiq, Y.M., Meftah, A.H. Alghamdi, M., Selouani, S-A., Qamhan, M.A., Alotaibi, Y.A. & Alshebeili, S.A. (2020). Optimizing Arabic speech distinctive phonetic features and phoneme recognition using genetic algorithm. *IEEE Access*, 8, 200395–200411, https://doi.org/10.1109/ACCESS.2020.3034762

Kochetov, A. (2017). Acoustics of Russian voiceless sibilant fricatives. *Journal of the International Phonetic Association*, 47(3), 321–348. doi:10.1017/S0025100317000019

Kong, Y-Y., Mullangi, A. & Kokkinakis, K. (2014). Classification of fricative consonants for speech enhancement in hearing devices. *PLoS ONE*, 9(4), e95001. doi:10.1371/journal.pone.0095001

Lilley, J., Spinu, L., & Athanasopoulou, A. (2021). Exploring the front fricative contrast in Greek: A study of acoustic variability based on cepstral coefficients. *Journal of the International Phonetic Association*, 51(3), 393–424. doi:10.1017/S002510031900029X

Maghrabi, R. O. (2020). Variation and variables in some Arabic varieties. *Journal of Arts and Humanities*, 9(1), 39-63.

Maniwa, K., Jongman, A. & Wade, T. (2009). Acoustic characteristics of clearly spoken English fricatives. *The Journal of the Acoustical Society of America*, 125(6), 3962–3973.

Marlina, L., Hermawan, A. & Budi, F.S. (2023). Studi analisis deskriptif kesalahan fonologis dalam percakapan bahasa Arab terhadap santri di Pesantren Mafaza Indonesia. *El-Ibtikar: Jurnal Pendidikan Bahasa Arab*, 12(1), 89–116.

Meluzzi, C. (2021). Sound spectrography. In *Manual of Clinical Phonetics* (pp. 418–443). Routledge.

Muhtar, A.F., Komaludin, J., Bahruddin, U., & Gbodofu, Y.B. (2022). Istiratijiyyatu tadris al-ashwat al-'Arabiyyah li thullabi qism al-i'dad al-lughawiy bi Jami'ah al-Raya. *Thariqah ilmiah: Jurnal Ilmu-Ilmu Kependidikan dan Bahasa Arab*, 10(2), 207–222. https://doi.org/10.24952/thariqahilmiah.v10i2.6292

Muzaki, H., & Darmawan, A. (2022). Analisis kesalahan berbahasa lisan pada Kanal Youtube Fouly. *Metalingua*, 7(1), 55–62.

Nasution, A.S.A. (2018). *Bunyi bahasa*. Jakarta: Amzah.

Nirgianaki, E. (2014). Acoustic characteristics of Greek fricatives. *The Journal of the Acoustical Society of America*, 135(5), 2964–2976.

Nurshafnita, P. & Zainuddin, D. (2023). Analisis kesalahan pelafalan huruf hijaiyah siswa kelas VII MTs al-Wasliyah Sigambal. *Tsaqofiya: Jurnal Pendidikan Bahasa dan Sastra Arab*, 5(2), 99–114. https://doi.org/10.21154/tsaqofiya.v5i2.198

Rafkahanun, R. (2021). Analisis kesalahan fonologis dalam keterampilan berbicara pembelajar BIPA di Pusat Studi Indonesia Ismailia Mesir. *Madah: Jurnal Bahasa dan Sastra*, 12(1), 78–87. https://doi.org/10.31503/madah.v12i1.380

Rahmatia, Darwis, M. & Lukman (2021). Analisis kesalahan fonologi dalam keterampilan membaca teks bahasa Arab siswa kelas XI MAN 1 Buton. *Nady Al-Adab*, 18(1), 121–139. https://doi.org/10.20956/jna.v18i1.13516

Reinisch, E., Juhl, K. I., & Llompart, M. (2020). The impact of free allophonic variation on the perception of second language phonological categories. *Frontiers in Communication*, 5, 47.

Ritchie, J., Spencer, L., & O'Connor, W. (2003). Carrying out qualitative analysis. *Qualitative research practice: A guide for social science students and researchers*, 2003, 219–62.

Roach, P. (2004). *Phonetics*. Oxford: Oxford University Press.

Sangkala, W., Syamsuddin, M.B. & Anwar, M. (2023). Analisis kesalahan pelafalan huruf dalam membaca nyaring teks bahasa Arab pada siswa kelas XI SMA IT Al Fatih Makassar. *Al-Fashahah: Journal of Arabic Education, Linguistics, and Literature*, 3(1), 1–10. doi: https://doi.org/10.59562/al-fashahah.v3i1.46710

SIL International. (2001). *Languages of Indonesia*. Jakarta: SIL International, Indonesia Branch.

Sindran, F. (2021). *Automatic phonetic transcription of standard Arabic with applications in the NLP domain*. Dissertation. Der

Friedrich-Alexander-Universität Erlangen-Nürnberg.

Singh, A., Illa, A., & Ghosh, P. K. (2020). A comparative study of estimating articulatory movements from phoneme sequences and acoustic features. In ICASSP 2020-2020 *IEEE International Conference on Acoustics, Speech and Signal Processing* (ICASSP), 7334–7338.

Spinu, L. & Lilley, J. (2016). A comparison of cepstral coefficients and spectral moments in the classification of Romanian fricatives. *Journal of Phonetics* 57, 40–58.

Supriadi, N. (2014). Analisis kesalahan fonologis bahasa Mandarin oleh mahasiswa D3 bahasa Mandarin Universitas Jenderal Soedirman. *Parole*, 4(2), 99–119.

Syihabuddin, S., Murtadho, N., Baso, Y.S., Maulani, H. and Khalid, S.M. (2024), The acquisition of nominal gender agreement: praxeology analysis of Arabic second language text book "Silsilah Al-Lisaan", *Journal of Applied Research in Higher Education*, 16(4), 1055–1068. https://doi.org/10.1108/JARHE-11-2022-0369

Teeranon, P. (2020). Thai tones in Chinese students after using the "Tone application" and their attitudes. *Journal of Language and Linguistic Studies*, 16(4), 1680–1697.

Wulandari, N. (2020). Analisis kesalahan fonologis dalam keterampilan berbicara bahasa Arab. *Al-Fathin: Jurnal Bahasa dan Sastra Arab*, 3(1), 71–84. https://doi.org/10.32332/al-fathin.v3i01.2089