Huele
Journal of Applied Linguistics, Literature and Culture
Volume 6, Issue 2 (2026)
E-ISSN: 2775-5703
DOI: https://doi.org/10.30598/huele.v6.i2.p126-139



# English Monophthong Production by Native General American and Javanese EFL Learners

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**Article History:**

**Received:**
September 29, 2026
**Accepted:**
November 11, 2026
**Published:**
November 13, 2026

**Keywords:**
Acoustic Phonetics;
English Vowels;
Javanese Speakers;
L2 Learners;
Vowel Production.

## ABSTRACT

This study investigated the production of the eleven English monophthongs by native General American and Javanese speakers. It aimed to describe vowel production in General American and Javanese speakers and identify differences in English vowel production between Javanese and General American speakers. The study involved 15 participants (5 native General American speakers and 10 Javanese speakers). A quantitative approach was employed to analyze the mean values of vowel height (F1) and tongue position (F2). The data were collected by recording an eleven-word list, then analyzed by extracting formants using PRAAT, normalizing data with the Lobanov method, and using Welch's t-tests to assess similarities and differences in vowel production. The findings revealed that six vowels, namely /i/, /ɪ/, /æ/, /ə/, /ɑ/, and /ʊ/, exhibited relatively similar distributions across the two groups. In contrast, Javanese speakers produced /ɜ/, /ʌ/, /ɔ/ and /u/ with a more open quality (higher F1), with the largest difference in /ɔ/ (151 Hz). In addition, Javanese speakers produced/ɛ/further back, while /ɔ/was produced further forward (highest F2: 170 Hz). This comparison is relevant to EFL teaching as it provides insights into vowel realization and serves as a reference for English pronunciation instruction.

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**How to cite this article:**
Maulana, A., & Dessiar, A. R. (2026). English Monophthong Production by Native General American and Javanese EFL Learners. *Huele: Journal of Applied Linguistics, Literature and Culture*, *6*(2), 126-139. https://doi.org/10.30598/huele.v6.i2.p126-139

Journal Homepage : https://ojs3.unpatti.ac.id/index.php/huele
Journal E-mail : journalhuele@gmail.com

## INTRODUCTION

Speech sound production is an important aspect of social interaction because how speakers produce sounds can affect the successful transmission and understanding of messages. Differences in sound production, particularly vowel production, may cause speech to be perceived differently and potentially lead to misunderstanding between speakers. That statement is also supported by Maulana et al. (2026), who found that differences in sound production may lead to differences in how speech is perceived by interlocutors. This issue becomes increasingly relevant in cross-linguistic communication, where speakers use a language other than their first language, see Barrios et al. (2016), Jacob (2022), Kim et al. (2020) and Lee and Cho (2018). Those articles stated that all speech sound production relies on the first-language (L1) speech sound inventory. English has a distinctive and relatively complex vowel inventory compared with many other languages. This system includes vowel categories such as /ʌ/, /ɑ/, /æ/, and /ɜ/, along with tense–lax vowel contrasts and asymmetrical vowel-mapping patterns. This factor contributes to the challenges learners face in mastering English pronunciation.

One approach to analyzing speech sounds is acoustic phonetics, which analyzes speech sounds based on their physical properties through acoustic parameters. Nowadays, acoustic phonetic analysis commonly uses software tools such as PRAAT to measure and examine various acoustic features of speech sounds (Wang et al., 2023). Batubara et al. (2025), Nurjannah et al. (2023), and Widya and Agustiana (2020) state that PRAAT is a computer program for analyzing, synthesizing, and manipulating speech that enables researchers to observe the spectrogram of each sound so that vowel quality can be measured.

Previous research by Perwitasari et al. (2016) investigated English vowel production among Javanese and Sundanese learners by examining formant frequencies (F1 and F2) and vowel space area. Their findings revealed differences in vowel realization between non-native and native English speakers, with Javanese and Sundanese learners demonstrating a smaller vowel space area. Interestingly, the differences were not limited to newly acquired English vowels but were also observed in vowels considered similar to those in their first-language vowel systems. These findings indicate that English vowel production among Javanese speakers involves complex phonetic characteristics that cannot be explained solely by the similarities or differences between L1 and L2 vowel inventories.

Building on these findings, the present study extends previous research by examining Javanese speakers' production of eleven General American monophthongs, using contemporary General American speakers as a reference group. Unlike the previous study, which examined ten English vowels among Javanese and Sundanese learners, this study focuses specifically on Javanese speakers. It provides a more targeted comparison of their vowel production. By examining similarities and differences in F1 and F2 values, this study aims to provide further insights into the acoustic characteristics of English vowel production among Javanese learners and contribute to understanding English pronunciation learning in the Indonesian EFL context.

Based on the background, this study aims to address two research questions: (1) How are the acoustic data on English vowel realization by native speakers of General American English and Javanese L1 speakers? (2) Do Javanese speakers produce the same as General American speakers? To provide more concrete, statistically supported findings, the study uses a Welch t-test to determine whether differences in acoustic measurements between the two groups are statistically significant.

## LITERATURE REVIEW

### *Previous Study of English Vowel Production*

Previous studies have investigated the realization of English L2 vowels by speakers with various L1 backgrounds worldwide. For example, Kim et al. (2020), Lee and Cho (2018), and Lee and Rhee (2019) examined how Korean L1 speakers produced English vowels. Those studies focused on L2 vowel production in relation to the asymmetric mapping between the English and Korean vowel systems. These studies on Korean learners showed that L1 influence plays a significant role in shaping L2 phonological realization. In particular, when a particular vowel category is absent from the learners' L1, they tend to realize the corresponding L2 vowel based on the closest or available vowel category in their L1 system.

Another study by Casillas and Simonet (2016) examined the /æ/–/ɑ/ vowel contrast in English and Spanish. Their findings further demonstrated that differences between the L1 and L2 vowel systems can influence how learners perceive and produce L2 vowel categories. Related research has also examined English vowel production by speakers whose L1s are Chinese and Polish, as reported by Schwartz and Kaźmierski (2020) and Wang et al. (2023), respectively. Collectively, these studies indicate that the phonetic realization of L2 vowels is strongly influenced by the structure and inventory of the learners' L1 vowel system, particularly when the vowel categories or contrasts in the L2 do not have direct equivalents in the L1.

***The Differences of English and Javanese Vowel Systems***

The distribution of the L1 vowel system is one factor that makes it difficult for EFL learners to produce the target vowels (Inayah et al., 2026). Javanese has only six vowels:/, /i/, /u/, /e/, /ə/, and /o/ (Nuzulia, 2023). Besides, General American vowels are more complex than Javanese vowels. General American English adopts eleven vowels in total, /i/, /ɪ/, /u/, /ʊ/, /ə/, /ɜ/, /ʌ/, /ɑ/, /æ/, /ɛ/, and /ɔ/ (Carr, 2020). The data show significant differences between the vowel systems of Javanese and English. English distinguishes vowels based on tense–lax characteristics and asymmetric vowel patterns, whereas the Javanese vowel system does not adopt these classifications. However, the Javanese language adopts some allophones of certain vowels, such as [ɪ], [ʊ], [ɛ], and [ɔ], that sometimes appear in a closed syllable (Wedhawati et al., 2001). However, Javanese speakers experience difficulties in pronouncing some vowels that exist in L1, which are influenced by the written graphemes. This difference may contribute to the challenges Javanese speakers face in perceiving and producing English vowels.

The differences in vowel realization can be understood through the perspective of the Second Language Speech Learning Model (SLM-r), which explains how learners' existing phonetic systems interact with the development of new phonetic categories in a second language (Flege & Bohn, 2021). According to this model, learners' perception and production of L2 sounds are influenced by their established L1 phonetic categories. When L2 vowels are perceived as similar to existing L1 vowels, learners may assimilate them into existing phonetic categories rather than develop new ones. Consequently, the first language's established phonetic system may influence how learners perceive and produce vowel sounds in the target language. This process may occur when learners encounter sounds that seem similar in both languages, leading them to draw analogies based on their first-language vowel system(Norrman, 2024). As a result, even when vowel sounds belong to the same phonological category in the target language, their phonetic realizations may show certain differences. Therefore, the differences in the realization of the two vowels may reflect the influence of the first-language vowel system on the production of English vowels.

***Acoustic Phonetics Using PRAAT***

The development of acoustic phonetic analysis, supported by software such as PRAAT, has increasingly expanded into research conducted in Indonesia. These studies have not been limited to comparisons of English L2 vowel realizations produced by speakers with Indonesian as their L1, as demonstrated by Azzahra et al. (2024), Istiqomah et al. (2021), and Widya and Agustiana (2020), but have also extended to speakers whose L1s are regional languages in Indonesia. In particular, comparative studies of English L2 acoustic phonetics among Javanese L1 speakers have been conducted by Perwitasari et al. (2016) and Rohmah et al. (2023). For instance, Perwitasari et al. (2016) investigated the realization of ten English monophthong vowels produced by Javanese and Sundanese speakers as L1 speakers. They compared their vowel realizations with those produced by native speakers of American English.

In another relevant study, Yusuf et al. (2024)examined the acoustic realization of English vowels produced by speakers with Acehnese as their L1, providing further evidence for applying acoustic phonetic analysis to the study of English L2 vowel production among speakers of regional Indonesian languages across genders. This research used vowel pair /iː/-/ɪ/, /ɛ/-/æ/, /uː/-/ʊ/, /ʌ/-/ɑː/, and /ɑː/-/ɒ/ to seek the differences among genders. The results showed that females could not distinguish between the tense and lax vowels, while males could distinguish /iː/-/ɪ/, /ɜː/-/ʌ/, /ʌ/-/ɑː/, and /ɔː/-/ɒ/. This model

was also found in Masykar et al. (2022), who also stated that EFL Acehnese-Indonesian speakers can easily distinguish vowels that exist in their mother tongue.

Previous studies have highlighted variations in English vowel production among speakers with different regional language backgrounds. Perwitasari et al. (2016) found that Javanese and Sundanese EFL learners experienced difficulties producing both similar and new English vowel sounds. Their vowel space areas were smaller than those of native English speakers, indicating deviations in F1 and F2 values and differences in vowel realization. Rohmah et al. (2023) found that Javanese phonological patterns influenced students' English pronunciation. Yusuf et al. (2024) identified gender-related differences in English vowel contrasts among Acehnese speakers. Similarly, Masykar et al. (2022) found that Acehnese-Indonesian EFL speakers could more easily distinguish vowels corresponding to categories in their mother tongue. However, further research is needed to provide updated acoustic comparisons of English vowel production between Javanese L1 speakers and native General American English speakers, particularly in terms of F1 and F2 measurements.

## METHOD

### *Research Design*

The data were analyzed using a quantitative acoustic study. Quantitative research tests objective theories by examining relationships among variables. These variables are measured using instruments, and the resulting numerical data are analyzed using statistical procedures (Creswell & Creswell, 2017). In this research, formant frequencies were extracted from PRAAT spectrograms. Formant frequencies were the values of formant 1 (F1), which showed the openness of the mouth, and values of formant 2 (F2), which showed the front or back position of the tongue (Boersma & Weenink, 2022). Vowel charts were then used to support the description of the statistical results. Integrating quantitative findings provided a comprehensive analysis of English monophthong production among native Javanese speakers compared with native General American (GA) speakers.

### *Research Site and Participants*

This research was conducted in a blended setting. General American speakers recorded their speech independently at home, whereas Javanese speakers were recorded in a designated quiet room at the Faculty of Social Sciences (FIB), Gadjah Mada University, Indonesia. Both groups of participants in this research are aged between 20 and 30 years old (mean age = 24). The General American speakers included two females and three males, while the Javanese speakers included five females and five males. Ten Javanese speakers graduated from the English department (English Language Education or English Literature) in their undergraduate programs. The Javanese participants were selected based on their learning background and exposure to the General American accent as a model of English pronunciation. They speak different dialects: three participants from the East Java dialect (Surabaya), four from the Yogyakarta dialect, and three from the West Javanese dialect (Banyumas). The Javanese participant selection criteria were established because all participants had received formal instruction in English phonetics and phonology at both the undergraduate and graduate levels. Consequently, they were assumed to possess an adequate theoretical foundation in English phonology, enabling them to provide more representative data for this study.

In addition, this research involved five native speakers of General American (GA) to compare English vowel production. The five native speakers of General American (GA) resided in the United States of America and spoke the General American accent. The group included five native General American (GA) speakers who lived in Montana (1 speaker), Wyoming (1 speaker), and Nebraska (3 speakers). These three states were expected to provide general data that did not focus on a single state.

### *Data Collection and Analysis*

This research examined eleven English monophthong vowels. Most target vowels occurred adjacent to plosive consonants, whereas six vowels appeared in word-initial position and another 5 vowels occurred in the nucleus position. This plosive environment limitation was intended to minimize the effects of co-articulation. The eleven English words were *Exam, Key, Two, Book, Bird, Applause, Apple,*

*Egg, Cup, Autumn*, and *Object*. The selected vowels were not limited to those occurring in stressed syllables but also included vowels in other positions, provided that their acoustic characteristics remained sufficiently distinguishable for analysis. The selection of the eleven monophthongs also relied on lexical accessibility to ensure participants could pronounce the target words without unnecessary difficulty. Accordingly, the elicitation words consisted of English nouns classified at the A1 proficiency level, as identified through the online Oxford Learner's Dictionaries. This selection was intended to minimize the influence of lexical difficulty on participants' pronunciation and to facilitate consistent vowel production across both speaker groups.

The data were collected by recording the participants as they produced a list of words containing the target English vowels for analysis. Participants were instructed to produce each word three times. Audio recordings were collected using smartphone voice-recording applications with external earphone microphones. Participants were instructed to record their speech in a quiet environment to minimize background noise and other potential audio disturbances. Participants then submitted the recorded audio files in various formats, which were converted to MP3 using the FreeConvert online platform (freeconvert.com) at a sampling rate of 44,100 kHz.

Furthermore, the quality of each recording was assessed using PRAAT software by listening to the audio and inspecting its waveform and spectrogram to identify potential background noise, signal distortion, or other technical disturbances that could interfere with acoustic measurements. We considered recordings with substantial interference that might affect vowel identification or formant measurement unsuitable for analysis, and participants were asked to repeat the recording. Only sufficiently clear recordings were retained for subsequent acoustic analysis. We then imported the audio recordings into PRAAT to obtain first formant (F1) and second formant (F2) frequency values for acoustic analysis. These acoustic measurements provided the basis for subsequent analyses of the participants' English vowel production.

During the data analysis, the first formant (F1) and second formant (F2) frequency values were measured from the three repetitions of each target word produced by each participant. The three repeated measurements for each vowel token were averaged to obtain a single representative F1 and F2 value for each token. Formants were measured in PRAAT using a maximum formant of 5000 Hz for male and 5500 Hz for female speakers. After all data were presented, formant tracking errors were examined to identify values falling outside the specified vowel frequency range of F1 between 200 and 1000 Hz and F2 between 700 and 2600 Hz. These averaged values were subsequently normalized using the Lobanov normalization method to minimize inter-speaker variation and facilitate comparison of vowel formant values across speaker groups. The present study employed Lobanov normalization because it is considered an effective method for normalizing vowel formant values while preserving phonemic and sociolinguistic variation. It also helps minimize the influence of speaker-related variables, such as gender, age, and anatomical differences (Adank et al., 2004). Normalization was performed by scaling the z-score-transformed data back to their original frequency unit, Hertz (Hz), using the NORM website. The scaling value results were used in the analysis of Tables 1 to 6. After normalization, we averaged the data across speakers within each group to obtain representative mean values for the two speaker groups: the General American (GA) group and the Javanese-speaking group.

The final step of data analysis was a Welch's t-test comparing native General American (GA) speakers and Javanese speakers. Welch's t-test was used to examine differences in mean values between the two speaker groups while accounting for unequal sample sizes. Welch's *t*-test was employed to examine whether the vowel production of Javanese speakers significantly differed from that of native General American speakers based on their F1 and F2 values. F1 was used as an acoustic correlate of vowel height, reflecting the degree of mouth opening, whereas F2 was used to indicate the horizontal position of the tongue. In addition, a paired-samples t-test was conducted to examine the possibility of a merger between the vowels /ɑ/ and /ɔ/ among General American speakers.

## FINDINGS

This study's results and discussion are divided into three sections. The first section presents the F1 and F2 values of the native General American (GA) speakers. The second section presents the F1 and

F2 values of the Javanese speakers. The third section compares vowel production of the native GA speakers and Javanese speakers based on their F1 and F2 values. The comparison presents an independent t-test to assess the significance of vowel production differences between native General American (GA) and Javanese speakers.

***Formant Values of Native General American (GA)***

In this study, the vowel production of native General American (GA) speakers serves as a reference point for evaluating Javanese speakers' English vowel production. The General American (GA) data in this study also serve to provide updated acoustic data on English vowel production, particularly for the General American accent. These data are expected to contribute to the phonetic literature and provide a useful reference for future acoustic phonetic studies of General American English. Table 1 presents detailed formant values for General American speakers.

**Table 1.** Formant Values of General American (GA)

| Vowels | Words | Formant Values | |
|---|---|---|---|
| | | F1 (Hz) | F2 (Hz) |
| /i/ | Key | 283 | 2,171 |
| /ɪ/ | Exam | 380 | 1,936 |
| /u/ | Two | 311 | 902 |
| /ʊ/ | Book | 388 | 999 |
| /ɜ/ | Bird | 389 | 1,436 |
| /ə/ | Applause | 479 | 1,410 |
| /ɔ/ | Autumn | 460 | 1,007 |
| /ɛ/ | Egg | 465 | 1,857 |
| /æ/ | Apple | 647 | 1,645 |
| /ʌ/ | Cup | 525 | 1,381 |
| /ɑ/ | Object | 530 | 1,173 |

Table 1 shows the formant values of General American speakers in vowel production. The data present the differences in the production of each vowel. The findings indicate that GA speakers tend to maintain distinct vowel contrasts, despite some shifts in vowel production, as reflected in both F1, which relates to vowel height or degree of mouth opening, and F2, which reflects tongue position, compared with English vowel production reported several decades ago, referring to Heffner (1950). Besides, the vowel production of General American is still in the same category of high, mid, and low vowels. See the chart below for the detailed distribution pattern of English vowels by native General American speakers.

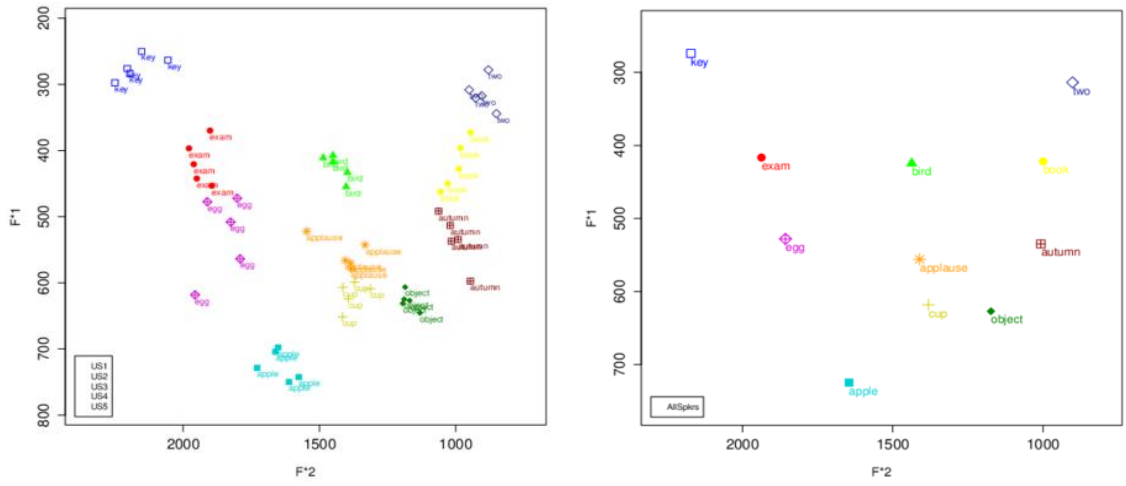



**Figure 1.** English Vowel Distribution by General American Speakers
Individual vowels (left); vowels mean (right)

Figure 1 shows the distribution of English vowels produced by native speakers of General American (GA). The chart shows the high vowels /i/ and /u/in the same expected articulatory position. According to Heffner (1950), the vowel /ɜ/has an average F1 frequency of 522 Hz, while this research finds an F1 value of 389 Hz. This shows that the vowel /ɜ/shifted toward a more closed position in production compared with Heffner (1950).

Clopper et al. (2005) indicate that speakers from the Western region, including Montana, exhibited a merger of the low-back vowels /ɑ/ and /ɔ/. Both male and female speakers showed similar or nearly identical acoustic realizations of these vowels, suggesting that the distinction between them was largely neutralized. This case is also analyzed by Bakos et al. (2022), who analyzed the low-back merger in Indiana speakers, showing that the vowels /ɑ/ and /ɔ/ had similar realizations but not a merger. However, the findings of the present study indicate that /ɑ/ and /ɔ/ do not merge. Instead, these vowels differ significantly in realization in two variables: tongue height ($p = 0.04$) and tongue backness ($p < 0.01$); see Table 2 below.

**Table 2.** Paired t-test /ɑ/ and /ɔ/ by General American Speakers

| Variable | /ɑ/ | | /ɔ/ | | t stat | df | *P** Values |
|---|---|---|---|---|---|---|---|
| | Mean | St. Dev | Mean | St. Dev | | | |
| F1 | 283 | 14.66 | 315 | 37.46 | -4.01 | 4 | 0.02 |
| F2 | 2,171 | 42.53 | 2,138 | 25.29 | -7.22 | 4 | <0.01 |

*$p$ < 0,05: Significantly Different

***Formant Values of Javanese Speakers***

This section presents the Formant 1 (F1) values, representing the degree of mouth openness (vowel height), and Formant 2 (F2) values, representing tongue position (vowel backness), as produced by Javanese speakers. The average formant values of Javanese speakers are displayed in Table 3 below. The formant values presented are final results that have undergone averaging and normalization procedures, which were applied in order to examine the realization of English vowels by comparing the speech of native General American English speakers with that of Javanese speakers.

**Table 3.** Formant Values of Javanese Speakers

| Vowels | Words | Formant Values | |
|---|---|---|---|
| | | F1 (Hz) | F2 (Hz) |
| /i/ | Key | 315 | 2,138 |
| /ɪ/ | Exam | 356 | 1,999 |
| /u/ | Two | 350 | 941 |
| /ʊ/ | Book | 399 | 1,008 |
| /ɜ/ | Bird | 461 | 1,430 |
| /ə/ | Applause | 508 | 1,315 |
| /ɔ/ | Autumn | 555 | 1,177 |
| /ɛ/ | Egg | 512 | 1,734 |
| /æ/ | Apple | 606 | 1,551 |
| /ʌ/ | Cup | 651 | 1,352 |
| /ɑ/ | Object | 538 | 1,189 |

The formant data in Table 3 reveal a systematic vowel space in Javanese speakers' production of English vowels: front vowels /i/ and /ɪ/ show low F1 and high F2 values, indicating high, front tongue positions, while back vowels /u/ and /ʊ/ show similarly low F1 but markedly lower F2, reflecting a retracted tongue position. Mid vowels (/ɜ/, /ə/, /ɔ/, /ɛ/) occupy an intermediate F1–F2 range, whereas low vowels (/æ/, /ʌ/, /ɑ/) exhibit the highest F1 values, marking the most open articulations. This overall F1–F2 distribution outlines the vowel space produced by Javanese speakers, providing a basis for comparison with General American English speakers to detect potential vowel shift, centralization, or substitution due to L1 phonological interference. See the chart below for a detailed description of vowel range.

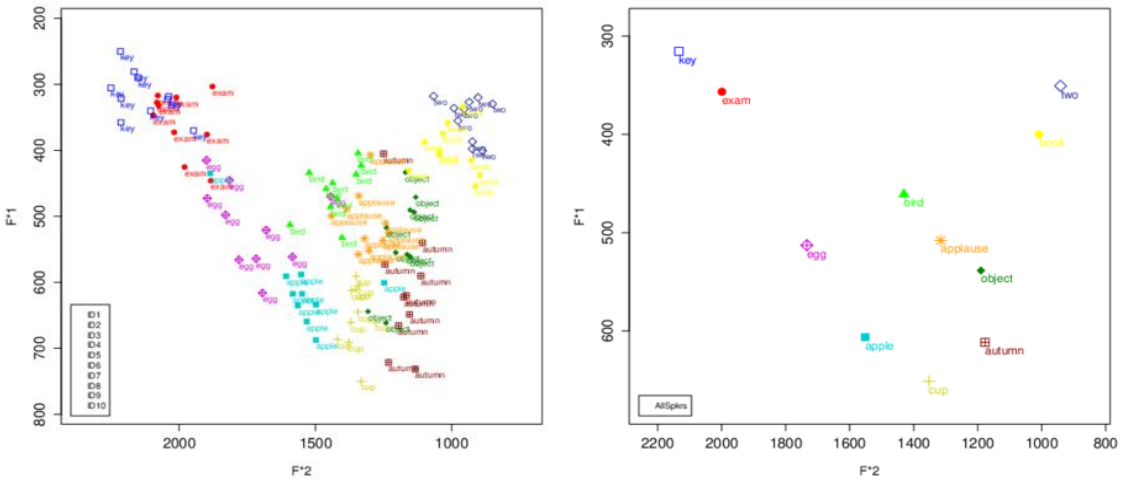



**Figure 2.** English Vowel Distribution by Javanese Speakers
Individual vowels (left); vowel means (right)

Figure 2 represents English vowel production by Javanese speakers. The chart shows that Javanese speakers realize high vowels similarly to General American speakers. Focusing on the vowel /ɑ/, Javanese speakers produced it more closely than/ɔ/. This is because the vowel /ɑ/ has no equivalent in Javanese, while [ɔ] occurs only as an allophone.

Overall, Figures 1 and 2 illustrate noticeable variation in vowel realizations between the two speaker groups, particularly among the mid and low vowels. However, these differences, based on the distribution of F1 and F2 values alone, do not provide sufficient statistical evidence to determine whether the two groups' vowel realizations differ significantly. Therefore, an independent-samples t-test was conducted to examine further the statistical significance of the differences in F1 and F2 values for each vowel category.

***Comparison of English Vowel Production by General American and Javanese Speakers***

This section presents a detailed analysis of English vowel production among Javanese speakers. This section compares Javanese speakers' vowel productions with those of General American speakers to identify similarities and differences in acoustic realization. Specifically, the analysis focuses on F1, which reflects vowel openness (tongue height), and F2, which represents tongue frontness or backness. To determine whether the observed differences between the two speaker groups are statistically significant, an independent-samples t-test is employed. This analysis provides a quantitative basis for evaluating how closely English vowels produced by Javanese speakers approximate or differ from those produced by General American speakers. The results and discussion were separated into three classifications: the production of English high vowels, the production of English mid vowels, and the production of English low vowels. This classification is based on the vowel chart presented in Carr (2020), which presents the types of General American vowels.

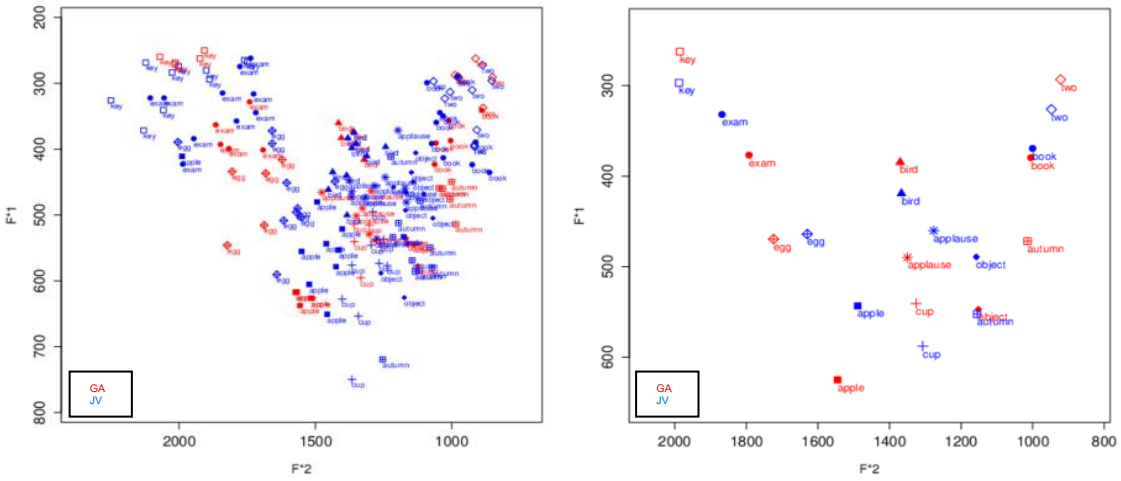



**Figure 3.** English Vowel Distribution by Two Groups
Individual vowels (left); Speakers' mean (right)

Based on the normalized data in Figure 3, the vowel distribution shows individual speaker production patterns and the mean values for each speaker group. Visually, several vowels, particularly high vowels, exhibit realization patterns relatively similar to those of General American (GA) speakers. However, differences in distribution are also observed in several vowels, particularly /ɔ/ and /ɑ/, which show overlapping patterns between the GA and Javanese-speaking (JV) groups. To statistically examine these differences, further analysis was conducted using Welch's t-test.

**The Production of English High Vowels**

The classification follows Carr's (2020) description, which identifies four high vowels, namely /i/, /ɪ/, /ʊ/, and /u/. Among these vowels, variation can be observed between the front vowels /i/ and /ɪ/ and the back vowels /ʊ/ and /u/, as displayed in Table 4 below.

**Table 4.** Welch's t-test of English High Vowels

| Vowels | Variable | GA | | JV | | t stat | df | *P** Values |
|---|---|---|---|---|---|---|---|---|
| | | Mean | St. Dev | Mean | St. Dev | | | |
| /i/ | F1 | 283 | 35.11 | 315 | 35.86 | -1.69 | 8 | 0.13 |
| | F2 | 2,171 | 73.76 | 2,138 | 98.19 | 0.73 | 11 | 0.48 |
| /u/ | F1 | 311 | 29.86 | 350 | 32.47 | -2.33 | 9 | 0.04 |
| | F2 | 902 | 39.10 | 941 | 60.52 | -1.49 | 12 | 0.16 |
| /ɪ/ | F1 | 380 | 25.26 | 356 | 48.09 | 1.23 | 13 | 0.24 |
| | F2 | 1,936 | 37.07 | 1,999 | 86.31 | -1.95 | 13 | 0.07 |
| /ʊ/ | F1 | 388 | 26.87 | 399 | 37.06 | -0.67 | 11 | 0.52 |
| | F2 | 999 | 43.07 | 1,008 | 84.38 | -0.27 | 13 | 0.79 |

*$p$ < 0,05: Significantly Different
GA: General American Speakers
JV: Javanese Speakers

Table 4 compares high English vowel production between General American speakers and Javanese speakers. The results indicate that the tense high front vowel /i/ does not show a statistically significant difference between the two groups in either F1 or F2, with p-values greater than 0.05. A similar pattern is observed for the lax high vowels /ʊ/ and /ɪ/, which also show no statistically significant differences in both F1 and F2 ($p > 0.05$). However, a statistically significant difference is found in the tense high back vowel /u/, particularly in F1 ($p = 0.04$), indicating a difference in the degree of vowel height between the two speaker groups. In contrast, the F2 measurement for /u/ does not show a statistically significant difference ($p = 0.16$), suggesting that the two groups exhibit relatively similar tongue positions in producing this vowel. Overall, these findings indicate that the production of most

high vowels is relatively comparable between General American and Javanese speakers. In contrast, the vowel /u/ demonstrates a notable difference primarily in its F1 dimension. On the other hand, the vowel /u/ showed a weaker difference that should be interpreted with caution.

**The Production of English Mid Vowels**

According to Carr (2020), English has three mid vowels: one tense vowel, /ɜ/, and two lax vowels, /ɛ/ and /ə/. This classification distinguishes mid vowels by their tenseness and laxness. Table 5 below shows the Welch's t-test of English mid vowels.

**Table 5.** Welch's t-test of English Mid Vowels

| Vowels | Variable | GA | | JV | | t stat | df | *P** Values |
|---|---|---|---|---|---|---|---|---|
| | | Mean | St. Dev | Mean | St. Dev | | | |
| /ɛ/ | F1 | 465 | 52.18 | 512 | 63.66 | -1.53 | 10 | 0.16 |
| | F2 | 1,857 | 73.08 | 1,734 | 142.66 | 2.20 | 13 | 0.04 |
| /ə/ | F1 | 479 | 26.16 | 508 | 44.96 | -1.53 | 12 | 0.15 |
| | F2 | 1,410 | 80.58 | 1,315 | 66.14 | 2.28 | 7 | 0.06 |
| /ɜ/ | F1 | 389 | 14.88 | 461 | 40.30 | -5.01 | 12 | <0.01 |
| | F2 | 1,436 | 37.39 | 1,430 | 82.02 | 0.21 | 13 | 0.84 |

*$p$ < 0,05: Significantly Different
GA: General American Speakers
JV: Javanese Speakers

As demonstrated in Table 5, the front mid vowel /ə/ shows no statistically significant difference between General American and Javanese speakers in either the degree of vowel height (F1) or tongue backness (F2), with p-values greater than 0.05. Interestingly, the two central mid vowels exhibit differences in either F1, F2, or both dimensions. The vowel /ɛ/ shows a statistically significant difference in F2 ($p = 0.04$), indicating a difference in tongue backness position between the two speaker groups. However, its F1 values do not differ significantly ($p = 0.16$), suggesting a relatively similar degree of vowel openness. In contrast, /ɜ/ demonstrates a statistically significant difference in F1 ($p < 0.01$), indicating a substantial difference in vowel height between General American and Javanese speakers. Nevertheless, no statistically significant difference is observed in F2 ($p = 0.84$), suggesting that the two groups exhibit a relatively similar degree of tongue backness in producing /ɜ/. On the other hand, vowel /ɜ/ also showed a weaker difference that should be interpreted with caution.

**The Production of English Low Vowels**

In the book entitled English Phonetics and Phonology, Carr (2020) classifies the English low vowel system into four vowels: front vowel /æ/, mid vowel /ʌ/, and back vowels /ɑ/ and /ɔ/. The Welch t-test in Table 6 tested the statistical significance of English low-vowel production between General American speakers and Javanese speakers.

**Table 6.** Welch's t-test of English Low Vowels

| Vowels | Variable | GA | | JV | | t stat | df | *P** Values |
|---|---|---|---|---|---|---|---|---|
| | | Mean | St. Dev | Mean | St. Dev | | | |
| /æ/ | F1 | 647 | 60.32 | 606 | 67.81 | 1.19 | 9 | 0.26 |
| | F2 | 1,645 | 57.53 | 1,551 | 154.58 | 1.70 | 13 | 0.11 |
| /ʌ/ | F1 | 525 | 40.65 | 651 | 49.20 | -5.25 | 10 | <0.01 |
| | F2 | 1,381 | 42.18 | 1,352 | 35.89 | 1.30 | 7 | 0.23 |
| /ɔ/ | F1 | 460 | 14.66 | 611 | 94.52 | -4.94 | 10 | <0.01 |
| | F2 | 1,007 | 42.53 | 1,177 | 52.27 | -6.73 | 10 | <0.01 |
| /ɑ/ | F1 | 530 | 37.46 | 538 | 72.98 | -0.27 | 13 | 0.79 |
| | F2 | 1,173 | 25.29 | 1,189 | 56.84 | -0.76 | 13 | 0.46 |

*$p$ < 0,05: Significantly Different
GA: General American Speakers
JV: Javanese Speakers

As shown in Table 6, two vowels, /æ/ and /ɑ/, exhibit similar distributions between the two speaker groups, with p-values greater than 0.05 for both F1 and F2. These results indicate that the production of these two vowels by Javanese speakers is statistically comparable to that of General American speakers. In contrast, differences are observed in /ʌ/ and /ɔ/. The F1 value of the/ʌ/ vowel shows statistically significant differences ($p < 0.01$), while the F2 value shows similarity in tongue backness ($p = 0.23$). In contrast, vowel /ɔ/ shows significant differences in both F1 and F2 ($p < 0.01$), indicating differences in vowel height and tongue backness. Overall, the findings suggest that the differences between the two groups in the production of vowel /ʌ/differ mainly in vowel height (F1). At the same time,/ɔ/ differs in both vowel height (F1) and degree of tongue backness (F2).

In second language pronunciation learning, two major perspectives are commonly discussed: the Nativeness Principle and the Intelligibility Principle. The former emphasizes achieving native-like pronunciation, whereas the latter prioritizes speech intelligibility without requiring learners to imitate native speakers. Levis (2024) further challenges the assumption that native-speaker pronunciation should be the ultimate standard of pronunciation learning. This selection does not imply that General American represents the only ideal pronunciation model but rather provides an acoustic reference for identifying similarities and differences in vowel production. Thus, acoustic differences are interpreted as pronunciation variations rather than direct indicators of communicative success.

## DISCUSSION

Related to findings in the new formant values of General American English, some vowels presented a shift. Based on Figure 1, the findings showed that the vowel /ɜ/ was produced higher than in previous findings by Heffner (1950). In addition, Figure 1 illustrates a more centralized and closer distribution of the vowels produced in the mid and low vowel categories. This finding is consistent with recent data reported by Kendall and Fridland (2017), which suggest a potential vowel merger in which low vowels become more centralized, or high vowels are realized with a relatively closer quality. Kendall and Fridland (2017) argue that this shift may be driven by the language's internal structure. Vowel realization is not static but a dynamic aspect of the sound system that can change over time. Therefore, the observed shift toward more centralized or closer vowel realizations may reflect ongoing development within the vowel system rather than differences among individual speakers.

Findings on English vowel distribution among Javanese EFL learners revealed variations in vowel realization compared with General American English. Imatufariq and Dessiar (2026) suggested that the absence of certain vowel categories, such as /ɑ/, in the Javanese phonetic system may contribute to these differences. A similar pattern was observed in the production of /ʌ/, which was realized with a lower tongue position (more open), as indicated by its higher F1 values. This finding is consistent with Yamaguchi and Chiew (2020), who associated the absence of back vowel categories with the centralization of English vowels. However, the statistical findings of the present study reveal that the relationship between L1 vowel categories and L2 production is not straightforward. Although /ɑ/ does not have a direct equivalent in the Javanese vowel system, it does not exhibit a statistically significant difference from General American. Conversely, /u/, which has a corresponding vowel category in Javanese, shows a significant difference. This suggests that the presence or absence of corresponding L1 vowel categories alone cannot fully explain the variations in L2 vowel production. Other phonetic factors and individual differences may also contribute to the observed patterns.

In addition, the vowel distribution between Javanese EFL learners and General American speakers showed several differences. This indicates that the acoustic realization of English vowels varies across the two speaker groups. The vowels /i/, /ɪ/, /ə/, /æ/, /ɑ/, and /ʊ/ did not show statistically significant differences in either F1 or F2, with p-values greater than 0.05, suggesting relatively similar realizations in terms of vowel height and tongue backness. In contrast, the vowels /ɜ/, /ʌ/, and /u/ demonstrated statistically significant differences in F1 ($p < 0.05$), indicating differences in vowel height or degree of openness, but no significant differences in F2 ($p > 0.05$), suggesting comparable tongue positions along the front–back dimension. Conversely, the vowel /ɛ/ showed a statistically significant difference in F2 ($p = 0.04$). While /ɛ/ showed no significant difference in F1 ($p = 0.16$), indicating that the two groups

differed primarily in tongue position rather than vowel height. The vowel /ɔ/ exhibits statistically significant differences in both acoustic parameters, namely F1, which represents vowel height, and F2, which indicates tongue position, with p-values below 0.01. Furthermore, the vowel /ɔ/ exhibited the greatest differences in formant values between General American (GA) and Javanese (JV) speakers, with a difference of 151 Hz in F1 and 170 Hz in F2. Overall, these findings demonstrate that the differences in English vowel realization between the two speaker groups are not consistent across all vowel categories, as some vowels exhibit similar acoustic patterns while others show significant differences in either F1 or F2.

This comparative study is relevant to English as a Foreign Language (EFL) teaching because it provides insights into the characteristics and variations of English vowel realization among speakers with different first-language backgrounds. The findings may serve as a reference for teachers to identify aspects of vowel production that may pose difficulties for learners, as supported by Jacob (2022) and Mantulameten (2023). In pronunciation teaching, these findings can help determine instructional priorities. This is particularly true for vowels that exhibit differences in acoustic characteristics between Javanese and General American speakers. This research found that although /ɔ/ and /ɛ/ are present in the Javanese vowel system, they differ in acoustic realization. Javanese speakers tend to produce /ɛ/further back. By contrast, the vowel /ɔ/ produced by Javanese speakers differed significantly from that of General American speakers. Javanese speakers tended to produce /ɔ/in a more open and front position. Consequently, pronunciation instruction can focus on improving vowel production accuracy and speech intelligibility without treating native-like pronunciation as the sole measure of learning success.

Overall, this study is expected to help teachers and lecturers produce L2 target vowels. It is relevant not only from an English perspective but also from a cross-linguistic perspective. This research provides a starting point for future research that examines the relationship between vowel production, perception, and first-language influence. This research is limited to the production of English monophthongs by Javanese EFL learners. This research is hoped to serve as a reference to enrich applied linguistic study in the future.

## CONCLUSION

This study examines the realization of English monophthongs produced by Javanese speakers with an educational background in English, using contemporary General American (GA) speakers as a reference group. The findings reveal both similarities and differences in vowel production between the two groups. Findings showed that GA produced /æ/ with a very open position, while /ɜ/was produced as a more closed vowel. The two groups' vowel categories show overlapping distributions, such as/ɔ/ in JV and /ɑ/ in GA. In contrast, both groups showed the same realization of/i/, /ɪ/, /ə/, /æ/, /ɑ/, and /ʊ/. However, differences are also observed in specific vowel categories. Javanese speakers produced /ɜ/, /ʌ/, and /u/ with a lower tongue position (more open), /ɛ/ further back, and /ɔ/ further open and forward than GA speakers. These findings indicate that differences in English vowel production are selective rather than consistent across all vowel categories and acoustic dimensions. On the other hand, vowels /ɛ/ and /u/ showed a weaker difference that should be interpreted with caution. Besides, the vowel /ɔ/ showed the largest difference in formant values between GA and JV, with F1 (151 Hz) and F2 (170 Hz). Overall, offers preliminary acoustic evidence of English vowel realization among Javanese speakers and highlights the relevance of first-language phonological backgrounds in understanding L2 vowel production.

This study has several limitations: only five GA speakers took part; the recordings were made with smartphones and saved as MP3 files, which may reduce recording quality; the English competency test scores of Javanese participants were not reported; and multiple comparisons were not corrected. Therefore, further research is needed to extend the scope of investigation by involving a wider range of samples and participants, improving recording procedures, using different materials, conducting double-correction testing, and exploring related topics in acoustic phonetics. This study's findings are expected to provide a foundation and serve as a reference for future research on acoustic phonetics. In addition, the findings may have pedagogical implications for English language teaching, both at the

school level and in higher education, particularly in developing greater awareness of English vowel production and pronunciation.

## REFERENCES


Adank, P., Smits, R., & Van Hout, R. (2004). A comparison of vowel normalization procedures for language variation research. *The Journal of the Acoustical Society of America*, *116*(5), 3099–3107. https://doi.org/10.1121/1.1795335

Azzahra, S., Syarfina, T., & Sembiring, F. E. D. R. B. (2024). Comparative Formants Analysis of English Vowels Using PRAAT. *Journey: Journal of English Language and Pedagogy*, *7*(2), 260–266. https://doi.org/10.33503/journey.v7i2.838

Bakos, J., José, B., & Phillips, B. S. (2022). A Real-Time Study of the "Naughty-Knotty" Merger in West-Central Indiana, USA. *Langages*, *226*(2), 25–39. https://doi.org/10.3917/lang.226.0025

Barrios, S., Jiang, N., & Idsardi, W. J. (2016). Similarity in L2 Phonology: Evidence from L1 Spanish late-learners' perception and lexical representation of English vowel contrasts. *Second Language Research*, *32*(3), 367–395. https://doi.org/10.1177/0267658316630784

Batubara, N. A., Rajagukguk, D. L., Rohani Ganie, R. G., & Maharani, P. (2025). Gender Phonology Studies: Differentiating Male & Female Voices through Praat Acoustic Analysis. *Linguistik, Terjemahan, Sastra (LINGTERSA)*, *6*(2), 120–128. https://doi.org/10.32734/lts.v6i2.21111

Boersma, P., & Weenink, D. (2022). *Praat: Doing Phonetics by Computer (6.2.22)*. https://praat.org/

Carr, P. (2020). *English phonetics and phonology: An introduction* (Third edition). Wiley-Blackwell.

Casillas, J. V., & Simonet, M. (2016). Production and perception of the English /æ/–/ɑ/ contrast in switched-dominance speakers. *Second Language Research*, *32*(2), 171–195. https://doi.org/10.1177/0267658315608912

Clopper, C. G., Pisoni, D. B., & de Jong, K. (2005). Acoustic characteristics of the vowel systems of six regional varieties of American English. *The Journal of the Acoustical Society of America*, *118*(3 Pt 1), 1661–1676. https://doi.org/10.1121/1.2000774

Creswell, J. W., & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications.

Flege, J. E., & Bohn, O.-S. (2021). The Revised Speech Learning Model (SLM-r). In R. Wayland (Ed.), *Second Language Speech Learning* (1st ed., pp. 3–83). Cambridge University Press. https://doi.org/10.1017/9781108886901.002

Heffner, R.-M. S. (1950). *General Phonetics*. University of Wisconsin Press.

Imatufariq, S. R., & Dessiar, A. R. (2026). Emerging shift and merger: Acoustic analysis in received pronunciation vowel production by Mandar EFL learners. *Leksika: Jurnal Bahasa, Sastra Dan Pengajarannya*, *20*(3), 344–357. https://doi.org/10.30595/lks.v20i3.30460

Inayah, N. A., Fajri, A. D., & Saffanatussa'idiyah. (2026). Phonological Interference of Javanese and Indonesian Vowels in the Foreign Language Acquisition of English Vowel /ɑ/. *Prologue: Journal on Language and Literature*, *12*(1), 230–246. https://doi.org/10.36277/jurnalprologue.v12i1.302

Istiqomah, S. A., Lintangsari, A. P., & Perdhani, W. C. (2021). Attitudes toward English phonetics learning: A survey on Indonesian EFL learners. *Journal on English as a Foreign Language*, *11*(1), 197–217. https://doi.org/10.23971/jefl.v11i1.2602

Jacob, E. (2022). Analyzing Students' Problems in Pronunciation During Their Self-Study in Pandemic Situation. *HUELE: Journal of Applied Linguistics, Literature and Culture*, *2*(2), 72–83. https://doi.org/10.30598/huele.v2.i2.p72-83

Kendall, T., & Fridland, V. (2017). Regional relationships among the low vowels of U.S. English: Evidence from production and perception. *Language Variation and Change*, *29*(2), 245–271. https://doi.org/10.1017/S0954394517000084

Kim, J., Cho, Y., Cho, Y., Hong, Y., Kim, S., & Nam, H. (2020). The Effects of L1–L2 Phonological Mappings on L2 Phonological Sensitivity: Evidence from Self-Paced Listening. *Studies in Second Language Acquisition*, *42*(5), 1041–1076. https://doi.org/10.1017/S0272263120000133

Lee, S., & Cho, M.-H. (2018). Predicting L2 vowel identification accuracy from cross-language mappings between L2 English and L1 Korean. *Language Sciences*, *66*, 183–198. https://doi.org/10.1016/j.langsci.2017.09.006

Lee, S., & Rhee, S.-C. (2019). The relationship between vowel production and proficiency levels in L2 English produced by Korean EFL learners. *Phonetics and Speech Sciences*, *11*(2), 1–13. https://doi.org/10.13064/KSSS.2019.11.2.001

Levis, J. (2024). Challenging Native-Speakerism: Embracing the Intelligibility Principle in Pronunciation and Spoken Language Instruction. *JALT Journal*, *46*(2), 211–225. https://doi.org/10.37546/JALTJJ46.2-4

Mantulameten, W. E. (2023). The Implementation of Short Animation Films to Enhance Students' English-Speaking Performance. *HUELE: Journal of Applied Linguistics, Literature and Culture*, *3*(1), 18–25. https://doi.org/10.30598/huele.v3.i1.p18-25

Masykar, T., Hassan, R. B., & Pillai, S. (2022). Perception of English vowel contrasts by Acehnese-Indonesian bilingual learners of English. *Indonesian Journal of Applied Linguistics*, *11*(3), 718–728. https://doi.org/10.17509/ijal.v11i3.35086

Maulana, A., Maharani, D. A., Viryanti, R. R., & Amalia, N. R. (2026). Errors in Pronouncing Interdental Consonants by American British Institute Students Yogyakarta. *Prologue: Journal on Language and Literature*, *12*(1), 151–162. https://doi.org/10.36277/jurnalprologue.v12i1.281

Norrman, G. (2024). First-language interference without bilingualism? Evidence from second language vowel production in international adoptees. *Applied Psycholinguistics*, *45*(5), 767–785. https://doi.org/10.1017/S0142716424000237

Nurjannah, N., Jannah, M., Zuhra, I., & Wati, F. (2023). Using PRAAT in Teaching the Monophthongs to the EFL Students in Indonesia. *Scope: Journal of English Language Teaching*, *7*(2), 232. https://doi.org/10.30998/scope.v7i2.16027

Nuzulia, I. F. L. (2023). Vowel Phoneme in Javanese Language Wonosobo's Dialect. *JELP: Journal of English Language and Pedagogy*, *2*(1), 14–25. https://doi.org/10.58518/jelp.v2i1.1467

Perwitasari, A., Klamer, M., & O. Schiller, N. (2016). Formant Frequencies and Vowel Space Area in Javanese and Sundanese English Language Learners. *3L The Southeast Asian Journal of English Language Studies*, *22*(3), 141–152. https://doi.org/10.17576/3L-2016-2203-10

Rohmah, A., Weano, M., Rahmah, M., & Kuspiyah, H. R. (2023). An Analysis of Student's Javanese Language Interference in Pronunciation of English. *Channing: Journal of English Language Education and Literature*, *8*(1), 19–26. https://doi.org/10.30599/channing.v8i1.2172

Schwartz, G., & Kaźmierski, K. (2020). Vowel dynamics in the acquisition of L2 English – an acoustic study of L1 Polish learners. *Language Acquisition*, *27*(3), 227–254. https://doi.org/10.1080/10489223.2019.1707204

Wang, S., Weng, Y., Wang, J., & Xu, Z. (2023). An Acoustic Study of English Monophthong Acquisition by Chinese English Learners in Different Phonological Environments. *OALib*, *10*(08), 1–10. https://doi.org/10.4236/oalib.1110536

Wedhawati, Nurlina, W. E. S., & Setiyanto, E. (2001). *Tata Bahasa Jawa Mutakhir*. Pusat Bahasa Jakarta.

Widya, W., & Agustiana, E. (2020). English vowels pronunciation accuracy: An acoustic phonetics study with Praat. *Scope: Journal of English Language Teaching*, *4*(2), 113. https://doi.org/10.30998/scope.v4i2.6229

Yamaguchi, T., & Chiew, P. S. (2020). Is there conflation? An acoustic analysis of vowels in Japanese English. *Asian Englishes*, *22*(1), 35–51. https://doi.org/10.1080/13488678.2018.1563665

Yusuf, Y. Q., Aziz, Z. A., Nurjannah, & Pillai, S. (2024). The sounds of Indonesian English: Acoustic phonetic analysis of the monophthong vowels across genders. *TEFLIN Journal - A Publication on the Teaching and Learning of English*, *35*(1), 169–192. https://doi.org/10.15639/teflinjournal.v35i1/169-192