Influence of Indonesian as a First Language on the Acquisition of English as a Second Language

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Abstract

Second language acquisition involves mapping, transferring, and acquiring new sounds onto the framework of one's native language (L1) phonology. The Indonesian language presents unique challenges for learners of English as a second language (ESL) due to its limited vowel inventory. The present study examined how L1 Indonesian influences the acoustic realization of 10 English vowels among 30 native adult speakers of Indonesian, as revealed through acoustic formant analysis. Recordings of word productions were analyzed using PRAAT to measure F1 and F2 values. Results were plotted and compared to native English norms. Vowels with similar L1 counterparts like [i], [o], [u], [e] were produced close to native targets, though subtle deviations occurred. English vowels absent from Indonesian, such as [ɪ], [æ], [ɑ], [ʌ], exhibited stronger assimilation toward nearby L1 categories rather than native patterns. The findings provide acoustic evidence that one's native language acts as a formative frame of reference during subsequent language acquisition, compelling non-native sounds to conform to established L1 articulatory categories. This helps explain the difficulties Indonesian learners face in producing certain English vowel contrasts, especially those not present in their first language.

Introduction

Background

Learning to speak a second language (L2) such as English has been seen to be difficult, especially by adult speakers. Second language proficiency has been correlated with the amount of "error" or accent perceived in their L2 sounds. It is a direct result of articulatory deviation that is strongly related to the mother tongue (L1) spoken by the speakers.

Each resonating frequency of the vocal tract is known as a "formant", with F1 and F2 representing the first and second formants. The influence of L1 on L2 vowel production can be recognized in formant frequency values, which is the broad spectral maximum produced by the acoustic resonance of the vocal tract.

Production of different vowels involves placing the tongue at different location inside the oral cavity, in addition to other changes such as lip rounding/spreading and jaw lowering/elevating. According to IPA (International Alphabet Association), different vowels can be depicted in a vowel chart (see Figure 1) in which vowels are divided based on tongue positions (Figure 2). Frontness of the tongue is divided into front, central, and back, while tongue elevation into high, mid, and low. Using such a vowel chart, one can perceive and categorize different vowels according to tongue position during vowel production. Thus, the vowel chart proposed by IPA is entirely physiological.

The tongue, lips, jaw, soft palate, etc. are known as articulators. Acoustically, any articulatory movement results in changes in the vocal tract configuration and the frequencies at which it resonates, and thus a change in formants. Formants refer to the frequencies at which the vocal tract resonates; first formant is the frequency of the first resonance, and vice versa. It has been documented that the relationship between F1 and F2 reflects the acoustic properties of

vowel sounds (see figure 1). When each vowel is placed on a graph, where the horizontal dimension represents the decreasing frequency of F1 and the vertical dimension represents the decreasing frequency of F2, it produces the mirror image of a vowel chart (see figure 2). F1 frequency is inversely related to vowel height - higher vowels have lower F1 values and lower vowels have higher F1 values. F2 frequency relates to the positioning of the tongue along the front-back dimension within the oral cavity. Lower F2 values indicate a longer front cavity caused by a more back tongue position, while higher F2 values indicate a shorter front cavity from a more front tongue position.

There are several theories about how native language (L1) sounds affect second language (L2) acquisition. One is the Perceptual Assimilation Model (Best et al.). This model suggests that adults perceive unfamiliar non-native speech sounds based on how similar or different their articulation is to native phonemes. Listeners unconsciously assimilate non-native sounds to existing native phoneme categories based on similarities in places and manners of articulation.

Another model is the Speech Learning Model (Fledge). It proposes that non-native sounds are classified based on their phonetic similarity to L1 phonemes. Because new L2 sound categories are more likely to be developed, learners are more likely to accurately produce and perceive categories very different from the closest sounds in their native language. Both models assume that adults' ability to distinguish between non-native speech sounds is systematically related to having already developed their native phonological system.

Literature Review

There is a limited number of studies that examine formant frequencies to evaluate the acquisition of English by Indonesian native speakers by acoustic measurement. Perwitasari et al.

in 2016 studied the formant frequencies of Javanese and Sundanese learners of English as a foreign language. Javanese and Sundanese are two languages spoken by the principal ethnic groups of the island of Java, Indonesia. They discovered that producing English vowels was difficult for these learners, not just for similar sounds like [ɪ], [ɛ], [ʊ] but also unfamiliar sounds such as [i], [æ], [ɑ], [ɔ], [u], [ʌ], [ɜ]. Additionally, the Javanese and Sundanese speakers also demonstrated a smaller vowel space area compared to native English speakers.

In 2017, Widagsa and Putro conducted a study involving five male Indonesian speakers who had been studying English in university for at least 3 years and concluded that the Indonesian learners also had a less spacious vowel space than native English speakers, were unable to distinguish between the vowels [i] and [ɪ], were able to produce the vowel [u] that was close to the vowel [ʊ], pronounced the vowel [æ] similar to [e] but higher than the production of native English speakers, produced the vowel [ɑ] in the same way as native English speakers produce the vowel [ʌ], and produced the English vowels [ɒ] and [u] in a similar manner to the English vowel [ʊ]. The authors concluded that Indonesian learners of English have difficulties in producing English vowels which do not exist in the Indonesian vowel system.

The present study seeks to build upon and expand the scope of prior research in several key ways. A larger sample size is taken to minimize sampling error and enhance reliability. The methodology includes both male and female participants analyzed separately, addressing a gap in previous studies. Finally, results will be compared to past studies for meaningful evaluation of consistency.

Objective

Overall, this current study aims to examine how Indonesian as one's first language affects production of English as a second language through the documentation of formant frequencies of English vowels produced by Indonesian native speakers, review of the vowel charts of [i], [ɪ], [e], [ɛ], [æ], [ɑ], [o], [ʊ], [u], [ʌ] and relational analysis to sounds present in the Indonesian language.

Methodology

Participants

A total of 30 Indonesian participants as the subjects, comprising 15 males and 15 females between the ages of 18-25 years old were recruited to participate in the study. The participants' exposure to English varied but all speakers acquired Indonesian was their first language. Meanwhile, comparison data was drawn from native American English speakers (AE) recorded by Hillenbrand et al (1995), comprising of 45 men and 48 women. Both sets of participants - the Indonesian subjects of this research and the AE individuals from the prior study - contained balanced gender representation and fell within a standardized age bracket to control for potential influences.

Procedure

Each participant was provided a digital document containing a set of standard English words excerpted from a protocol used by speech therapists for English accent reduction therapy. Analysis was done for a combination of the words that corresponded to the English vowels [i], [ɪ], [e], [ɛ], [æ], [ɑ], [o], [ʊ], [u], [ʌ] (see table 1). The recordings were made with

preamplification unit (M-Track II, M-Audio) and a high-quality condenser microphone (SM58, Shure) placed at a distance of about 3-5 cm from the participants' mouths. The order at which the vowels were recorded was randomized in order to avoid possible order effect. The participants were recorded one by one in order to ease the analysis.

Table 1

Words Analyzed and Their Corresponding English Vowels.

beat, heed	[i]
bit, hid	[ɪ]
bait, aid	[e]
bet, head	[ɛ]
bat, had	[æ]
bought, awed	[ɑ]
boat, owed	[o]
put, hood	[ʊ]
boot, who'd	[u]
but, hud	[ʌ]

Data Analysis

HUAWEI MateBook D 15 laptop was used to analyze the recording data. This recording and analysis process took place at the University of Hong Kong. The recordings were analyzed using PRAAT 6.2.23, which draws the waveform and spectrogram display and has a feature to trace F1 and F2 from the formant frequencies. The F1 and F2 values are tabled into Microsoft Excel and inputted into Adam Baker's Formant Plotter to create the vowel chart. Results are compared to those reported from native English speakers in the literature. Error patterns in English pronunciation seen through the vowel chart are studied and related to sounds present in Indonesian and the Indonesian vowel chart.

Results and Discussion

The formant frequencies recorded (see table 2) generated the vowel chart of Indonesians (see figure 3 and figure 4). Comparisons between these vowel charts with the AE formants and the IPA vowel chart produce the following initial observations:

1. [i], [o], [u], and [e] are pronounced relatively similarly.
2. [ɪ] is produced with a close-mid rather than in between close and close-mid mouth.
3. [ɛ] is produced with central rather than front tongue position.
4. [æ] is produced with an open rather than open-mid mouth, and central rather than front tongue position.
5. [ɑ] is produced with an open-mid rather than open mouth.
6. [ʌ] is produced central rather than back tongue position.

Table 2

F1 and F2 Values for Female and Male Native American English and Indonesian Speakers

		Female Native		Female Indonesian		Male Native		Male Indonesian	
Words	Vowels	F1	F2	F1	F2	F1	F2	F1	F2
beat, heed	[i]	437	2761	323	2561	342	2322	263	2151
bit, hid	[ɪ]	483	2365	512	2323	427	2034	434	1796
bait, aid	[e]	536	2530	453	2441	476	2089	377	2106
bet, head	[ɛ]	731	2058	846	1968	580	1799	545	1640
bat, had	[æ]	669	2349	858	1853	588	1952	697	1492
bought, awed	[ɑ]	936	1551	768	1161	768	1333	628	1004
boat, owed	[o]	555	1035	468	1062	497	910	420	886
put, hood	[ʊ]	519	1225	470	1189	469	1122	437	1195
boot, who'd	[u]	459	1105	377	1090	378	997	342	1046
but, hud	[ʌ]	753	1426	840	1509	623	1200	599	1299

The Indonesian language only has six monophthongal phonemes: [i], [u], [e], [ə], [o] and [a].[5] The Indonesian speakers produced the vowels [i], [o], [u], and [e] with relatively similar formant frequencies and positions that align relatively closely with native AE productions. However, slight deviations of articulations were observed for [u] and [o], perhaps due to the influence of analogous Indonesian vowels.

For vowels not present in the Indonesian language, such as [ɪ], [æ], [ʌ], [ɑ], the speakers' productions tended to be displaced towards acoustic spaces occupied by the vowels that do exist in Indonesian, suggesting transfer of L1 articulatory settings. For example, [ɪ] was realized with close-mid rather than between close and close-mid mouth, closer to [e] or [ə] in Indonesian. Likewise, [æ], [ɑ] and [ʌ] were produced more open and central compared to native norms, resembling the Indonesian [a] vowel. Especially for [ɑ], the F1 and F2 values were consistently around 150 Hz and 350 Hz respectively above the American English Native speakers' formant values. This meant that the Indonesian speakers were consistently producing the vowel lower and with a shorter front cavity as a result of a more front tongue position compared to the native speakers' production and the vowel's standard pronunciation based on the IPA chart.

These results mirror and expand upon several key findings from prior literature. As observed in earlier investigations of Javanese, Sundanese and other Indonesian speakers, the present participants exhibited a constricted vowel space relative to native English norms. Their productions clustered more closely together compared to the dispersed mapping seen for AE speakers. This restricted dispersion provides acoustic evidence that the Indonesian vowel inventory of just six monophthongs acts as a formative constraint, compelling subsequent language acquisition to conform to its boundaries.

These findings also align with the overarching ideas of the Perceptual Assimilation Model and the Speech Learning Model, as the speakers' ability to distinguish and produce English sounds that are not present in Indonesian is connected to their native language system. However, it concurs more positively with the former model as there appears to be a robust correlation between how Indonesian speakers implement unfamiliar English vowels and the limited vowel inventory of six monophthongs in their native language. While familiar vowels were replicated relatively well, vowels with no direct Indonesian equivalent tended to be assimilated to acoustically and articulatorily similar established L1 categories instead of adopted authentically from L2 English.

Conclusion

This study examined the influence of L1 Indonesian phonology on English vowel production among 30 Indonesian speakers. Formant frequency analysis provided insights into how the 10 English vowels were realized acoustically in relation to native English norms and the Indonesian vowel system.

The results demonstrated that for vowels with close counterparts in Indonesian such as [i], [o], [u], and [e], participants were generally able to articulate them similarly to native speakers. However, English-specific vowels without direct Indonesian equivalents exhibited stronger interference effects from L1 transfer. Vowels like [ɪ], [æ], [ɑ], [ʌ] were assimilated to perceptually close Indonesian categories rather than native targets. Notably, [ɑ] was consistently produced with higher-frontal formants resembling Indonesian [a] rather than the English vowel. These findings align with previous research showing reduced vowel spaces and distortions of non-Indonesian vowels among Indonesian learners. This provides acoustic evidence that the

native language exerts a formative influence, acting as a frame of reference that subsequent languages must conform to, especially for novel sounds.

Overall, the acoustic insights into how L1 categories are mapped onto an L2 system further understanding of second language acquisition.

Appendix

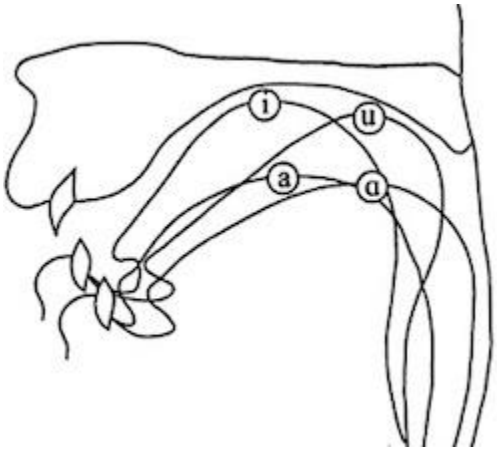

Figure 1. Vowel space of the corner vowels. Lindsey, Geoff. “The Vowel Space - English Speech Services.” *English Speech Services*, 27 Mar. 2013, www.englishspeechservices.com/blog/the-vowel-space/. Accessed 18 Sept. 2023.

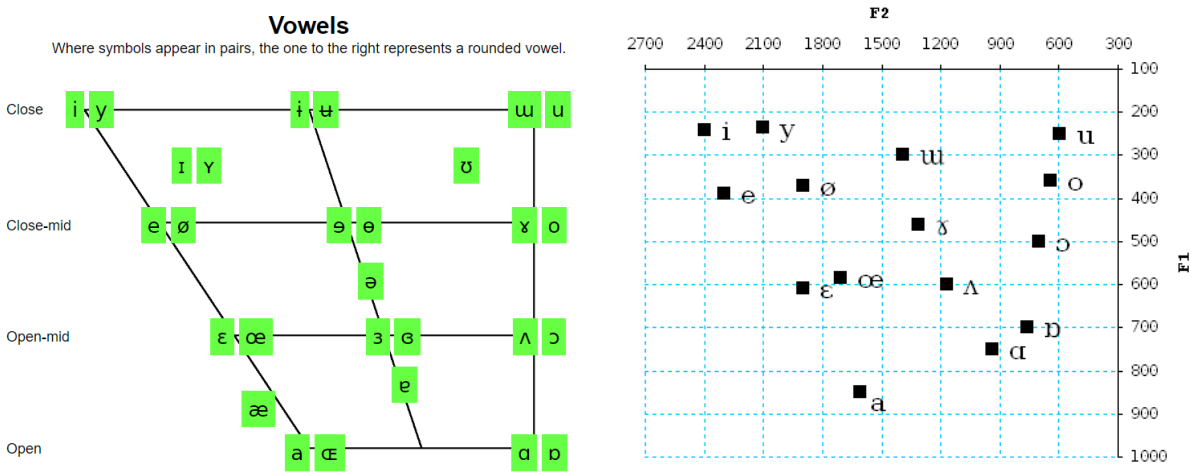

Figure 2. Vowel chart used in the International Phonetic Alphabet (left). “IPA Chart.” *Ipachart.com*, 2023, www.ipachart.com/. Accessed 10 Sept. 2023.

Average vowel formants (right). “By Любослов Езыкин - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=71013415

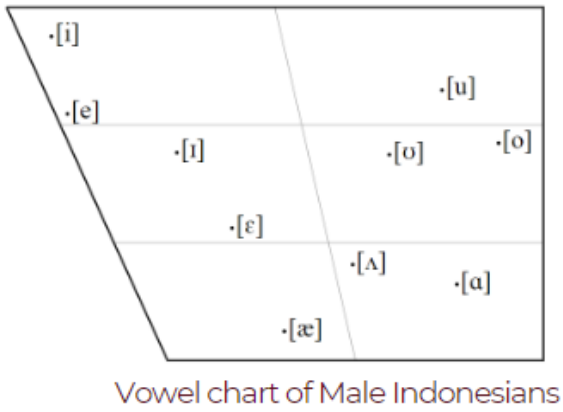

Figure 3. Vowel chart of Male Indonesians generated from averages of participants' F1 and F2 values.

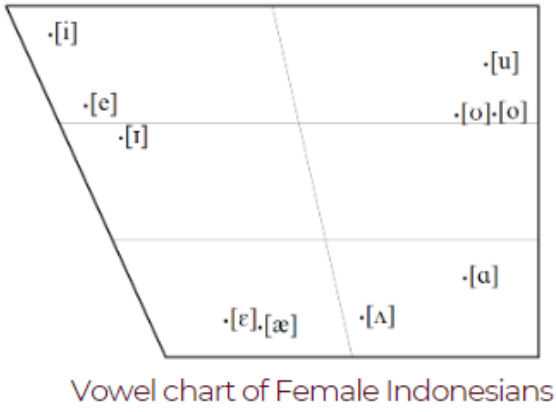

Figure 3. Vowel chart of Female Indonesians generated from averages of participants' F1 and F2 values.

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