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An Acoustic Study on English Vowels Produced by Indonesian Speakers: Exploring Determining Factors and Contact Situations

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ABSTRACT

Compared to English varieties spoken in the inner circle (e.g., Australian English and New Zealand English), the English variety spoken in Indonesia, especially in acoustic phonetics, is still understudied. Using the Praat computer program, this acoustic study investigates the English vowel production of fifteen Indonesian females and males. The formants (F1 and F2) of their English vowel in words heed /hid/, hid /hɪd/, head /hɛd/, had /æ/, hod /hɑd/, hawed /hɔd/, hood /hʊd/, who'd /hud/, hud /hʌd/, and heard /hɝd/ are measured and then compared with the vowels produced by American English speakers. Regardless of the speakers' gender and English skill levels, the vowels [æ] and [ɑ] show the most significant differences between Indonesian and American English speakers. The difference in this study is conditioned more by linguistic factors, i.e., phonetics and phonemics, than by non-linguistic factors, i.e., gender and English skill level. The findings of this study offer a discussion of how acoustic evidence resulting from language education may shed light on possible language contact situations.

INTRODUCTION

In his three circles model of English, Kachru (1988), as cited in Crystal (2003), reported that the number of speakers in the inner circle of English (e.g., UK, USA, Australia) is approximately 320-380 million, while the estimates in the outer circle (e.g., India, Singapore) are in a range of 300 million to 500 million. Interestingly, the estimated number of speakers of around 500-1000 million in the expanding circle (e.g., Russia, China, Indonesia) has increased and outranked the inner and outer ones. Nowadays, various distinct regional varieties of English have emerged around the globe, and new pronunciation features that diverge from the phonological patterns of native speakers from the inner circle have been developed (Deterding & Kirkpatrick, 2006). Compared to English varieties spoken in the inner and outer circles, the pronunciation features in the expanding circle, such as in Indonesia, are still understudied. Our current study offers an acoustic description of English vowels produced by Indonesian speakers. The study compares the acoustic similarities and differences between American English speakers examined in Hillenbrand et al. (1995) and Indonesian speakers involved in this study. The investigation also sheds light on the interaction between the acoustic evidence and the sociolinguistic factors, namely gender and the English skills background of the speakers.

To the best of the authors' knowledge, details of the vowel characteristics of the emerging English variety in Indonesia are less commonly examined, but some investigations exist. There are at least two categories of studies. The first one looked at the English vowels produced by native speakers of local languages of Indonesia, and the second one worked on the English vowels produced by native Indonesian speakers. In her dissertation, Perwitasari (2019) investigated English vowels produced by Sundanese and Javanese speakers. Additionally, Fata et al. (2017) discussed Acehnese speakers' production of English vowels, and Widagsa et al. (2018) work involved Minangkabau speakers.

For English vowels produced by Indonesian speakers, Widagsa and Putro (2017) examined English vowels produced by male university students residing in Yogyakarta. Subandowo et al. (2020) worked on the English vowels produced by university students in the Lampung area. Despite being the first acoustic studies on the English vowels produced by Indonesian speakers, these two works are not without limitations. The limitations include the lack of information about speakers' gender, local language, and English skills backgrounds. In addition, these studies do not compare Indonesian and English vowels. The following paragraphs discuss these limitations.

Widagsa and Putro (2017) involved only male participants, comparing their English vowel production with British English speakers from Hawkins and Midgley's (2005) work. However, Widagsa and Putro did not mention whether the British English speakers are also males. In addition, the investigation conducted by Subandowo et al. (2020) only involved female participants. Involving both male and female speakers is important for physiological and sociolinguistic reasons. Due to physiological differences between males and females, i.e., the size of the vocal tract, the formant values produced by the two groups are also different. The female formant values are generally higher than males (Hillenbrand et al., 1995; Pépiot, 2012, among others). Both groups should be considered for sociolinguistic reasons as their conversational behaviour may differ (Coates, 2015). In characterizing female speech, Lakoff (1973) listed standard form as one of the features. As English is acquired in Indonesia at formal schools, i.e., requiring the mastery of the standard variety, we cannot neglect the roles of speakers' gender background in studying English vowel production.

There needs to be local language information provided by studies by Subandowo et al. (2020) and Widagsa and Putro (2017). They only reported that their participants were from various ethnic backgrounds and studied in the universities where the investigation occurred. Since it is not uncommon for Indonesians to be multilingual who may have (near) native fluency in one of the local languages, a local Indonesian variety, Standard Indonesian (and possibly English), the information about the participants' language background is crucial as their local languages may affect their English vowel production.

None of the studies above provided information about the English skill level of the speakers. Widagsa and Putro (2017) mentioned that their participants are third-year English students, while Subandowo et al.'s (2020) participants are second-semester English education students. Although majoring in English, there is no guarantee that their participants have reached adequate English mastery. They needed to determine whether their participants were also basic learners of English. Involving basic learners may cause the results to be biased towards Indonesian vowels.

Subandowo et al. (2020) compared the results with Indonesian vowels without comparing the results with the vowels produced by native English speakers. On the other hand, Widagsa and Putro (2017) compared the vowels produced by Indonesian and British English speakers without providing a comparison with native Indonesian vowels.

This present study aims to offer a fuller description of English vowels produced by Indonesian speakers by exploring the extent to which linguistic factors, i.e., phonetics and phonemics and sociolinguistic factors, i.e.,

speakers' gender and English skill level, determine the results of vowel production. To achieve the purpose of the study, the following research questions are proposed:

a. Is there a significant difference between English vowels produced by Indonesian speakers of English (L2) and American English speakers (L1)?
b. Is English vowel production by Indonesian speakers of English (L2) determined by linguistic or sociolinguistic factors, i.e., speakers' gender and English skill levels?

Both female and male participants with intermediate and advanced skills backgrounds are involved in answering research question one. Additionally, the study uses American English vowel production (Hillenbrand et al., 1995) and Indonesian vowel production (Van Zanten, 1989) to address the second research question.

METHOD

Participants

The examination was conducted with fifteen female and fifteen male Indonesians in Jakarta, the capital of Indonesia. The female group consists of eight advanced and seven intermediate speakers of English. Similarly, the male group also consists of eight advanced and seven intermediate speakers of English. This study does not include basic learners of English because, as discussed above, the vowels produced by basic learners might be biased towards native Indonesian vowels, i.e., it would show significant differences from English vowels produced by native speakers. Although the English vowel production from the intermediate and advanced speakers may still be influenced by the native Indonesian vowels, not including the basic learners would reduce the risk of having skewed results.

All participants are college-educated and range in age from 23 to 54. For female speakers, eleven of them acquired only Indonesian in their childhood, three speakers acquired Indonesian and Javanese, and one speaker acquired Indonesian and Sundanese. Eleven male speakers acquired only Indonesian in their childhood, two acquired Indonesian and Javanese, one acquired Indonesian and Kerinci, and one acquired Indonesian and Sundanese. Based on their language backgrounds, most speakers in this study are monolingual Indonesian, and only a few others are bilingual.

Procedures

Ten vowels were investigated in this study. They include [i, ɪ, e, æ, ɑ, ɔ, u, ʊ, ʌ, ɝ] in words with *h_d* context: *heed* [hiːd], *hid* [hɪd], *head* [hed], *had* [hæd], *hod* [hɑːd], *hawed* [hɔːd], *who'd* [huːd], *hud* [hʌd], and *heard* [hɝd]. These English words have been used in previous studies, such as those by Hillenbrand et al. (1995) and Ladefoged and Johnson (2011), among others, as they have different vowels from various tongue positions. These words are embedded in carrier sentences: *Budi said 'heed,' Budi said 'hid,'* and so forth. Recordings were conducted of each participant reading the carrier sentences in a quiet room. All recordings were made using the *Praat* computer program (Boersma & Weenink, 2021). The metadata from each speaker was also obtained. The estimated recording time for each speaker is around five to ten minutes.

Acoustic Measurements

All acoustic measurements were done in *Praat*, developed by Boersma and Weenink (2021), and have been commonly used in acoustic science for spectral and formant analyses. The waveform and spectrogram generated in *Praat* in this study were used to analyze the spectrum of the frequency of vowel speech signals (in Hertz) produced by the participants. The frequency indicates the tongue's position in terms of height and back/front dimension when the participants articulate English vowels.

The acoustic analysis measured the mid-point in formant one (F1) and formant two (F2) values of the participants' English vowel production. F1 is related to the height of the tongue, while F2 is associated with the back/front dimension of the tongue. An example of the spectral analysis is shown in Figures 1 and 2.

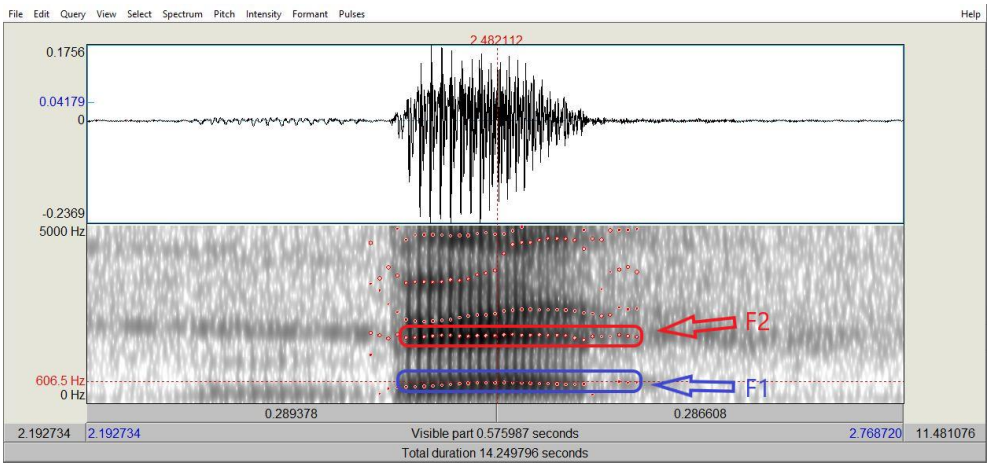

Figure 1. Example of F1 and F2 in Vowel [ɪ]

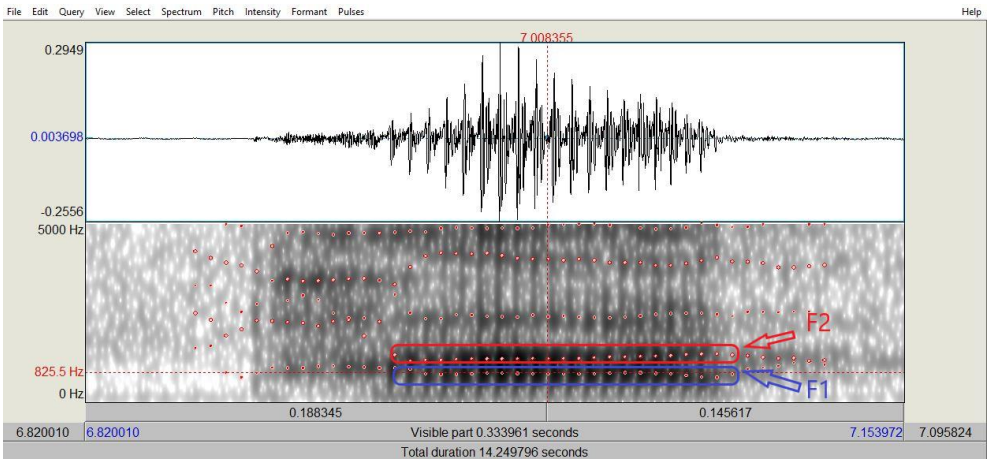

Figure 2. Example of F1 and F2 in Vowel [ə]

To observe differences in F1 and F2 between American English speakers from Hillenbrand et al.'s (1995) study and the Indonesian speakers involved in this study, a two-tailed *t*-test is applied for each vowel. We implement .05 values as the significant level threshold. All statistical tests were done on *R* (*R* Core Team, 2021). Additionally, we examine the connection between the acoustic evidence and Indonesian orthography influences and discuss possible situations of phonological contact between English, Indonesian, and local languages based on the phonetic results we have.

FINDINGS & DISCUSSION

This section first discusses the results from female speakers and then focuses on the findings from male speakers. The tables in this section present the mean values of F1 and F2 produced, while each speaker's F1 and F2 values are available in the appendix.

Female Speakers

The results of the female speakers are divided into two categories: advanced and intermediate groups. Table 1 shows the findings from the advanced female Indonesian speakers in this study, the female English speakers from Hillenbrand et al. (1995), and the *t*-test results.

Table 1. English vowels by female speakers of advanced level

Vowels	Mean values of F1			Mean values of F2			Mean values of F2-F1		
	Ame[^]	Ind[^]	*p* values	Ame	Ind	*p* values	Ame	Ind	*p* values
heed [i]	437[†]	367	.031*	2761	2402	.840	2324	2034	.127
hid [ɪ]	483	445	.286	2365	2439	.407	1882	1994	.328
head [e]	731	864	.001*	2058	2060	.979	1327	1195	.115
had [æ]	669	897	<.001**	2349	1966	<.001**	1680	1068	<.001**
hod [ɑ]	936	693	<.001**	1551	1128	<.001**	615	435	<.001**
hawed [ɔ]	781	843	.281	1136	1251	.049*	355	408	.169
hood [ʊ]	519	416	.002*	1225	1177	.363	706	762	.228
who'd [u]	459	434	.077	1105	1237	.104	646	803	.040*
hud [ʌ]	753	805	.397	1426	1580	.001**	673	775	.166
heard [ɝ]	523	618	.062	1588	1662	0.098	1065	1044	.722

* Indicates significant difference; ** indicates highly significant difference; Ame: American; Ind: Indonesian; [†]all values are in Hertz; [^]Ame: American speakers; Ind: Indonesian speakers; these are all applied throughout the article.

A two-tailed *t*-test was performed to compare the mean values of F1, F2, and F2-F1 of each English vowel produced by female Indonesian speakers of advanced level and female American speakers in Table 1. Vowels that show significant differences in F1, F2, and F2-F1 are [æ] and [ɑ]; vowels that exhibit significant differences only in F1 are [i], [e], and [ʊ]; vowels that indicate significant differences only in F2 are [ɔ] and [ʌ], and vowels that represent significant differences only in F2-F1 is [u]. Only vowels [ɪ] and [ɝ] demonstrate evidence of insignificant differences in all formant values. As presented in the results, vowels [æ] and [ɑ] show more differences than other vowels in female speakers of advanced level.

Table 2. English vowels by female speakers of intermediate level

Vowels	Mean values of F1			Mean values of F2			Mean values of F2-F1		
	Ame	Ind	*p* values	Ame	Ind	*p* values	Ame	Ind	*p* values
heed [i]	437	425	.787	2761	2208	.014*	2324	1783	.016*
hid [ɪ]	483	413	.034*	2365	2407	.731	1882	1994	.432
head [e]	731	677	.415	2058	1990	.498	1327	1313	.91
had [æ]	669	841	<.001**	2349	1915	<.001**	1680	1074	<.001**
hod [ɑ]	936	666	.003*	1551	1259	<.001**	615	593	.598
hawed [ɔ]	781	807	.495	1136	1388	.044*	355	581	.060
hood [ʊ]	519	461	.051	1225	1237	.855	706	775	.261
who'd [u]	459	430	.456	1105	1125	.790	646	695	.446
hud [ʌ]	753	719	.733	1426	1488	.549	673	769	.398
heard [ɝ]	523	627	.006*	1588	1676	.427	1065	1049	.892

In Table 2, the vowels where all formants, i.e., F1, F2, and F2-F1, display significantly different mean values are [æ] and [ɑ]. Interestingly, these results are similar to those of the advanced level. For vowels [ɪ] and [ɝ], only F1 that shows significant difference. Vowels [i] and [ɔ] exhibit significant differences only in F2, and vowels [i] and [æ] demonstrate significant differences in F2-F1. There are no significant differences in the production of vowels [e], [ʊ], [u], and [ʌ].

The significant differences between the female groups in the current study, and female American English speakers from Hillenbrand et al. (1995) are found in vowels [æ] and [ɑ]. In terms of insignificant differences, female speakers of the intermediate level have more numbers of vowels than those of the advanced level. It looks like, so far, the English skill levels of the female groups in our study do not determine the results. The significant differences in vowels [æ] and [ɑ] show this phenomenon. In addition, if the English skill levels of

the female speakers determine the results, we would find more vowels that show insignificant differences in the advanced group.

Male Speakers

Like the results from female speakers, the results from male speakers are also divided into two groups: advanced and intermediate groups of speakers.

Table 3. English vowels by male speakers of advanced level

Vowels	Mean values of F1			Mean values of F2			Mean values of F2-F1		
	Ame	**Ind**	***p* values**	**Ame**	**Ind**	***p* values**	**Ame**	**Ind**	***p* values**
heed [i]	342	362	.352	2322	2326	.936	1980	1964	.997
hid [ɪ]	427	494	.107	2034	2121	.160	1607	1627	.707
head [e]	580	695	<.001**	1799	1638	.010*	1219	944	.004*
had [æ]	588	756	<.001**	1952	1668	<.001**	1364	913	<.001**
hod [ɑ]	768	666	.013*	1333	1126	.004*	565	460	.074
hawed [ɔ]	652	671	.657	997	968	.657	345	535	.134
hood [ʊ]	469	420	.103	1122	1162	.615	653	742	.258
who'd [u]	378	475	.072	997	1178	.123	619	854	.122
hud [ʌ]	623	702	.027*	1200	1334	.007*	577	631	.247
heard [ɝ]	474	577	.010*	1379	1400	.693	905	823	.305

In Table 3, we can see immediately that vowels [e], [æ], [ɑ], [ɑ], and [ʌ] indicate significantly different mean values of F1 and F2 between the two groups of speakers. Significant differences can also be found in the mean values of F2-F1 in the vowels [e] and [æ]. The rest of the vowels, i.e., [i, ɪ, ɔ, ʊ, u], show no significant differences, except for the F1 value in vowel [ɝ]. Interestingly, the results from advanced and intermediate female speakers also demonstrate significantly different mean values of F1 and F2 in the vowels [æ] and [ɑ], the same as those from the advanced male speakers.

Table 4. English vowels by male speakers of intermediate-level

Vowels	Mean values of F1			Mean values of F2			Mean values of F2-F1		
	Ame	**Ind**	***p* values**	**Ame**	**Ind**	***p* values**	**Ame**	**Ind**	***p* values**
heed [i]	342	335	.718	2322	2178	.082	1980	1843	.147
hid [ɪ]	427	373	.026*	2034	2094	.287	1607	1721	.068
head [e]	580	633	.122	1799	1841	.326	1219	1208	.721
had [æ]	588	663	.12	1952	1771	.028*	1364	1108	.021*
hod [ɑ]	768	842	.161	1333	1168	.186	565	523	.589
hawed [ɔ]	652	691	.372	997	1132	.041*	345	441	.066
hood [ʊ]	469	389	.004*	1122	1127	.903	653	737	.016*
who'd [u]	378	385	.814	997	1189	.015*	619	804	.031*
hud [ʌ]	623	669	.357	1200	1377	.003*	577	708	.014*
heard [ɝ]	474	575	.026*	1379	1393	.766	905	818	.140

Unlike the results found in female speakers and male speakers of advanced level, the results in Table 4 show different patterns. The significant differences in the mean values are not concentrated in certain vowels but scattered around in almost all vowels. Vowels that display significant differences in F1 are [ɪ], [ʊ], and [ɝ], while vowels that present significant differences in F2 are [æ], [ɔ], [u], and [ʌ]. In addition, we can find significant differences of F2-F1 in vowels [æ], [ʊ], [u], and [ʌ]. Interestingly, only vowels [i], [e], and [ɑ] show insignificant differences across F1, F2, and F2-F1.

This section discusses the numbers of vowels showing significant differences in their F1, F2, and F2-F1 values produced by the four groups of speakers. It presents the visualization of the results in the Bark scale figures. In addition, this section discusses linguistic and non-linguistic factors that may determine our results so far.

Table 5. Summary of vowels with significant differences

		heed	hid	head	had	hod	hawed	Hood	who'd	hud	heard	Total
F1	FA	i		e	æ	ɑ		ʊ				5
	FI		ɪ		æ	ɑ					ɝ	4
	MA			e	æ	ɑ				ʌ	ɝ	5
	MI		ɪ					ʊ			ɝ	3
F2	FA				æ	ɑ	ɔ			ʌ		4
	FI	i			æ	ɑ						3
	MA			e	æ	ɑ				ʌ		4
	MI				æ		ɔ		u	ʌ		4
F2-F1	FA				æ	ɑ			u			3
	FI	i			æ							2
	MA			e	æ							2
	MI				æ			ʊ	u	ʌ		4
Total		3	2	4	11	7	2	3	3	5	3	

*FA: female advanced, FI: female intermediate, MA: male advanced, MI: male intermediate

The vowels in Table 5 indicate significant differences from American speakers' vowel production. They may be different in F1, F2, or F2-F1 values. Across the four groups of speakers, i.e., regardless of the speakers' gender and English skill levels, the vowel [æ] shows the most significant differences, followed by the vowel [ɑ], as shown in the bottom row.

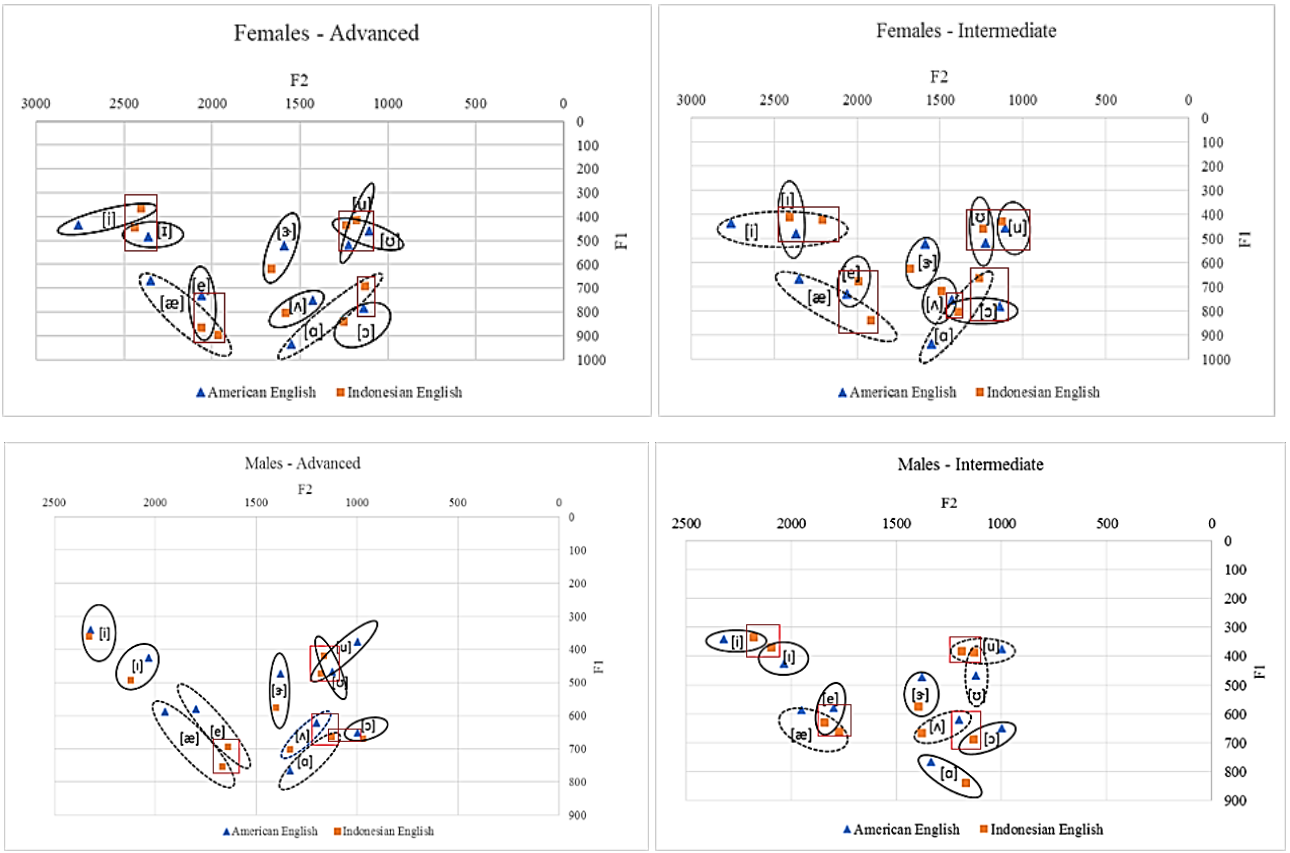

Figure 3. Bark scales of the four groups of Indonesian speakers

Regarding the number of vowels in the last column, we expect to find advanced speakers producing fewer vowels that exhibit significant differences from those of intermediate speakers. However, the results do not suggest such a way. The total number of vowels that show significant differences in each group is between two and five, as shown in the last column of Table 5. To clarify, visualizations of the results are represented in the Figure 3.

The positions of the vowels in Figures 1 and 2 are related to the tongue position. F1 values indicate the vowel height and F2 values show the advancement, i.e., the front/back position of the tongue. In all figures, further distances indicated by the dashed lines can be observed in the vowels, which show significant differences. Visually, we can see that these vowels are further apart than vowels that do not show significant differences.

Our results so far show that non-linguistic factors, i.e., gender and English skill level, of the speakers do not determine the use patterns. The next step is to look at linguistic (phonemic and phonetic aspects of speakers' L1) and Indonesian orthographic factors that may condition the results.

It should be noted that some vowels are clustered very closely, as marked with red square lines in Figure 3. This phenomenon may indicate that those English vowels are acoustically and perceptually quite similar for Indonesian speakers. For example, the vowels in *heed* [hi:d] and *hid* [hɪd], who'd [hu:d] and *hood* [hʊd], are possibly perceived and produced identically by the Indonesian speakers. Lapoliwa (1981) reported that [i] and [u] are phonemic, while [ɪ] and [ʊ] are allophonic in Indonesian. Indonesian speakers seem to use their L1 phonemic knowledge in the production and perception of the English vowels, leaving aside the allophonic production patterns. In addition, Lapoliwa included [e] in the Indonesian phoneme inventory but did not include [æ]. This might be the factor that [æ] is perceived and produced as [e] by Indonesian speakers. For example, Indonesian speakers may perceive the words *head* and *had* as [hed]. Thus, we have strong indicators that phonemic factors play an important role in the production and perception of vowels.

To examine the phonetic factor, we focus on the evidence from [æ] and [ɑ], where significant differences are mostly found. First, we observe closely the F1, F2, and F2-F1 of [æ] and [ɑ] produced by Indonesian and American English speakers, and the Indonesian vowels [e] (corresponds to English vowel [æ]) and [o] (corresponds to English vowel [ɑ]) produced by Indonesian native speakers in Indonesian words from Van Zanten's (1989) acoustic study on Indonesian vowels. For the vowel [o] in Indonesian, Van Zanten did not report whether the formant values were taken from allophones [o] (mostly produced in open syllables) or [ɔ] (mostly produced in closed syllables). Since the target word she used is in closed syllable, we assume the production is closer to [ɔ] than [o]. Therefore, we use the phonetic symbol [ɔ] in Table 6. It is important to note that Van Zanten (1989) investigated the allophonic realization of Indonesian vowels produced by Javanese, Sundanese, and Toba Batak speakers. However, the speakers in the current study are from Jakarta, which means we cannot directly compare the allophone [ɔ] produced by our current Indonesian speakers with those in Van Zanten's study.

Since Van Zanten only involved male Indonesian speakers in her study, this current study also only examines the formant structures from the male speakers, which comparison is shown in Table 6.

The Table 6 shows that the English vowel [æ] produced by Indonesian male speakers is closer to the Indonesian vowel [e] than the English vowels [æ] and [e] produced by American male speakers (the bolded parts). Interestingly, the English vowel [ɑ] produced by the advanced male speakers is close to the Indonesian vowel [ɔ]. In contrast, the English vowel [ɑ] produced by the intermediate speakers is close to the English vowel [ɔ] produced by the American speakers. However, none are close to the English vowel [ɑ] produced by the American speakers.

Table 6. A comparison of English [æ] and [ɑ] and Indonesian [e] and [ɔ]

	F1	F2	F2-F1		F1	F2	F2-F1
MA [æ]	756	1668	912	MA [ɑ]	666	1126	460
MI [æ]	663	1771	1108	MI [ɑ]	842	1168	326
MInd [e]*	611	1716	1105	MInd [ɔ]	587	1017	430
MAme [æ]	**588**	**1952**	**1364**	MAme [ɔ]	652	997	345
MAme [e]	**580**	**1799**	**1219**	**MAme [ɑ]**	**768**	**1333**	**565**

*MInd: Indonesian males; MAme: American males

One might think that the acoustic evidence in Table 6 may be because of the factor of orthography. The English vowel [ɑ] is orthographically written as <o> as in <hod>, which may confuse speakers to pronounce it as [ɔ] since orthographic <o> should be pronounced [ɔ] in Indonesian. Since this only occurs among advanced speakers, it is difficult at this point to conclude that the orthography determines our results. Furthermore, if we look at the word <had>, the English [æ] as in <had> should be pronounced [a] by Indonesian speakers as the orthographic <a> is pronounced [a] in Indonesian. Instead, the Indonesian speakers use [e] in producing <had>. Accordingly, the orthographic influence seems to be inconclusive at this point.

We have found many similar patterns in the production of F1 and F2 between the advanced and intermediate speakers. The different exposure to English experienced by the two groups of Indonesian speakers does not significantly affect their English vowel production. This might suggest an emerging unique pattern of English vowels used by Indonesian speakers that differs from American English. In language contact situations, an emerging variety may occur due to contact between varieties. In our case, the contact occurs through years of English training and other ways of exposure to English. The linguistic factors that determine the results show evidence of LI (Indonesian) influence on L2 (English) vowels production across sociolinguistic categories. This exhibits evidence of contact between speakers' L1 and L2.

Within the scope of phonetic and phonological contact, the results of this study may be used as an onset to investigate further contact situations between English, Indonesian, and local languages currently occurring in Indonesia. Since there are around 700 local languages and many emerging varieties of Indonesian, we need to carefully consider the situations of language contact between English, Indonesian, and local languages in Indonesia. We provide a figure that may illustrate the condition.

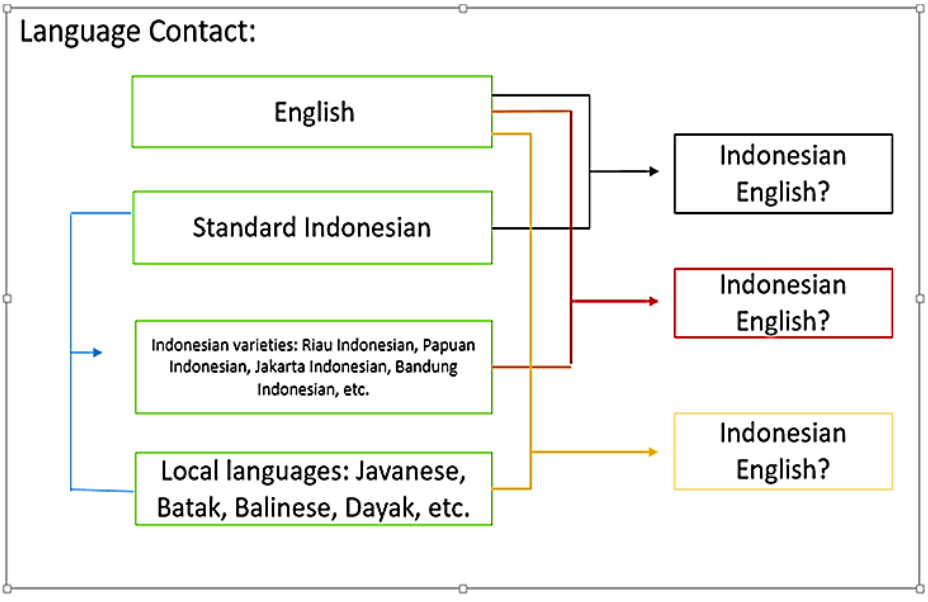

Figure 4. Language contact

We suggest three possible scenarios of the contact between English and varieties spoken in Indonesia. The first one is a contact between English and Standard Indonesian. As commonly known, Standard Indonesian is a formal variety of Indonesian that is mostly spoken in official settings throughout the nation. If English is in contact with Standard Indonesian, we should find a single emerging version of the Indonesian-English variety spoken across archipelagos. If this is the case, our study's acoustic evidence on vowel production should be similar to that of other areas in Indonesia. The second possibility is the contact between English and varieties of Indonesian. Varieties of Indonesian emerged as a result of contact between Standard Indonesian and the local languages of Indonesia. See Ewing (2005), Adisasmito-Smith (2004), and Englebretson (2003), among others, for detailed discussions of varieties of Indonesian. Our current study may fall into the second category, where the speakers are primarily monolingual Indonesians from Jakarta. The third possibility is direct contact between English and local languages. Suppose the second and the third possibilities occur. In that case, every region creates its unique English variety, i.e., no single English variety is spoken in Indonesia. This will significantly contribute to the emerging number of English varieties in the expanding circle.

CONCLUSION

The findings have answered the two research questions proposed in this study. In general, significant differences between Indonesian and American English speakers' vowel production are variably found across vowels. This study does not find the sociolinguistic backgrounds of the speakers, i.e., the gender and English skill levels, to be a determining factor of vowel production. It is most likely that linguistic factors, i.e., phonemic and phonetic factors in the L1 phoneme inventory, condition the use patterns. The most notable examples are the differences found in the production of vowels [æ] and [ɑ] regardless of speakers' gender and the level of English skills.

This evidence shows that Indonesian speakers of English have created a unique characteristic of their English vowel productions. The insignificant differences between the intermediate and advanced speakers may inform us that idiosyncratic use patterns emerge across these two learning stages. If the vowel productions from the advanced speakers are closer to the American English speakers than the intermediate ones, pedagogical factors may determine the production of the vowels. However, this study does not show such a case.

Our current research has shown how acoustic evidence may provide a better understanding of possible language contact situations in language education contexts. Applying a similar model in a larger scale of acoustic investigations in the future may help us to understand which language contact fits into the three possible scenarios above.

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APPENDIX

Table 1. Advanced male speakers

	heed /i/			hid /ɪ/			head /ɛ/			had /æ/			hod /ɑ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
MA-S1	307	2314	2007	867	1586	720	366	2147	1781	576	1795	1219	672	1034	362
MA-S2	412	2164	1752	762	1838	1076	479	2100	1621	656	1746	1090	634	1114	480
MA-S3	300	2449	2149	721	1600	879	464	2019	1555	726	1531	805	677	944	267
MA-S4	351	2160	1809	638	1664	1026	455	2224	1769	635	1732	1097	551	1108	557
MA-S5	430	2480	2050	813	1684	872	508	2142	1634	815	1684	869	711	1159	447
MA-S6	402	2374	1972	709	1730	1021	710	2399	1688	731	1570	839	842	1352	510
MA-S7	402	2236	1834	799	1623	823	426	2081	1656	760	1398	639	652	990	338
MA-S8	290	2427	2137	738	1622	884	543	1856	1314	660	1652	992	587	1304	717
Means	362	2326	1964	756	1668	913	494	2121	1627	695	1638	944	666	1126	460
	hawed /ɔ/			hood /ʊ/			who'd /u/			hud /ʌ/			heard /ɝ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
MA-S1	620	966	346	434	1204	770	354	1054	700	691	1260	569	523	1370	847
MA-S2	566	1099	533	503	1021	518	418	1078	661	711	1393	681	490	1548	1058
MA-S3	692	892	200	389	930	541	355	919	564	770	1218	448	633	1273	639
MA-S4	853	1575	721	352	1146	794	357	947	590	685	1470	785	507	1508	1001
MA-S5	649	1863	1215	357	1210	852	634	1676	1042	834	1347	513	610	1586	976
MA-S6	829	1364	535	461	1620	1159	561	1367	807	716	1337	622	497	1441	943
MA-S7	608	963	355	331	964	633	673	2385	1712	557	1197	640	637	1270	633
MA-S8	549	921	372	532	1204	672	453	1207	754	655	1447	792	716	1204	488
Means	671	1205	535	420	1162	742	475	1329	854	702	1334	631	577	1400	823

Table 2. Advanced intermediate speakers

	heed /i/			hid /ɪ/			head /ɛ/			had /æ/			hod /ɑ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
MI-S1	301	2376	2075	419	2236	1817	764	1995	1231	720	1936	1215	893	1604	711
MI-S2	289	2087	1798	289	1963	1674	531	1851	1319	497	1816	1319	N/A	N/A	N/A
MI-S3	336	2210	1873	385	2130	1745	654	1861	1207	780	1712	932	686	1066	380
MI-S4	347	2323	1976	352	2292	1940	637	1921	1284	614	2047	1433	623	955	332
MI-S5	358	2238	1880	389	2098	1709	686	1845	1160	788	1598	810	686	1229	543
MI-S6	283	2192	1909	342	2005	1662	586	1698	1112	612	1672	1060	709	1123	414
MI-S7	429	1822	1393	433	1934	1501	574	1719	1145	629	1618	989	444	1202	758
Means	335	2178	1843	373	2094	1721	633	1841	1208	663	1771	1108	842	1168	523
	hawed /ɔ/			hood /ʊ/			who'd /u/			hud /ʌ/			heard /ɝ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
MI-S1	741	1093	352	433	1664	1231	415	1321	906	785	1310	525	517	1610	1094
MI-S2	662	1053	391	307	1034	727	317	1119	802	608	1261	653	419	1257	838
MI-S3	493	936	443	348	1100	752	498	1172	674	715	1454	740	597	1305	708
MI-S4	841	1185	345	373	1056	684	394	971	577	767	1431	665	591	1433	841
MI-S5	648	1197	549	415	1198	783	313	1297	984	746	1508	762	612	1321	709
MI-S6	719	1085	366	427	1104	677	N/A	N/A	N/A	619	1422	803	572	1389	817
MI-S7	733	1376	643	421	1267	846	372	1254	883	442	1253	810	717	1433	716
Means	691	1132	441	389	1127	737	385	1189	804	669	1377	708	575	1393	818

N/A: not available due to noise background

Table 3. Advanced female speakers

	heed /i/			hid /ɪ/			head /ɛ/			had /æ/			hod /ɑ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
FA-S1	448	2367	1919	437	2057	1621	748	2102	1354	801	2125	1324	770	1135	366
FA-S2	351	1613	1263	373	2705	2331	850	2077	1227	817	2109	1292	746	1299	553
FA-S3	425	2775	2350	471	2620	2149	962	1964	1002	954	1615	661	738	1165	428
FA-S4	298	2090	1793	441	2507	2066	913	2036	1123	917	1938	1021	612	1053	441
FA-S5	475	2864	2389	442	2353	1911	950	2023	1074	914	2010	1096	686	1126	440
FA-S6	356	2637	2281	653	2159	1505	851	1858	1007	990	1899	909	650	1041	391
FA-S7	288	2975	2687	385	2430	2045	860	2015	1154	901	1771	870	610	1079	469
FA-S8	300	1892	1592	359	2685	2326	781	2402	1621	885	2260	1374	732	1126	394
Means	367	2402	2034	445	2439	1994	864	2060	1195	897	1966	1068	693	1128	435
	hawed /ɔ/			hood /ʊ/			who'd /u/			hud /ʌ/			heard /ɝ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
FI-S1	1027	1237	210	457	1094	637	469	1659	1190	961	1682	721	814	1533	719
FI-S2	850	1267	417	454	1264	810	431	1125	695	572	1689	1118	696	1782	1086
FI-S3	858	1360	502	487	1162	675	486	1168	682	923	1637	713	673	1855	1182
FI-S4	1030	1472	442	388	1131	743	411	1145	734	939	1494	554	625	1603	977
FI-S5	697	1146	449	346	1164	818	411	1271	860	798	1585	787	414	1643	1229
FI-S6	852	1330	479	418	1100	682	388	1072	684	570	1474	903	508	1600	1092
FI-S7	588	1044	457	467	1477	1010	460	1383	923	747	1604	857	623	1580	957
FI-S8	840	1151	311	309	1025	716	420	1074	654	926	1477	550	588	1700	1111
Means	843	1251	408	416	1177	762	434	1237	803	805	1580	775	618	1662	1044

Table 4. Intermediate female speakers

	heed /i/			hid /ɪ/			head /ɛ/			had /æ/			hod /ɑ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
FI-S1	458	2220	1763	460	2455	1995	403	2178	1775	756	1889	1133	746	1324	578
FI-S2	423	2824	2400	364	2868	2504	748	2171	1423	841	2139	1298	742	1239	497
FI-S3	382	1526	1144	317	2396	2079	883	1891	1008	933	1812	879	907	1388	481
FI-S4	658	2079	1421	507	1829	1323	576	1538	962	890	1844	954	437	1105	668
FI-S5	358	2326	1968	425	2339	1914	782	1822	1040	801	1816	1015	537	1090	553
FI-S6	284	1900	1616	359	2485	2125	761	2158	1397	843	1889	1046	588	1174	587
FI-S7	409	2579	2170	459	2475	2016	589	2174	1585	825	2015	1190	705	1492	787
Means	425	2208	1783	413	2407	1994	677	1990	1313	841	1915	1074	666	1259	593
	hawed /ɔ/			hood /ʊ/			who'd /u/			hud /ʌ/			heard /ɝ/		
Speakers	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**	**F1**	**F2**	**F2-F1**
FI-S1	696	1239	543	473	1148	675	516	1199	684	559	1187	628	675	1431	756
FI-S2	858	1351	493	428	1128	700	322	959	637	970	1628	658	619	1208	590
FI-S3	911	1205	294	443	1066	623	380	920	540	942	1430	488	731	1673	942
FI-S4	920	1442	521	502	1148	646	397	935	538	497	1094	597	636	1981	1345
FI-S5	698	1118	421	360	1297	937	341	1340	999	330	1654	1324	517	1927	1410
FI-S6	819	1918	1098	563	1541	979	584	1353	769	904	1684	780	615	1771	1156
FI-S7	748	1445	697	461	1329	868	470	1166	697	831	1737	907	596	1740	1144
Means	807	1388	581	461	1237	775	430	1125	695	719	1488	769	627	1676	1049