Proceedings

The 2nd International Language and Language Teaching Conference

Friday-Saturday, 25-26 September 2015
at Sanata Dharma University, Yogyakarta, Indonesia

English Language Education
Sanata Dharma University
Jl. Affandi, Mrican, Caturunggal
Depok, Sleman
Yogyakarta 55281
(+62)274-513301
PROCEEDINGS

The 2nd International Language and Language Teaching Conference

Editors
Christina Kristiyani, S.Pd., M.Pd.
C. Tutyandari, S.Pd., M.Pd.
Barli Barm, Ph.D.
Yuseva Ariyani Iswandari, S.Pd., M.Ed.
Truly Almendo Pasaribu, S.S., M.A.

Published by
English Language Education Study Program
Sanata Dharma University
Jl. Affandi, Mrican Catur Tunggal Depok Sleman Yogyakarta 55281
Telp: (0274) 513301, 515352 ext. 1131

Preface

The Organizing Committee are delighted to present the proceedings of the Second International Language and Language Teaching Conference (2nd LLTC), whose main theme is English as a Second Language (ESL) Teaching in the 21st Century: Research and Trends. There are 87 full papers in the compilation, covering various topics in language learning-teaching, linguistics and literature, mostly related to the English language. As an academic forum, LLTC is organized by the English Language Education Study Programme of Sanata Dharma University or Program Studi Pendidikan Bahasa Inggris (Prodi PBI) Universitas Sanata Dharma (USD) Yogyakarta. It is expected that all complete papers in the proceedings will enrich our knowledge and broaden our insights into language learning-teaching, linguistics and literature.

Editors
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Acoustic Analysis of English Vowel Formant Frequencies Produced by Indonesian Native Speakers

Rudha Widagsa, M.A.
Universitas PGRI Yogyakarta
widagsa@upy.ac.id

Abstract

Each vowel has a unique structure of formant frequency which indicates the quality of the vowel. Formants have long been known as suited parameters for describing vowel production due to its correlation with traditional articulatory transcription of vowel. This study is intended to describe the characteristic of English vowels production of Indonesian native speakers (L2) based on formant frequencies. The frequencies of first formants (F1) and second formants (F2) of the vowels are analysed to describe the characteristics of English-L2 vowels production and perception. This study involves 10 students in English Department (PBI-UPY) who are native speakers of Indonesian as respondents. The data are analysed through several steps, firstly, data are collected through listening and recording 11 /hVd/ words representing 11 types of English vowels, secondly, the recordings are processed using PRAAT software to figure out the frequencies of F1 and F2 of each vowel (values in Hertz). Finally, both formants are plotted in Bark Scale to ease the process of describing the characteristic of English-L2 vowel productions, simultaneously, the English-L2 F1 and F2 vowels are compared with similar vowels of English native speakers to figure out the differences so that the perception can be concluded. The result shows that the English vowels production of English-L2 tend to be very close to the nearest Indonesian vowels. It is proved by some distinct characteristics of English-L2 vowel productions compared with English-L1. The major differences appear in the production of vowel /i/ in ‘heed’ and /ɪ/ in ‘hid’ where the F1 and F2 frequencies of both vowels are identical (F1 403.5 Hz, F2 2070.4 Hz for /i/ and F1 416.5, F2 2065.5 for /ɪ/), English-L2 Learners are not able to discern the differences, both are pronounced as ‘hid’. Another major distinctive utterance is /ɜ/ in ‘hod’ where F1 597.3 Hz and F2 1348.7 Hz, this vowel is closely perceived as /ɔ/ as in Indonesian ‘tokoh’ and the frequencies are in common with the vowel /ɔ/ as in ‘hoard’ produced English-L1. Furthermore, based on distant differences between F1 and F2, vowel /ɜ/ of English-L2 sounds more “front” instead of “back”.

Keywords: formant, frequencies, vowel, English-L1, L2

Introduction

Teaching English pronunciation in Indonesia could emerge some complicated problems since Indonesia has its own superior national language (bahasa Indonesia or Indonesian) and thousands of local languages which are mother tongues to its people. Mother tongues could interfere target language. As stated by Brown (2007:78) the process of second language (L2) acquisition is more sensitive to the interference of first language (L1). Pronunciation would be a major learning problem, though, because the sound systems of those two languages are quite different (Steinberg, 2001:233). It means that the background of the learners affect the learning of L2 or more accurately in the correlative relationship with the character of contrast with L1 which lays in its system or rules.
Each language has its own rules including how the sounds of language are produced such as vowels and consonants. Human sound systems are very diverse. Consequently, this could trigger intelligibility problem when people from a particular language make an attempt to interact with people from a different language. Contrastive analysis hypothesis proposed by Lado (1957) was also based on the assumption that people who come into contact with a foreign language will find some features of it quite easy and others extremely difficult. Those elements that are similar to their native language will be simple for him, and those elements that are different will be difficult (1957:2).

Mother tongue interference cannot simply be shaken off when speaker of the language gets older. Adults tend to stabilize their language learning at a certain stage. Nemser in Ellis (1994:309) claimed that learner speech was ‘structurally organized’ in the sense that it constituted a system in its own right. This process called fossilization; when a sound in L2 consistently replaced with a sound which is phonetically close to L1. Therefore, the speech production in L2 is different from the similar speech produced by a native speaker. Selinker (1972) aslo noted that relatively few adult learners reach native-speaker competence.

In learning a second language, the level of difficulty experienced by the learner will be directly related to the degree of linguistic difference between L1 and L2. Difficulty will manifest itself in errors; the greater the difficulty, the more frequent the errors (Ellis, 1994:308). Similarly, The difference between English and Indonesian vowel system could be a barrier for Indonesian learners of English who want to speak like native speakers.

The problems encountered by non-native speakers pronouncing or perceiving unfamiliar phonemes in L2 are well-known. Indonesian learners of English frequently have difficulties with English vowel system because there are dissimilarities in articulating vowel sounds of these two sound systems. This research aims at describing English vowel production pronounced by Indonesian native speakers (English-L2). This research uses formant frequencies to find out the characteristic of English vowels produced by English-L2.

In Indonesia, English pronunciation instruction mainly focuses on audio-lingual approach such as minimal pairs drills and articulatory descriptions. Correction and analysis of students’ production generally depends on the teachers’ subjective auditory judgement. In fact, one of the accurate ways to discern the differences would be based on acoustic analysis. Thus, this research attempts to investigate English-L2 production in English pronunciation by examining the acoustic difference between British English vowels and English vowels produced by English-L2.

**English Vowels and the Acoustic Features**

Vowels are syllabic sounds made with free passage of air down the mid-line of the vocal tract, usually with a convex tongue shape, and without friction. They are normally voiced; and they are normally oral (Odgen, 2009:56). Vowels of English vary enormously by variety, many phoneticians have different perspective in defining the number of English vowels. Jones (1957:63) mentioned that there are eight vowels in Southern English, whereas Finegan (1992:40) proposed twelve vowels for Australian English. However, English has at least 11 pure vowel sounds or monophthong.

All voiced sounds including voiced sounds made by human (vowel) have a fundamental frequency and harmonics, some of which are emphasized, depending on the resonant qualities of the vocal tract. These emphasized harmonics are the formants (Ball and Lowry, 2001:67). Speech analysts are usually concerned mainly with the first and the
The second formant (F1 and F2). Each vowel has a formant structure which indicates vowel height, tongue advancement and lip shape. The first formant frequency (F1) is inversely related to vowel height. F1 corresponds to tongue height: close vowels have lower F1 values, and open vowels have higher F1 values while F2 usually reflects the front–back position of the tongue, with front vowels having higher F2 values than back vowels. Lip-rounding is indicated by a lowering of all of the formant values (Ball and Lowry, 2001:67, Ladefoged, 2011:196).

Formants have long been held to be acceptable parameters for describing vowel quality, mainly because F1/F2 plane correlates with traditional articulatory-auditory description of vowels. We can see some of the relationships between traditional articulatory descriptions and formants when we plot the formant frequencies given in Figure 1. The measurement of formant frequencies of English vowels had already been done by J.C. Wells in his M.A. thesis entitled A Study of the Formants of the Pure Vowels of British English in 1962, he measured the formant frequencies of 11 /hVd/ British English vowels. Here is the table of formant frequencies found by Wells.

<table>
<thead>
<tr>
<th>Vowels</th>
<th>F1 (Hz)</th>
<th>F2 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i:</td>
<td>280</td>
<td>2620</td>
</tr>
<tr>
<td>i</td>
<td>360</td>
<td>2220</td>
</tr>
<tr>
<td>e</td>
<td>600</td>
<td>2060</td>
</tr>
<tr>
<td>æ</td>
<td>800</td>
<td>1760</td>
</tr>
<tr>
<td>a</td>
<td>740</td>
<td>1180</td>
</tr>
<tr>
<td>ə</td>
<td>560</td>
<td>920</td>
</tr>
<tr>
<td>ɔ</td>
<td>480</td>
<td>760</td>
</tr>
<tr>
<td>ʊ</td>
<td>380</td>
<td>940</td>
</tr>
<tr>
<td>ʌ</td>
<td>320</td>
<td>760</td>
</tr>
<tr>
<td>ə</td>
<td>760</td>
<td>1320</td>
</tr>
<tr>
<td>ɜ</td>
<td>560</td>
<td>1480</td>
</tr>
</tbody>
</table>

Table 1. Formant frequencies of British English vowels produced by adult male.

Figure 1. Data on British English vowels in Table 1 plotted as a traditional articulatory description (Bark scale)
The table will be used for comparison. The formant frequencies of English-L2 will be compared with the formant frequencies of British English native speakers in order to find out the distinctive features of vowel quality produced by English-L2.

**Indonesian Vowels and The Acoustic Features**

Indonesian phonology indicates six monophthongs for the Indonesian vowel system; /i, u, e, ә, o and a/. There is allophonic variation between realisations in open and closed syllables but there is no agreement on the extent to which allophonic variation takes place (Halim, 1974:169). Indonesian vowels are pronounced differently in many regions in this country. However, these differences are only accent. To illustrate this, in South Sumatra, it is found that each of the six vowels, except /a/ and /ә/, is phonetically represented by two allophonic variants; according to Dardjowidjojo (1967) allophonic variation occurs in all monophthongs except /ә/. Subardi in Marsono (2008:37) stated that there are ten vowels due to Javanese interference.

Looking at the various statements, the number of Indonesian vowels vary according to its experts. Amongst the Indonesian monophthongs very few differences were acoustically observed. This has been a long dispute among the Indonesian linguists. Here, the Indonesian monophtongs are presented in a table based on some experts.

<table>
<thead>
<tr>
<th>Words</th>
<th>Dardjowidjojo/Soebardi</th>
<th>Halim/Lapoliwa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ikan, gila, kita, bila</td>
<td>i</td>
<td>i</td>
</tr>
<tr>
<td>Pinggir, kerikil, adik</td>
<td>2</td>
<td>1 Realization i</td>
</tr>
<tr>
<td>Ekor, enak, eja</td>
<td>3</td>
<td>e</td>
</tr>
<tr>
<td>Nenek, leher, geleng</td>
<td>4</td>
<td>ɛ Realization e</td>
</tr>
<tr>
<td>Bata, kata, anak, ada</td>
<td>5</td>
<td>ɑ a</td>
</tr>
<tr>
<td>Elang, selu, reda, belah</td>
<td>6</td>
<td>ɔ ә</td>
</tr>
<tr>
<td>Kota, pola, roda</td>
<td>7</td>
<td>o o</td>
</tr>
<tr>
<td>Otot, tokoh, dorong</td>
<td>8</td>
<td>ɔ Realization o</td>
</tr>
<tr>
<td>Ukir, paku, bulan, utara</td>
<td>9</td>
<td>u u</td>
</tr>
<tr>
<td>Ukur, urus, turun</td>
<td>10</td>
<td>U ʊ u</td>
</tr>
</tbody>
</table>

Table 2. The classification of Indonesian vowels

Acoustic measurements on Indonesian have not been reported by Indonesian linguists. There are many interesting theoretical problems connected with the vowel distinction. Here is the acoustic measurement of Indonesian vowels.

<table>
<thead>
<tr>
<th>WORD</th>
<th>SYMBOL</th>
<th>FEMALE</th>
<th>MALE</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F1</td>
<td>F2</td>
<td>F1</td>
</tr>
<tr>
<td>bila</td>
<td>i</td>
<td>303</td>
<td>2142</td>
<td>327</td>
</tr>
<tr>
<td>enak</td>
<td>e</td>
<td>814</td>
<td>2276</td>
<td>612</td>
</tr>
<tr>
<td>nenek</td>
<td>ɛ</td>
<td>744</td>
<td>2110</td>
<td>564</td>
</tr>
<tr>
<td>belah</td>
<td>ә</td>
<td>483</td>
<td>1721</td>
<td>436</td>
</tr>
<tr>
<td>bola</td>
<td>o</td>
<td>448</td>
<td>1073</td>
<td>549</td>
</tr>
<tr>
<td>tokoh</td>
<td>ɔ</td>
<td>575</td>
<td>1220</td>
<td>601</td>
</tr>
<tr>
<td>bulan</td>
<td>u</td>
<td>428</td>
<td>1136</td>
<td>565</td>
</tr>
<tr>
<td>ukur</td>
<td>o</td>
<td>428</td>
<td>1136</td>
<td>565</td>
</tr>
<tr>
<td>bata</td>
<td>a</td>
<td>805</td>
<td>1730</td>
<td>589</td>
</tr>
</tbody>
</table>

Table 3. Formant frequencies of adult speakers
The difference between English and Indonesian becomes the main factor that Indonesian native speakers generally find it difficult to produce native-like sounds particularly in English vowels. Looking more closely at this problem, Dardjowidjojo (2009:49) compared English vowels with Indonesian vowels, he found that there are some vowels in English which could not be found in Indonesian, he even made a clear statement that Indonesian language does not have consistency in pronunciation. The different pronunciation in pronouncing /e/ and /ә/ in ‘pegawai’ is only allophonic, whereas in English, whether /e/ or /ә/ is a different phoneme in any kind English word.

In this research, what we need to know is in what ways vowels differ from each other or more accurately to discover the vowel quality. The first matter to consider in defining the vowel quality is the shape of the lips and the position of the tongue. Ladefoged (2010:20) made a brief summary about this gesture, he described in terms of three factors: (1) the height of the body of the tongue; (2) the front-back position of the tongue; and (3) the degree of lip rounding. Accordingly, vowels are classified into front and back vowels, high-low vowel, rounded and unrounded. He also stated that one important measurement in vowel is by using formant frequencies.

Research Method
Participants

This research involves ten participants who are native speakers of bahasa Indonesia (Indonesian). Five participants are male and the other five are female. They study English in English Department of Universitas PGRI Yogyakarta (PBI-UPY) and all participants have been studying English for at least 3 years. The participants had known that the recording of their voice will be used for educational and experimental purposes.

Material

In this section, each participant was given a printed material containing a set of 11 /hVd/ words (heed, hid, head, had, hard, hod, hoard, hood, who’d, hudd, herd). After participants received the material then they were asked to listen to it in order to get better understanding and comprehension about the words. The listening materials taken from
Immediately after listening section, they were instructed to pronounce the words, simultaneously, the researcher started to record them.

**Recording Procedure**

The recordings were made with Compaq CQ40 notebook and an attached headset-microphone placed at the distance of about 10 cm from the participants’ mouth. The participants were recorded one by one in order to ease the analysis. This process took place in language laboratory of Universitas PGRI yogyakarta.

**Analysis**

The PRAAT software was applied to analyse the recordings, including measuring the formants of each vowel. The formant frequencies then plotted using spreadsheet in Microsoft Excel to serve the numerical data into chart which is similar to the traditional articulatory description of vowels.

**Findings and Discussion**

The formant frequencies of British English vowels produced by Indonesian native speakers are served in following tables and figures.

### Table 4. English-L2 F1 frequencies (value in hertz)

<table>
<thead>
<tr>
<th>VOWEL</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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| i    | 1949| 1935| 2432| 2.009| 2118| 2537| 1510| 1326| 2426| 2462| 2070,4 |
| i    | 1888| 1933| 2259| 1.949| 2093| 2311| 2095| 1574| 2219| 2334| 2065,5 |
| e    | 1769| 1626| 2007| 1.804| 1917| 2160| 1758| 1144| 1815| 2149| 1814,9 |
| æ    | 1725| 1464| 2036| 1.770| 1854| 2182| 2138| 1793| 1573| 2112| 1864,7 |
| a    | 1231| 1315| 1361| 1409| 1262| 1442| 1629| 1431| 1423| 1581| 1408,4 |
| o    | 1211| 1290| 1373| 1118| 1293| 1265| 1569| 1390| 1290| 1688| 1348,7 |
| ə    | 897| 1187| 1279| 1115| 1041| 1266| 1400| 1062| 1137| 1206| 1159    |
| ɔ    | 1183| 1710| 1283| 1074| 1444| 1604| 1279| 1406| 1211| 1860| 1405,4 |
| u    | 1005| 1703| 1109| 1099| 1287| 1015| 1379| 1418| 1327| 1425| 1276,7 |
| ʌ    | 1374| 1456| 1419| 1802| 1515| 1761| 1041| 1285| 1918| 1822| 1539,3 |
| ɔ    | 1222| 1438| 1772| 1466| 1353| 1621| 1861| 1426| 1602| 1488| 1524,9 |

### Table 5. English-L2 F2 frequencies (value in hertz)
Table 4, 5 and figure 3 illustrate that there are some distinct characteristics of English-L2 vowel productions compared with English-L1. It can clearly be noticed that English-L2 vowel production is more tightly-clustered than that for Native speakers of British English. English-L2 tend to produce approximations to British English vowel when there is an equivalent vowel in Indonesian. It can be seen in figure 3 and 4 when the English vowels /ʌ/ and /ɑ/ have a closely equivalent in Indonesian /a/, the F1 and F2 frequencies of English-L2 are close to each other.

Vowel /ə/ and /e/ of English-L2 seem to be very close, it is seen from the average frequencies of F1 and F2 (F1 683, F2 1814,9 for /e/ and F1 662,7, F2 1864,7 for /ə/). English vowel /e/ is half-open front whereas /ə/ is an open front vowel and it is higher than /e/. However, vowel /e/ of English-L2 is apparently pronounced as open-front vowel and it is lower than /ə/.

The major differences appear in the production of vowel /i/ in ‘heed’ and /ɪ/ in ‘hid’ where the F1 and F2 frequencies of both vowels are identical (F1 403.5 Hz, F2
2070.4 Hz for /i/ and F1 416.5, F2 2065.5 for /u/), English-L2 Learners are not able to discern the differences, both are pronounced as ‘hid’. Another main distinctive utterances is /b/ in ‘hod’ where F1 597.3 Hz and F2 1348.7 Hz, this vowel is closely perceived as /ɔ/ as in Indonesian ‘tokoh’ and the frequencies are in common with the vowel /ɔ/ as in ‘hoard’ produced English-L1. Furthermore, based on distant differences between F1 and F2, vowel /u/ of English-L2 sounds more “front” instead of “back”.

However, English-L2 produce a good impression of English vowel /ɛ/, the formant frequencies of the vowel are in common with the English-L1 when producing the same vowel. It can also be seen in figure 3 that both English-L2 and English-L1 plotted charts of vowel position are close to each other.

Conclusion and Future Work

In conclusion, this research shows that English vowel production of English-L2 generally perceive English vowels which are different from English-L1. My analysis is that English-L2 are strongly influenced by their mother tongues. It is proved by the plotted frequencies which are more tightly-clustered. This pattern is similar to the plotted chart of Indonesian vowel produced by Indonesian-L1. From the eleven British English vowels, there is only one vowel /ɜ/ which is pronounced correctly and the formant frequencies are quite similar to British English native speakers.

This research is only a preliminary study which still requires further research related to acoustic features of English vowels produced by non-native speakers particularly Indonesian speakers. In this paper, I only report an average data of male and female respondents. Gender is known to be an important factor of phonetic variation. Gender and aged-related would also be interesting topic for future research. Hopefully, this research would be worthwhile for language teaching in Indonesia.

References
