

AN ANALYSIS OF FORMANT FREQUENCY OF INDONESIA VOWELS BY BATAKNESE AND JAVANESE SPEAKERS

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ABSTRACT

This study is aimed at analyzing the comparison between the measurement of frequency and formant frequency values of Bataknese and Javanese male and female in producing the vowels of the Indonesian language: /i/, /e/, /ə/, /a/, /u/, and /o/. The subjects of this study are two Indonesian sentences that consist of all of the vowels. The respondents are six Bataknese males and females from Medan and six Javanese males and females from Surabaya. In this study, the researcher used a qualitative method by presenting the numerical value of frequency and formant and the description of the findings. The result of this study showed that both Javanese females and males have a higher frequency and formant frequency in producing the vowels of the Indonesian language than Bataknese. Even though Bataknese speakers sound like they have a higher intonation, the fact is that the frequency of Javanese speakers is higher. Furthermore, female speakers produce each word and vowel with a higher value than male speakers.

Keywords: Phonetics Acoustic, Vowel, Frequency, Formant

INTRODUCTION

Numerous ethnic groups inhabit the several islands that make up Indonesia. Javanese and Bataknese are two of them. When diverse ethnic groups from various places come together, they may need to converse in Indonesian, which serves as a uniting language. Sometimes these differences won't work well because of other factors like intonation and accent.

One major problem that arises between Bataknese and Javanese individuals is that Javanese speakers speak at a lower volume than Bataknese speakers do. This

could have an impact on the miscommunication that occurs during speech between the two speakers. Furthermore, speaking with Bataknese speakers can cause pain for Javanese speakers.

Observing the communication between Bataknese and Javanese in Medan, North Sumatera, Afifa, Singarimbu, and Nasution (2002) found that in communicating, Bataknese seemed angry because their voices were too loud and fast. While Javanese people talked lower and slower.

At some point, the formant frequency of the Javanese language is higher than that of Bataknese. Javanese pronounced the words louder in vowels /i/, /e/, /ə/, /a/, /u/, but the speaker was getting lower in the word consist of vowel /o/ (Hasibuan, Siregar, Syarfina, Rangkuti, 2023).

The results of the earlier study also indicated that the male and female sounds differ significantly from one another. Males often have a lower sound frequency than females. This study, which builds on the previous one, aims to examine how frequently speakers of Java and Bataknese generate Indonesian at the same time, in order to examine each formant of the vowels that each speaker produces. But it will be interesting to observe the differences between Javanese and Bataknese male and female sounds, particularly in terms of frequency and formant frequency.

LITERATUR REVIEW

Phonetics is the study of how the sound of a language is produced. It is a study of the sound wave caused by the vibration of the source of the sound. As we already know, there are three branches of phonetics. Pronunciation issues, sound tracts, vowel syllables, tone and intonation, sound rhythm, and consonants and vowels are among the other topics covered in phonetics. They are acoustic phonetics, auditory phonetics, and articulatory phonetics. Otherwise, this research is focusing on acoustic phonetics in the Indonesian language.

Phonetic acoustics is the study of analyzing sound propagation with some kind of electronics by using physics. (Akhyaruddin, Harahap, and Yusra, 2020, p. 15). Sound properties in acoustic phonetics are frequency, intensity, time, and formant. This study focuses on the frequency and formant of the vowel produced by some Bataknese and Javanese women and men.

Frequency is the vibration of an individual sound produced by the vocal cord vibration in a unit of time calculated by Hertz (Hz). The higher the vibration is produced, the higher the frequency of sound can be analyzed. The lower vibration will show a lower frequency either way. Frequency is the vibration of an individual sound produced by the vocal cord vibration in a unit of time calculated by Hertz (Hz). The thickness and tension of the vocal cords will have an impact on the realization of their acoustic characteristics. The thinner it is, the higher frequency

could be analyzed. Otherwise, the thicker the sound, the lower the frequency will be.

The resonance of sound is called the formant. Formant is the peak-frequency energy in the sound spectrum produced by humans or other sound sources. The first formant and the second formant are quite interesting to talk about the vocal quality in the vocal space. The comparison between the vocal qualities can be clearly determined from both formants. Acoustically, the vocal formants can be heard as a combination of notes. (Lapoliwa, 1988). The vowels correspond to the height of the vowel scale. The high formants are generally affected by the shape of the mouth and how the sound is produced. As the shape of the mouth becomes rounder, the formant will get lower.

As the vowel tends to be the front vowel, the F2 tends to be higher. Otherwise, the back vowels tend to show the lower F2. Even so, Lapoliwa also mentioned that as the sound gets louder, the high formants tend to decrease. This means that the front and back vowels can show different values in different sounds. Vowels are language sounds in the process of formation, in which the air currents coming from the lungs are completely unobstructed by the speech organs. The vowels in the Indonesian language are /i/, /e/, /ə/, /a/, /u/, and /o/.

The previous study showed that there is a significant difference between the male and female sounds. The sound frequency of males tends to be lower than that of females. It will be quite interesting to see the different characteristics of the male and female sounds of Batakese and Javanese, especially in the frequency and the formant frequency.

RESEARCH METHOD

This research used a qualitative method. Qualitative research is done to explore and explain narratively what is shown in quantitative data. The participants of this research are three Batakese males and three Batakese females who live in North Sumatera. And they are Javanese males and females from Surabaya. All of the participants chosen are twenty to thirty years old.

The instrument data for this research was software such as the PRAAT application. PRAAT is used to analyze the frequency of the sound produced by the participants and the first formant (F1) and the second formant (F2) of the Indonesian vowels between Batakese and Javanese. Although the PRAAT application is still a computer-based tool and is not yet available for mobile devices, it does offer the ability to capture speech directly using an installed device. Following the acquisition of the sound recording, PRAAT is able to extract and synthesize more detailed portions of the sound by breaking the sound down into a comprehensive spectrogram.

Technically, this research was done by recording the sounds of speakers saying some sentences given by the researcher. The sentences consist of the six vowels of the Indonesian language (/a/,/i/,/u/,/e/,/o/,/ə/). Next, the researcher converted the recording from OGG into WAV since the WAV file is the only one being detected by PRAAT.

Table 1. Word List

Indonesia		
Vowels	Words	English
/a/	Anak	Kid
/i/	Kecil	Small
/u/	Lima	Five
/e/	Ekor	Tail
/o/	Udara	Air
/ə/	Boros	Extravagant

The first step done by the researcher was recording the speakers by WhatsApp application. Since the file was in OGG form, the researcher converted the file into WAV so it could be input into PRAAT software. Next, the researcher was analyzing the frequency of each word pronounced by the speakers to see the comparison between Bataknese and Javanese people. The researcher gave the speaker two sentences that consist of six vowels: *Anak kecil itu sedang melihat lima ekor burung terbang di udara*. (The little kid is looking at a flying bird in the air) and *Mereka boros sekali* (They are so wasteful).

After all of the frequencies of the words were analyzed, the researcher analyzed the formant frequency of each vowel. F1 and F2 were analyzed since the two formants were considered to show appropriate quality of vowels. The high vowel tone is related to F1, and the dimensional representation of the front or back vowel tone is shown in F2. (Jacobi, 2009; Watt & Tillotson, 2001).

FINDING

The PRAAT application was used to identify the frequency value of Indonesian words pronounced by six Bataknese and six Javanese. The recording in the form of WAV was transferred into PRAAT to get the value of each word. The six vowels (a, i, u, e, o, and ə) are pronounced into the words anak, kecil, lima, ekor, udara, and boros.

The researcher used text grid analysis in the PRAAT application to see the frequency values of each word. The participants were given two sentences in Indonesian, which consist of six vowels.

Tabel 2. Pitch Analysis for Bataknese Male

	Words	Pitch
Bataknese (1)	Anak	92 Hz
	kecil	106 Hz
	lima	108 Hz
	udara	88.95 Hz
	boros	105 Hz
	ekor	103.8 Hz
Bataknese (2)	Anak	108 Hz
	kecil	107 Hz
	lima	104.6 Hz
	udara	90.76 Hz
	boros	97.44 Hz
	ekor	101.5 Hz
Bataknese (3)	Anak	108 Hz
	kecil	106.9 Hz
	lima	105 Hz
	udara	102.7 Hz
	boros	90.63 Hz
	ekor	96.82 Hz

Table 3. Pitch Analysis for Javanese Male

Male Speaker	Words	Pitch
Javanese (1)	Anak	111.4 Hz
	kecil	111.9 Hz
	lima	116.4 Hz
	udara	87.75 Hz
	boros	94.85 Hz
	ekor	117 Hz
Javanese (2)	Anak	147.5 Hz
	Kecil	156.3 Hz
	Lima	154 Hz
	Ekor	158.6 Hz
	Udara	105.8 Hz
	Boros	104.4 Hz

Javanese (3)	Anak	153.5 Hz
	Kecil	153.4 Hz
	Lima	133.3 Hz
	Ekor	135.7 Hz
	Udara	116.2 Hz
	Boros	140.6 Hz

From the table above, it can be seen that Javanese males speak at a higher pitch. Both Bataknese and Javanese speakers tend to speak in lower pitch when there are /u/ and /o/ vowels. However, Javanese speak louder and clearer than Bataknese.

Table 4. Pitch Analysis for Bataknese Female

Female Speaker	Words	Pitch
Bataknese (1)	Anak	202 Hz
	Kecil	211 Hz
	Lima	193.2 Hz
	Udara	176 Hz
	Boros	205.9 Hz
	Ekor	190 Hz
Bataknese (2)	Anak	257.7 Hz
	Kecil	254.5 Hz
	Lima	233 Hz
	Udara	186.2 Hz
	Boros	216.2 Hz
	Ekor	220.3 HZ
Bataknese (3)	Anak	208.6 Hz
	Kecil	214.1 Hz
	Lima	190.3 Hz
	Udara	169.2 Hz
	Boros	218.5 Hz
	Ekor	188.6 Hz

Table 5. Pitch Analysis for Javanese Female

Female Speaker	Words	Pitch
Javanese (1)	Anak	240.6 Hz
	Kecil	250.2 Hz
	Lima	234.9 Hz
	Ekor	222.7 Hz

	Udara	183.4 Hz
	Boros	208.2 Hz
	Anak	207.4 Hz
Javanese (2)	Kecil	214.2 Hz
	Lima	211.3 Hz
	Ekor	210.8 Hz
	Udara	190.2 Hz
	Boros	193.5 Hz
	Anak	229.5 Hz
Javanese (3)	Kecil	237.6 Hz
	Lima	193.1 Hz
	Ekor	212.8 Hz
	Udara	189.8 Hz
	Boros	204.1 Hz

Based on the findings, Javanese females also speak at a higher pitch than Bataknese females. The frequency of Javanese is 240.6 Hz in the word “anak” and it is 202 Hz in Bataknese. This also happens in the word “kecil”. The frequency of the Javanese third speaker is 237,6 Hz and 214,1 Hz in Bataknese. As can be seen in male findings, the results show similarities in the words “udara” and “boros” with /u/ and /o/ vowels. The frequency of all of the participants pronunciation tends to be lower in the words consisting of /u/ and /o/ vowels.

As we can see from all of the analyses of the frequency value between male and female in Javanese and Bataknese, the pitch of Javanese people tends to be higher than that of Bataknese people. It can be shown by the fact that Javanese speak louder in every word given by the researcher.

Above all, female speakers still speak at a higher frequency than male speakers in both Javanese and Bataknese. As all speakers pronounced “udara” and “boros” at a lower frequency, the female still pronounced the words louder than the male.

Formant Analysis of Bataknese and Javanese Male

In pronouncing each vowel of the Indonesian language, the Javanese male made it louder than the Javanese male. There is a significant difference between the first formant and the second formant in both speakers. The formant frequency of Indonesian vowels in Javanese speakers tends to be higher in some vowels, such as /a/, /u/, /e/, and /o/. However, Bataknese pronounced vowel /i/ and /ə/ higher than Javanese, but only in a small comparison.

Table 6. Formant Frequency of Batakese Male

Vowels	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
/a/	591	1183	5,22	8,59
/i/	358	2049	3,4	11,65
/u/	372	1242	3,52	8,85
/e/	464	1748	4,27	10,74
/o/	485	941	4,43	7,39
/ə/	403	1680	3,78	10,52

Table 7. Formant Frequency of Javanese Male

	Ave. F1 Hz	Ave. F2 Hz	Ave. F1 (Bark)	Ave. F2 (Bark)
/a/	804	1531	6,62	10
/i/	345	1640	3,28	10,38
/u/	347	1388	3,3	9,45
/e/	618	1983	5,41	11,46
/o/	437	1249	4,05	8,88
/ə/	338	1646	3,22	10,4

The F2 of /i/ in Batakese is 2049 Hz, while it is 1640 Hz in Javanese. And the F2 of /ə/ in Batakese is 1680 Hz, while it is 1646 in Javanese. The comparison is only for 40 Hz.

From the data, it is also shown that in both Batakese and Javanese, the vowels /i/ and /e/ are higher than other vowels, as it is mentioned in the theory that the high formants are generally affected by the shape of the mouth and how the sound is produced. As the shape of the mouth becomes rounder, the formant will get lower.

Formant Analysis of Batakese and Javanese Female

Table 8. Formant Frequency of Javanese Female

	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
/a/	856	1432	6,92	9,63
/i/	383	2289	3,61	12,29
/u/	660	1604	5,7	10,26
/e/	575	2274	5,11	12,25
/o/	547	1279	4,91	9,01
/ə/	444	1831	4,11	11,01

Table 9. Formant Frequency of Bataknesse Female

Vowels	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
/a/	984	1846	7,62	11,05
/i/	442	2700	4,09	13,26
/u/	357	1242	3,39	8,85
/e/	751	2421	6,29	12,62
/o/	530	1184	4,78	8,59
/ə/	507	1501	4,6	9,89

From the data above, it can be clearly identified that the formant frequencies of Bataknesse females in vowels /a/, /i/, and /e/ are higher than Javanese. The F2 of Bataknesse in the /a/ vowel is 1846 Hz, and it is 1432 Hz in Javanese. The comparison is quite bigger than that of male speakers. The F2 of /i/ in Bataknesse is 2700 Hz and 2289 Hz in Javanese. Furthermore, the F2 of Bataknesse in /e/ is 2421 Hz, while it is 2274 Hz in Javanese. This happened because of the duration taken by each word. Javanese females pronounce the vowel faster than the other speakers.

DISCUSSION

The Bataknesse and Javanese people of Indonesia have distinct dialects, intonations, and voice frequencies when conversing. greater vibration levels allow for greater sound frequencies to be examined. In any case, the lower vibration will display a lower frequency. The vibration of a single sound made by the vocal cords in a time interval measured in Hertz (Hz) is known as frequency. The manifestation of the voice chords' acoustic features will depend on their thickness and tension. The higher frequency that might be examined, the thinner it is. Otherwise, the frequency will decrease with increasing sound thickness.

According to Afifa, Singarimbu, and Nasution's research (2022), despite the fact that Bataknesse talk with a higher intonation, it can be challenging for the Batak ethnic group to interact and communicate with the Javanese tribe. One participant claimed that when Javanese people talk, it even seems like they are fighting. The results demonstrated that speakers of Javanese have a higher frequency of creating Indonesian. Both male and female speakers experience this.

These comparison results between speakers of Javanese and Bataknesse demonstrate that Bataknesse speakers do not form Indonesian vowels due to their strong intonation. Conversely, even though their intonation is lower than that of Bataknesse, Javanese speakers may pronounce Indonesian vowels more frequently.

This work advances our understanding of the phonetic features of the language by offering a thorough investigation of the acoustic characteristics of

Indonesian vowels.

Researchers and linguists interested in the phonetic systems of the Indonesian languages may find this useful. Furthermore, the study's acoustic measurements can be applied to the development of speech technology applications, like automatic speech recognition (ASR) systems, which need precise representations of Indonesian vowels in order to function better.

The Javanese language eventually has a higher formant frequency than Bataknese. Vowels like /i/, /e/, /ə/, /a/, and /u/ were spoken more loudly in Javanese words, however the speaker lowered their voice when speaking phrases that had the vowel /o/ (Hasibuan, Siregar, Syarfina, Rangkuti, 2023). The results above demonstrate that speakers of Javanese and Bataknese created Indonesian vowels that are higher in the vowel /a/ and tend to be lower in the vowel /o/. The first formant (F1) and the second formant (F2) show this.

CONCLUSION

The result of this study showed that the frequency and formant frequency of Javanese speakers, both female and male, are higher than those of Bataknese speakers. The highest formant frequency produced by all the speakers is the vowel /a/, and the lowest formant frequency is produced by the vowel /o/. There are only small comparisons between Javanese and Bataknese males in producing each vowel. But the comparison became more significant between Javanese and Bataknese females. On the other hand, the result showed that female speakers spoke at a higher frequency than male speakers, which also happens at a higher frequency. The female speaker produced the vowels (/a/, /i/, /u/, /e/, /o/, /ə/) higher in every word. The results of this study are important for phonology, particularly dialectology, since they serve in the documentation and preservation of the languages spoken by Javanese and Bataknese people. Nevertheless, the scope of this study was restricted to studying the vowels in Javanese and Batak languages.

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