
Comparison of the Vowel Formant Measurements in Karo and Simalungun Language

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Abstract

The study aimed to discuss the vowel formants of the Karo and Simalungun languages. This study used qualitative methods with the data described as numeric tables. In collecting data, the researchers involved three native speakers from both sides. The native speakers were three females from the Karo and Simalungun areas between 17 and 45 years old. The data was obtained by recording in a convenient location, and the syllables were naturally uttered. This study found that the Karo language had six vowels, such as /a/, /i/, /u/, /e/, /ə/, and /ɔ/, and was similar to the Simalungun language except for the vowel /ə/. To compare the vowels, the researchers placed similar vowels to compare the form between both languages. The syllables' positions, /a/, /i/, /u/, and /e/, were put at the beginning to make the syllables manageable, and the syllable /ɔ/ was placed at the end of the word. This study used the software Praat to measure the vowel formants. Afterward, the data were calculated using the F1 and F2 from the spectrogram in the Praat software. The results showed that the highest formants in vowels /a/, /i/, /u/, and /e/ came from KL, and the highest vowel /ɔ/ came from SL.

Keywords: Vowel, formant measurements, Praat analysis

1. INTRODUCTION

Language is a tool for humans to deliver information or ideas to another human being. It is simply a communication system. Using

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Br Sembiring, F. E. D. R., Tengku Syarfina, & Sekar Azzahra. (2024). Comparison of the Vowel Formant Measurements in Karo and Simalungun Language. *JADEs Journal of Academia in English Education*, 5(1), 105-118. Submitted May 20, 2024.

Accepted Jun 4, 2024; Published June 30, 2024

DOI: <https://doi.org/10.32505/jades.v5i1.8745>



language can make it more effective for a human to live their life in this world. Language is not something that forms gratuitously in our lives. Meanwhile, language is structured from the smallest to the most extensive composition; it starts with a phoneme, morpheme, phrase, and sentence and ends with a text. The structure that is shown in language makes the researchers realize that language has a uniqueness. Because the researchers acknowledge that no two languages are exactly alike

There are some ways to express language, such as spoken, written, and sign language. The function of language that is extraordinarily useful for humans is to express and intertwine emotion and thought with the listener. The relationship cannot only be intertwined but intonation or gesture can also strengthen the bond with the listener and help the listener understand the speech. Spoken language is a way for humans to speak or say the language using sound.

There are many captivating branches in linguistics; however, a branch that deepens in this discussion about sound is called Phonology and Phonetics. Phonology is microlinguistics that focuses on the sound structure and how the sound is arranged; therefore, it can represent the meaning. Meanwhile, phonetics as a macrolinguistics examines most of the production of sound (Syarfina, 2009, p. 23). It is also divided into three branches such as articulatory phonetics, which describes more about how the sound is being produced and articulated, the second one is acoustic phonetics, in which on this branch the sound is studied physically using a measurement machine called a spectrograph; and auditory phonetics, which explores about how the listener perceives the sound (Skandera & Burleigh, 2005, p. 3). In discussing phonetics, it has commonly directed us to talk about speech sounds and speech organs like lips, teeth, tongue,

and so on. The reason is that phonetics shows us how sound is produced and transmitted until our ears perceive the sound.

Acoustic phonetics can be seen as a study that deals with part of speech as though it is a sound wave in the air (Yule, 2010, p. 26). It commonly happens when the speech sound is transmitted into the other person's ears. Speech sound is a unit of speech that is made of the result of the tongue and lips movements. The basic source of how speech sound is produced is the respiratory system, which pushes the air out of the lungs. Basically, there are two types of sound produced, such as voiced which defined as the sound produced because of the vibrating of vocal folds (when the air from the lungs goes up to the windpipe and into the larynx), and the other one is voiceless, the opposite of voiced which the vocal folds are apart (Ladefoged, 2015, p. 4). Therefore, this research is much more narrowing the study to the type of sound being represented. Technically, a vowel is a sound that does not obstruct airflow from the larynx to the lips (Roach, 1991, p. 10). Typically, a vowel is a voiced sound. It can also be defined as a sound that occurs at the syllables' centres. It involves less narrowing than the consonant and can be classified in terms of the vowel space, representing the four-sided or quadrilateral chart. The quadrilateral chart functionally facilitates the reader to understand the vowel sounds easily. Vowel space uses three dimensions in describing vowels: vowel height (vertical dimension), frontness and backness (horizontal dimension), and rounding (lip posture) (Ogden, 2009, p. 59).

In acoustic phonetics, there is a representation of the acoustic itself. There are two specific kinds of acoustic representations: waveforms (a kind of graph representing time and amplitude) and spectrograms (pictures of speech sound or voiceprints). The spectrogram is much more

complex than waveforms since it shows the frequency. Frequency determines the higher and lower pitch sound. In other words, frequency is defined as a vibration of a sound that expresses the number of cycles in repetition waveform per second (Syarfina, 2009, p. 32). A frequency measured in Hertz (Hz). Fundamental frequency (f_0) is a complete cycle of the vocal folds in one second. One of the important visual properties in the spectrogram is namely formants. It is known as the darker horizontal band that runs through the spectrogram. In fact, there are many formants in spectrogram; thus, usually, only the first until three are researched inquisitively (Ogden, 2009, p. 33). Concisely, formants are a natural resonance and are crucial in discerning different sounds. The formant frequency also determines the vowel quality (Rogers, 2013, p. 143-144).

One of the diverse countries, Indonesia, is well known as a country that is prosperous and unique in culture and also language. This research will discuss two languages from Indonesia, specifically from Sumatra. It is known as the Karo language (KL) and Simalungun language (SL). Both languages are cognate in the Batakese family. Woolams (1996) states the difference in the territory between both tribes, which Karo includes on the Northern side, and Simalungun is more closely related to the Southern group, indeed making the speech sound of these languages different from one another.

The research focuses on finding the difference in formant value in KL and SL vowels. In the Karo language, six vowels occurred, such as /a/, /i/, /u/, /e/, /ə/, and /ɔ/ (Tarigan, 2018, p. 49). Otherwise, the Simalungun language has five vowels, such as /a/, /i/, /u/, /e/, and /ɔ/ (Siregar, 2001, p. 29). This research investigates similar vowels in both languages, giving out the distinction in formant value. The researcher is also interested in analyzing the first formant, which refers to vowel height

(F1), and the second formant, which relates to frontness and backness vowel (F2) (Ogden, 2009, p. 62-63). In this research, Praat is a worthwhile application for measuring the value of formant in vowel sounds. Praat is an application programmed to record the sound and inspect the characteristics of the sound both visually and auditorily (Benus, 2021, p. 45). Many features on the application Praat can be useful for analyzing sounds, such as spectrogram, pitch, intensity, pulses, and formants. This research concentrates more on comparing the value of the formants of both languages, Karo and Simalungun.

2. LITERATURE REVIEW

Discussion about vowel or formant analyses is a common trend if it is tangent with acoustic phonetics. The vowel itself is an important part of the language. Because the researchers believe that almost every word has at least one vowel. After doing some research, the researcher finds some related studies that are important to amplify the research.

The first related study is an article from Nasution and Syarfina (2023) explaining vowel formant measurements, which use Praat to measure words' highest and lowest formants. This study conducts on how the pitch of a male, female, and also teenager in sounding a sentence can differ. Using the content analysis approach, one of the parts of descriptive qualitative, the writer finds that the result when the respondents pronounce the exact words is clearly different from one another. After segmenting the sentence until obtaining the word's vowel, the writer starts to analyze the F1, F2, and F3 to get the value of the formants. The writer states that female respondents are dominantly higher than males and teenagers, and the lowest in sounding formant is teenagers. It distinctly shows the researcher how the software Praat

precisely measures the results of the formant value in evaluating sound, giving relevant information about how acoustic phonetics works.

Another study that examines the formant vowels was conducted by Bradley (2018), which compared the acoustic vowel spaces in speech and song. This study also points out where the two mediums used were and how the respondents pronounced the sentences in different ways (speech and singing). The writer recruits fifteen singers (eight female and seven male) from the university community, classified into 'professional' and 'amateur' singers. Technically, the data was recorded, and after that, the writer transcribed and segmented the words so that the pitch and formant frequency values were measured using Praat. The study resolves how the differential effects on how to pronounce each word change the vowel spaces between speaking and singing. It turns out that with more focus on F1 and F2, the sounds denote that the vowel spaces in singing are higher and backer than in speech. Nevertheless, the variance of formant values in speech is higher than in singing. The result helps the researcher gain more knowledge on how the effects in the mode (speech and sing) contribute to changing the articulation of vowels (in speaking and singing), which are revealed in formants.

Lastly, an article by Novita and Widayati (2018) conducts a study on the relationship between the Karo Language, Nias Language, and Simalungun Language. This study aimed to determine what group of relations occurred between those languages. The writer decides to use qualitative and quantitative methods in analyzing the research. Three similarities that can be concluded are that languages come from the same proto, such as phonetics and phonology, morphology, and syntax. The writer's findings indicate a high percentage of kinship between the Karo and Simalungun languages, demonstrating their close linguistic

relationship. The relationship between the language is clearly seen in some words that exist in both languages when one of the conditions (the words identic, phonemic, phonetically similar, and differ in a phoneme) is fulfilled. Novita and Widayati's study confirmed that the kinship between words in Karo and Simalungun is significantly similar. The analysis results strengthen the study the researcher discussed by comparing the Karo and Simalungun languages using similar words.

3. METHODS

In conducting this study, the researcher used the qualitative method. Since the data relies on in-depth observation and analysis of textual and visual data, it is appropriate for the researcher to use the descriptive method. In his book, Creswell states that analyzing accurate or valid data requires using specific requirements for recording the data, analyzing the information with multiple analysis steps, and adding approaches to strengthen the results. These are some requirements for doing qualitative methods (2014:183). Also, it can be seen that the study of phonetics (physical sound) is often related to audio and visual and highly directed to the modern method.

Furthermore, this study used programmed software to examine, reconstruct, and manipulate the speech sound. The software used by the researcher is Praat. It is a reliable application for achieving what researchers want in measuring the first formant (F1) and the second formant (F2) in the vowels of speech sounds.

In the data collection, the researcher implicated some native speakers of the KL from Berastagi and some native speakers of the SL currently live at Haranggaol Horison, Simalungun. The native speakers chosen by the researcher are three females from the KL and three from the SL. The speakers are adults between 17 and 45 years old. The researcher

analyzed that the speakers use the same languages daily for interaction. Understanding the language and how often they use it became the standard condition for the researcher in collecting speakers.

In collecting the data, the researcher guides the speaker in recording their voice using the recorder on their mobile phone. Therefore, the speaker starts to pronounce each word given by the researcher. There are five words, and each syllable consists of one vowel analyzed. These five words have been created as the target of the research. In addition to comparing both languages, the researcher decides to use the similar vowels [/a/, /i/, /u/, /e/, and /ɔ/] between Karo and Simalungun. Table 1 shows the word list and the meaning of each word. To make the syllable most manageable to segment, the position of the syllables /a/, /i/, /u/, and /e/ is put at the beginning, and the syllable /ɔ/ is placed at the end of the word. To achieve the proper data, the recording process was appropriately preconcerted, with a convenient area (not recording in a crowded environment), and the syllables were naturally uttered without removing the accents of each native speaker.

Table 1. The Word List

No	English	Vowels	Karo	Simalungun
1	Stay	a	Tading	Tading
2	Who	i	Ise	Ise
3	Sit	u	Kundul	Hundul
4	Come On	e	Eta	Eta
5	Steal	ɔ	Tangko	Tangko

The beginning stage after recording the voice data is when the researcher converts the data to a .wav file. From now on, the voice data will be put in the Praat application, version 6.3.16 (Boersama & Weenik, 2023). The data begins to be trimmed to get the vowel sound. To acquire the acoustic components of the vowel sound in the KL and SL, the researcher disclosed measuring the first formant (F1) and the second

formant (F2) of the acoustic component on the spectrogram and started to measure it at the middle point of the vowel sound. The measurement of the unit of frequency can be calculated in Hertz, usually abbreviated Hz. F1 is the lower pitch that can be differentiated in a creaky voice, and F2 (the second formant) is the higher pitch that can be heard when whispering (Ladefoged, 2015, p. 24-25). The data that have been achieved were analyzed and compared to find the lowest and highest vowels between both languages and described in tables.

4. RESULTS

The analysis of formant, which uses Praat as the application for measurement, is indeed important for this study. By using the Praat application, the researchers simplified measuring the formant from each data recording. Five words have been chosen by the researcher, and they are pronounced by three females using the KL and three females using the SL. The words are *tading*, *ise*, *kundul* (*hundul* in the Simalungun Language), *eta*, and *tangko*. These words were chosen because of their similarity in form.

After the data has been analyzed by converting, extracting, and cutting the data recording using the Praat application, the results are obtained by measuring the vowels, including the first formant (F1) and second formant (F2). The results of the data recording are shown in Table 1.1, in which the researcher explains using the average frequencies of the collected data for F1 and F2 in pronouncing the Karo and the Simalungun languages. The formant values shown are based on F1 and F2 from the spectrogram in Praat using Hertz (Hz), and the researcher converts the value into Bark.

In Table 1.1, the researcher shows the average formant frequency values of Karo native speakers. There are five vowels that have been analyzed; they are /a/, /i/, /u/, /e/, and /ɔ/. In this section, Karo

native speakers seem much louder in pronouncing the vowels than Simalungun. The averages of F1 and F2 are both completely different to one another. It can be seen how the Karo native speaker pronounces the vowel much higher than the Simalungun native speaker.

Table 2. Formant frequency analysis of Karo Native Speaker

No	Vowels	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
1	a	979 Hz	1731 Hz	7.59	10.69
2	i	370 Hz	2980 Hz	3.5	13.84
3	u	510 Hz	1093 Hz	4.63	8.17
4	e	567 Hz	1890 Hz	5.05	11.19
5	o	562 Hz	956 Hz	5.02	7.47

4.1 Vowel /a/ production

The vowel /a/, drawn on the word 'tading', was articulated by three females from Karo native speakers. It shows the measured in F1 at 979 Hz and F2 at 1731 Hz. Otherwise, the vowel /a/, which Simalungun native speakers pronounce in Table 1.2, is much lower in the values shown in F1 at 908 Hz and F2 at 1395 Hz. The analysis shows that the average F2 of Karo native speakers is much higher in formant value than that of Simalungun native speakers.

4.2 Vowel /i/ production

Table 1.1 displays the formant frequency articulated by the Karo native speakers. It also shows the vowels /i/ significantly higher pronounced by Karo native speakers. The data for the vowel /i/ in both languages is from the word 'ise'. Based on the data recording, the average of F2 in this vowel is higher than the other. The F2 in KL reveal the vowel /i/ of the formant value measured at 2980 Hz and in the F2 SL at 1655 Hz.

4.3 Vowel /u/ production

After observing the formant frequency in the vowel 'u', which is drawn in the word 'kundul' or 'hundul' in the SL, the researcher found

that the average formant frequency between both languages is only 3 Hz apart. It can be seen in Table 1.1 that the F2 of the Simalungun native speaker is 1093 Hz and 1090 Hz in the F2 of the SL.

Table 3. Formant frequency analysis of Simalungun Native Speaker

No	Vowels	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
1	a	908 Hz	1395 Hz	7.21	9.48
2	i	438 Hz	1655 Hz	4.06	10.43
3	u	441 Hz	1090 Hz	4.09	8.15
4	e	583 Hz	1669 Hz	5.17	10.48
5	ɔ	648 Hz	1049 Hz	5.62	7.95

4.4 Vowel /e/ production

In this section, the researcher observes the vowel /e/ distribution as produced by three female speakers from both languages, KL and SL. The data for pronouncing the vowel /e/ is from the word 'eta' which means 'come on'. From the observation, the researcher found the average F2 in KL, which in Table 1.1 measured at 1890 Hz and in Table 1.2, the F2 in SL at 1669 Hz.

4.5 Vowel /ɔ/ production

The last vowel analyzed by the researcher is the vowel /ɔ/. This vowel is well articulated by three female native speakers from KL and SL. This research provides evidence that the vowel is articulated by the female native speakers with the quality of /ɔ/, with F1 from KL measured at 562 Hz and F2 at 956 Hz. Otherwise, the researcher found that the formant frequency of Simalungun native speakers are more higher than in Karo native speakers. The sound frequencies are 648 Hz for F1 and 1049 Hz for F2 in SL. It is different from the four vowels that have been analysed before.

This research presents a detailed analysis of the formant frequency of the Karo Language compared to the Simalungun Language. Both

languages contribute to building a deep understanding of the acoustic phonetics and the characteristics of each language. The research also can be valuable for the next researchers studying Karo Language and Simalungun Language, and the linguists dabbled in this study. Moreover, the formant measurements from both languages can be compared with other languages to identify the similarities and differences in their acoustic phonetic systems. It helps future generations to become familiar with the diverse languages of each ethnicity in Indonesia and expand access to accurate information about their linguistic legacy.

5. CONCLUSSION

This study found that the Karo Language has six vowels, such as /a/, /i/, /u/, /e/, /ə/, and /ɔ/, and the Simalungun language has five vowels namely /a/, /i/, /u/, /e/, and /ɔ/. Most of the higher vowel is produced in Karo native languages. There are /a/, /i/, /u/, and /e/, which are significantly higher when articulating the vowel in each word given. While the vowel /ɔ/ is higher in Simalungun native speakers. The research calculated the vowel formants measurements in the Karo Language and Simalungun Language based on F1 and F2 from the spectrogram in the Praat application. The higher average measurements of the vowel formant in Karo native speakers are vowel /a/ F2= 1731 Hz, vowel /i/ F2 = 2980 Hz, vowel /u/ F2 = 1093 Hz, and vowel /e/ F2 = 1890 Hz. Furthermore, the higher average measurements of the vowel formant in Simalungun native speakers are vowel /ɔ/ F2= 1049 Hz.

The research's findings are valuable in phonetics and phonology because they support other linguists observing the vowel characteristics of the Karo and Simalungun languages. Otherwise, this research has limitations since it only analyzes the vowels of the Karo and Simalungun

languages. The researchers recommend that the next researcher explore consonants through an acoustic approach.

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