COMPARISON OF VOWEL SPACE AREA IN TWO DIALECTS OF KHASI

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ALL INDIA INSTITUTE OF SPEECH AND HEARING

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JULY, 2020

CERTIFICATE

This is to certify that this dissertation entitled "**Comparison of Vowel Space Area in Two Dialects of Khasi"** is a bonafide work submitted in part fulfilment for the degree of Master of Science (Speech-Language Pathology) of the student with Registration Number: 18SLP028. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any Diploma or Degree.

Mysore
July, 2020

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CERTIFICATE

This is to certify that this dissertation entitled "**Comparison of Vowel Space Area in Two Dialects of Khasi"** is a bonafide work submitted in part fulfilment for the degree of Master of Science (Speech-Language Pathology) of the student (Registration Number: 18SLP028). This has been carried out under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled "**Comparison of Vowel Space Area in Two Dialects of Khasi"** is the result of my own study under the guidance of Dr. N. Sreedevi, Professor and Head, Department of Prevention of Communication Disorders (POCD), All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier in any other University for the award of any other Diploma or Degree.

Mysore **Registration No: 18SLP028**

July, 2020

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Dedicated to my Lord

My Guide, Mother, Father,

brothers and sister

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CHAPTER I

Introduction

Speech is the communication of ideas and thoughts by vocal sounds expressed, or the ability to convey ideas and thoughts in this way. DeVito (1986) defines communication as the method or act of transmitting a message from a transmitter to a receiver, through a channel, and with noise interference. Some would expand on this concept, saying the message is intentional and conveys meaning to bring about change.

Speech mechanism involved the structural synchronization of continuously shifting of the articulators producing the sound of speech: tongue, lips, jaw, vocal tract, vocal cords, and respiration. The acoustic signal generated during speech production, when the vocal organs move, resulting in the patterns of the air molecules in the air stream. The speech waveform is the product of the interaction of one or more sources with the vocal tract filter system (Fant, 1960). Speech sounds are classified into vowels and consonants. Vowels are speech sounds that are generated by voiced excitation of the open vocal tract. Without audible friction, the energy produced through the oral or nasal cavity can be radiated. Vowels can be classified based on tongue height, tongue advancement, degree of muscular effort, rounding of lips, duration, position of soft palate, and tone (Kent, 2003).

Vowels are the easiest sounds to investigate and describe its acoustic characteristics of speech sound and have been described by a very simple set of acoustic descriptors such as the formant frequencies, formant bandwidth, and temporal characteristics such as the vowel duration, consonant duration (Picket, 1980). Studying of acoustic characteristics of speech sound would provide information about the articulatory nature of the sound and also how it is perceived (Picket, 1980).

Vowels are primarily categorized by the first (F_1), second (F_2), and third (F_3) formant frequencies. The tongue height varies inversely with first formant frequency (F_1) and tongue advancement with increased lip rounding for all the formant frequencies decreases directly varies with the second formant frequency (F_2) (Hixon, Weismer, & Hoit, 2008). The formant frequencies and patterning are the acoustic signals of the talkers and they are the most significant for vowel detection, i.e., listeners only needed the first (F_1) and second (F_2) formants to recognize a vowel. In general, the formant frequencies were derived from the natural speech to synthesize the vowels.

1.1 Vowel space area

Vowel space area is a graphical method to characterize the speech sounds, such as vowels and their position in both "acoustic" and "articulatory space. When vowels of a language are represented graphically, it either takes the shape of a triangle or a quadrilateral depending on the vowel inventory of the language. The accuracy of vowel articulation which indicates gross motor control ability of the tongue and jaw coordination can be represented in a vowel working space area. The first and second formants are used to plot the vowel space area, the first formant (F_1) frequency was plotted on the vertical axis and the second formant (F_2) frequency were plotted on the horizontal axis with the lines connecting the points representing the distance between the first two formants (F_1- F_2). The position of the tongue body in an articulatory space to some degree corresponds to the 2-dimensional representation (Krishna & Rajashekhar, 2012). F_1 has been measured to be associated with the changes in tongue height and it was believed that F_2 is associated with the changes in tongue advancement and lip rounding (Chiba & Kajiyama, 1958, pp. 115–154; Fant, 1960, pp. 209–211; Kent et al. 1999).

To investigate the vowel working spaces of the individual's, the most common vowels that are frequently chosen in all the languages are the "corner vowels" /a/, /i/, and /u/ (Ladefoged & Maddieson, 1996), these vowels have extreme formant frequencies in acoustic space and are acoustically and perceptually exceptional since they characterize the great positions of the speaker's articulatory vowel working space (Lindblom, 1990). Many factors such as gender, age, phonetic context, and dialects affect the vowel space areas. Studies on acoustic characteristics of vowels in different dialects become important.

Many researchers have been used vowel space area (VSA) to study the relationship between vowel space and factors such as age, gender, dialects, speech intelligibility, various speech disorders, etc. (Nearey & Assmann, 1986; Watson & Harrington, 1999) stated that vowels are never truly static and at least exhibit some amount of vowel spectral change. (Fox & Jacewicz, 2009) found that vowel variants across regional dialects of American English and this spectral change were different, also called dynamic formant movement. (Jacewicz, et al. 2007) found both in vowel duration in cross-dialectal differences and in speech tempo (Jacewicz et al. 2009; Jacewicz et al. 2010), both of which affect vowel dynamics, including the spectral rate change in a vowel (Fox & Jacewicz, 2009). (Bradlow et al.1996) found a systematic variation in the vowel space area (VSA) as a function of speaking styles, (Turner et al. 1995; Liu et al. 2005) in speech disorders and (Vorperian & Kent 2007) child development patterns. To conclude, the findings from these studies reduced in VSA production indicate lower intelligibility scores in perception.

1.2 Khasi Language

Khasi is primarily spoken by the people of Meghalaya in the north-eastern state of India and also in neighbouring parts of Assam and Bangladesh. On 21st January 1972, the late then Prime Minister of India, Smt Indira Gandhi officially inaugurated the State of Meghalaya. The name “Meghalaya” means “The Abode of Clouds”. Khasi is a member of the Austro-Asiatic language family similar to South-east Asia, Cambodian, and Mon-Khmer languages and the Munda branch spoken in eastern-central India. There are about 1.6 million Khasi speakers in India according to the 2001 census. In 2005, Khasi was accepted as an “associate official language” of Meghalaya. Compared to other Austro-Asiatic groups of languages, Khasi is relatively young (statistical reports say between 1,500 and 2,000 years) and is only moderately diverse. Neighbouring places of Meghalaya speak either the Tibeto-Burman or the Indo-Aryan family. To the northern part lies the Assam Valley, where Assamese is the main spoken language, to the southern and south-east parts lies the Bangladesh and the Bengali speaking areas of Assam, were both Assamese and Bengali are Indo-Aryan languages. The Mikir Hills and North-Cachar Hills districts of Assam are situated to the east and north-eastern regions, where Mikir and Cachari are the local languages belonging to the Tibeto-Burman family. Its western neighbour, the Garo Hills district of Meghalaya, is also linguistically Tibeto-Burman. Khasi itself is divided into various dialects, including Sohra, Pnar or Synteng, Lyngngam, Bhoi (Nongpoh), Bhoi (Tyrso), Maram, War, Nongstoiñ, War-Jaintia, etc.

During the past, Khasi language did not have its script. In 1824, with the aid of the natives, the missionary by the name William Carey first started writing with the Bengali alphabet to translate the New Testament into the “Khashee” language. The New Testament was printed in Serampore in 1831 in Bengali. In 1841, the first to write Khasi with the Latin alphabet was Thomas Jones, a Welsh missionary who served the Khasi area. He documented the Khasi language in Roman Script and calls him “The founding father of the Khasi alphabets and literature” was inscription on his gravestone. Khasi has a special system in Latin script, different from the English alphabet. It uses 20 letters alphabet system by eliminating the letters c, f, q, v, x, and z from the standard Latin alphabet, and by adding the diacritic letters ï and ñ, and the digraph ng, regarded as a letter of its own. The recognized Khasi alphabets used in schools, newspaper, and literature are given in the order:

A B K D E G NG H I Ï J L M N Ñ 0 P R S T U Y

The peculiar placement of ‘k’ is due to its substitution of ‘c’. ‘K’ and ‘kh’ were replaced instead of the original ‘c’ and ‘ch’ when ‘c’ and ‘ch’ was removed from the alphabet. The presence of ‘g’ in the alphabet is largely because of its existence in the letter ‘ng’, ‘g’ alone is not present in Khasi words and even in loan-words. The original ‘g’ sound tends to be assimilated to the Khasi ‘k’ sound. It is only found in the initial position in very early texts.

The present study investigates **two dialects of Khasi (Maram & Nongstoiñ dialects).** Both dialects are spoken by the people of West Khasi Hills District, Meghalaya. Maram dialect is also spoken by the people of South West Khasi Hills District, Meghalaya.

Figure 1.1

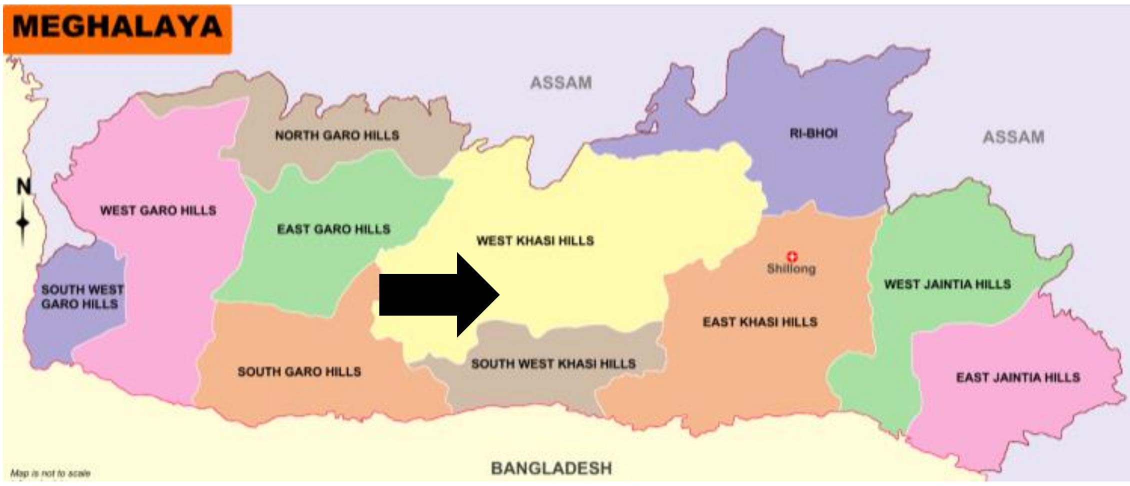
Picture depicting Khasi men and women

Figure 1.2

Map of Meghalaya in relation to rest of India

Figure 1.3

Map of Meghalaya with its districts.



1.3 Need for the study

Several studies have explored the various acoustics parameters of speech in several regional dialects of Indian languages (Telugu, Kannada, Malayalam, Tamil, etc). In North-East India currently, the focus is on the linguistic aspects of the languages and anthropology for the culture of the people. There is a dearth of information in the acoustics of speech sounds of the north-east languages. There is a requisite of studies on vowel spaces to help in estimating the similarities or differences between multiple dialects. Currently, there are no published reports on the acoustic characteristics of vowels across many languages of North-Eastern states. These languages are also phonetically different compared to other Indian languages as they majorly belong to the Indo-Aryan, Tibeto-Burman, and Austro-Asiatic language families. From a Speech-Language Pathologist's point of view, there is a need to study the acoustic characteristics of vowels of the languages of the north-east, as this information will help the SLP's in the assessment and intervention of communication disorders. Hence, the present study is a preliminary attempt to look into the acoustic characteristics of vowels of two dialects of one of the major languages of the north-eastern region i.e. Khasi which is spoken by the people of Meghalaya and belongs to the family of Austro-Asiatic languages.

1.4 Aim of the study

The study aims to investigate and compare the vowel space areas across two regional dialects of the Khasi language (Maram & Nongstoiñ) spoken in the state of Meghalaya.

1.5 Objectives of the study

1) To obtain a vowel triangle using first (F_1) and the second (F_2) formant frequencies of the corner vowels /a/, /i/, /u/ and calculate the vowel space area in Maram speaking adults of 20-30 years of age.
2) To obtain a vowel triangle using first (F_1) and the second (F_2) formant frequencies of the corner vowels /a/, /i/, /u/ and calculate the vowel space area in Nongstoiñ speaking adults of 20-30 years of age.
3) To compare the vowel space area of Nongstoiñ speaking individual with that of the Maram speaking individuals.
4) To compare the vowel space area between males and females in two dialects of Khasi.

1.6 Hypothesis

The null hypotheses of the present study are:

- There is no significant difference in vowel space area (VSA) between the two dialects of Khasi.
- There is no significant difference across gender in the two dialects of Khasi.

CHAPTER II

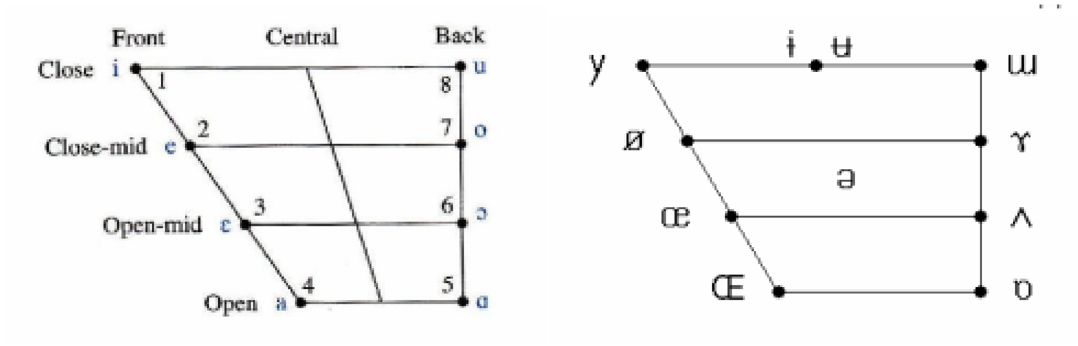
Review of literature

Vowel sounds are created by a source at the glottis, through acoustic excitation of the vocal tract. The vocal tract is viewed as an acoustic circuit, and the acoustic disturbances in this circuit are typically defined in terms of sound pressures and volume velocities of vibration of the air at different points in the circuit (Kenneth & Arthur, 1961). The voiced excitation of the open vocal tract produced vowels. Vowels can be produced in isolation without altering the position of the articulators and use the glottis as the primary source of the sound. Vowels /a/, /i/, and /u/, are referred to as corner vowels and these vowels also occur frequently in the world's languages (Maddieson, 1984).

The famous phonetician Daniel Jones (1956) found the articulatory description of vowels to be of limited use and created a perceptual scale of vowel classification to explain the difference between vowels of different languages. He set up the cardinal vowels that would be independent of any specific language and are located in the periphery of the vowel area. Hence, it is possible to place a particular vowel in relation to the cardinal vowels. He proposed primary and secondary cardinal vowels which are shown in the following figure.

Figure 2.1

Primary and secondary cardinal vowels



Primary cardinal vowels   Secondary cardinal vowels

Vowels are the simplest sounds to analyze and describe acoustically. Vowels are primarily categorized by the first (F_1), second (F_2), and third (F_3) formant frequencies. The most important cues for the acoustic perception of vowels are the frequencies and the formants patterns of the speaker's. A formant is a preferred resonating frequency of an acoustical system and is distinguished by its center frequency and the range of frequencies on both sides having amplitudes within 3 dB of the central frequency. The first three formants are called the F-pattern (F_1, F_2, and F_3) for a vowel (Hixon et al. 2008). Vowels are classified based on tongue position, (eg: front vowels, central vowels, back vowels, etc), based on lip rounding (rounded vs. unrounded), nasality (oral and nasal) and based on the muscular effort (tense vs. lax vowels) (Maddieson, 1984).

2.1 Acoustic Vowel space

The vowel space area is a graphical method to characterize the speech sounds, such as vowels and their position in both "acoustic" and "articulatory space. To plot the vowel space the first and second formants are used, the first formant (F_1) frequency were plotted on the vertical axis and the second formant (F_2) frequency was plotted on the horizontal axis with the lines connecting the points representing the distance between the first and second formants (F_1- F_2). The position of the tongue body in an articulatory space to some degree corresponds to the 2-dimensional representation (Krishna & Rajashekhar, 2012). When vowels of a language are represented graphically, it either takes the shape of a triangle or a quadrilateral depending on the vowel inventory size of the language. If the vowels in a language are less, it takes the shape of a triangle and if vowels in a language are more, it takes the shape of a quadrilateral. A vowel triangle figures and vowel quadrilateral are shown below:

Figure 2.2

Vowel triangle (Source: Krishna & Rajasekhar, 2012)

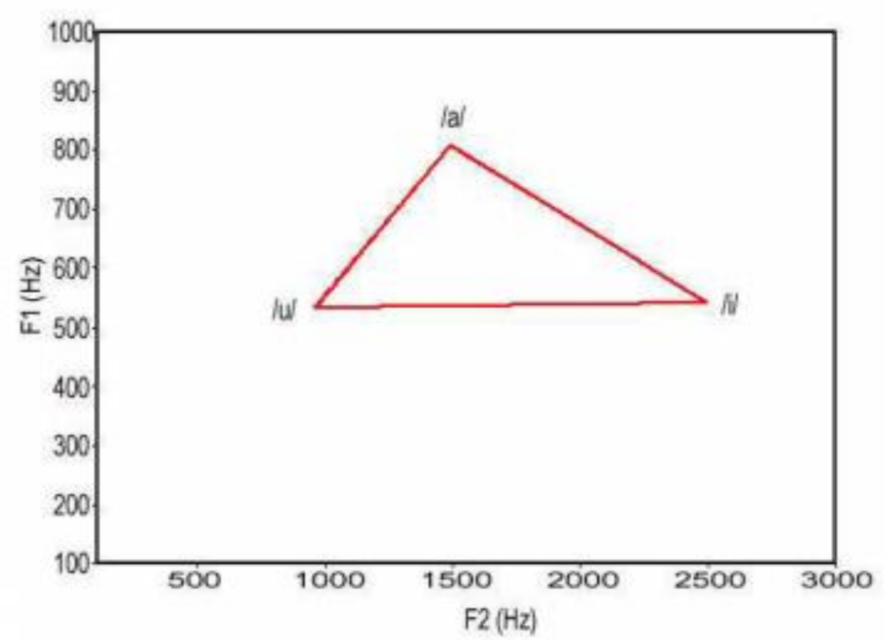
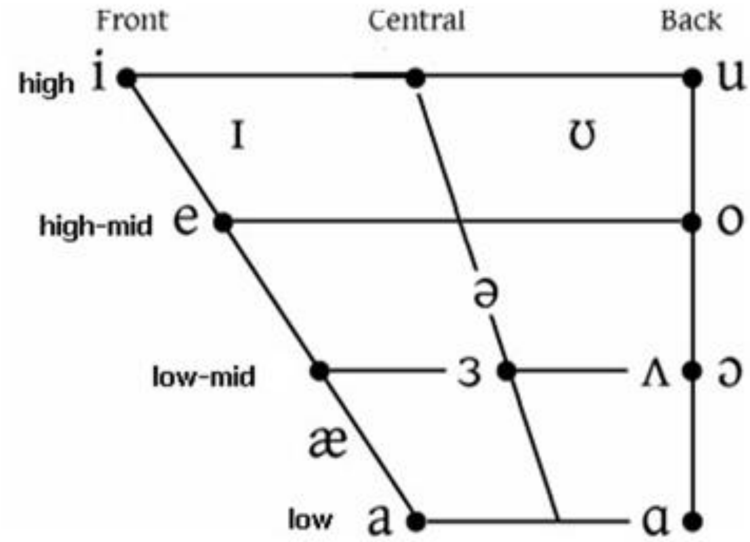


Figure 2.3

Vowel quadrilateral



Acoustic vowel space is measurable in various ways, based on three vowels in the corner /i, ɑ, u/ (triangular acoustic vowel space), and four vowels in the corner /i, u, ɑ, æ/ or lax corner vowels (Tjaden, Rivera, Wilding, & Turner, 2005). The "corner vowels", have been described as a quantal point and are the most common in all languages (Ladeoged & Maddieson, 1996). The vowel space area of the vowels arises from the articulatory configuration of the tongue and jaw movement. The basis measurement of the vowel space area (VSA) reflects the formant patterns of the synchronized motion of the tongue and jaw. The acoustics of vowels are affected by various factors such as age, gender, language, dialects, speech intelligibility, etc.

2.2 Acoustic Vowel space area across age

Vorperion et al. (2005), investigates the vocal tract development, intensively analyzing 605 MRI and CT images of individuals between birth and 19 years. The findings suggested that there is non-uniform and nonlinear growth of the vocal tract and the speed of growth differs depending on the development process, the vocal tract lengthens by around 2 cm in the first two years, and rapid descending of the larynx and hyoid bone also occur in the same period, the growth speed varies depending on the vocal tract segment, for example, by the age of 18 months, the hard palate reaches 80% of the adult length, while the pharynx reaches 80% of the adult length by 6 years, while other segments such as the larynx and hyoid bone descent reach only 65% of the adult stage by 6 years and tend to continue maturing to the adult position.

Chung et al. (2012) investigated the vowel space (VSA) in cross-linguistic variation position of three common vowels of five languages (Cantonese, American English, Greek, Japanese, & Korean) in three age groups (2-year-olds, 5-year-olds, and adults). Repetition tasks of the familiar word were elicited by using the vowels /a/, /i/, and /u/. The results suggested that 5 year-olds indicated that language specific patterns in their vowel spaces were similar to that of adults. These language specific features were also found in 2-year-olds vowel productions, but the adult-like patterns were less pronounced and much less consistent. Furthermore, vowel productions were more variable for 2 year-olds compared to the other older age groups. Vowel space area found to increase with an increase in age.

Krishna and Rajashekhar (2012) studied the vowel space and formant frequencies across age and gender of Telugu language in three different age groups (6-9 years, 13-15 years, & 20-30 years) with equal number across gender. The results suggested that the vowel space area is smaller in adults as compared to children. As age increased the first (F_1) and second (F_2) formants are reduced for all the vowels (/a/, /i/ & /u/). Jyotsna (2015) studied on comparison of vowel space across age groups (3-4, 7-8, & 20-25), gender, and three different phonetic contexts (velar, bilabial, retroflex) in Malayalam speaking individuals. The results suggested that there is a reduction in VSA in all the three phonetic contexts; 3-4 years > 7-8 years > 20-25 years as age increased. Group 1 has the highest VSA in the context of bilabial /b/, Group 2 and 3 have the highest VSA for the context of velar /k/, and all the three groups had the least VSA for the context of retroflex /t/. Children demonstrated higher VSA than adults.

Studies have shown that vowel space changes with increase in age. Changes may be attributed to the structural and physiological development of laryngeal and vocal tract structures along with the speech motor control development.

2.3 Acoustic Vowel space area across gender

Female speakers have been found to have greater acoustic vowel space for several languages than male speakers (Diehl et al.1996) for American English and (Whiteside, 2001) for British English.

Simpson (2001) investigated the relationship between articulation and its acoustic products and to investigate the gender differences of the vocal tract. A total of 48 participants from the age range 18 and 37 years, speaking the Upper Midwest dialect of American English. The tasks used are linguistic (reading short texts, telephone numbers) and non-linguistic (swallowing). The data consist of the articulatory positions of eight gold pellets (four lingual, two labial, two mandibular), extracted for each acoustic data. The vowel acoustic data were analyzed from the words “they”, and “all” from the sentence “they all know what I said”. The diphthongs for the word “light” from the sentence “The coat has a blend of both light and dark fibers” are considered for acoustic analysis. The results suggested that F_1 excursion for a vocalic stretch was maximum in female speakers as compared to male speakers. It was also observed that posterior male lingual pallets moved maximum distance at a higher speed than females, leading to the reduced vowel space area.

Weirich and Simpson (2014) investigated the male and female articulatory vowel space on 5 male and 4 female German speakers, from the age range of 23 and 43 years old. In the study they had two sets, firstly they had used the three-point vowels /aː uː iː/ that contained the vowel sequences in the IAA, AUU, and BII abbreviation embedded in carrier sentence "They went to the IAA very fast last week". The second data includes the sequence /gV/ with V being /iː ɪ eː ɛ aː a oː ɔ uː ʊ/ in the name GVbi embedded in the carrier sentence Ich sah GVbi "I looked at GVbi'". For the /gV/-material, three different conditions of accent have been recorded. The results suggested that males show larger articulatory vowel spaces, as seen in a temporally privileged context in terms of a lower and more retracted tongue position for /aː/ and for /iː/ higher tongue position. Also, the amount of undershoot in unaccented conditions is often higher in male than in female speakers. It may be attributed to a greater coarticulation effect in males than in females. Jacewicz et al. (2007) investigated the vowel space areas across gender of American English (south-central Wisconsin, western North Carolina, & central Ohio). The participants consist of 54 speakers from the age range of 20-34 years. The results suggested that females had larger vowel space area than males.

Krishna and Rajashekhar (2012) studied vowel space in the dialects of Telugu language (Coastal, Rayalaseema & Telangana**)**. The results suggested that Telugu's three dialects showed significant difference in vowel space areas across dialects and males have a smaller vowel space area than females. A similar finding was also reported by Jyotsna (2015) in her study on comparison of vowel space area in three different age groups (3-4, 7-8, & 20-25) and across gender and three different phonetic contexts (velar, bilabial, retroflex) in Malayalam speaking individuals. The results suggested that that the vowel space area across three age groups was decreasing as the age increases and females had higher VSA across all the phonetic contexts. Anitha (2015) compared the vowel space of two tribal languages and across gender in Malayalam individuals of Kerala. The results suggested that vowel space area across gender was larger for females than males.

2.4 Acoustic Vowel space area across languages

Languages differ in the size and arrangement of inventories of vowels; they range from 3 to 24 distinct vowels. Cross-linguistic investigations revealed that the general organization of vowel inventories is ruled by auditory and articulatory limitations. Theoretical studies have attempted to predict the impact of vowel inventory size on the overall vowel systems organization. Bradlow (1995) studied English and Spanish and the results suggested that the productions of the common vowels of /i/, /e/, /o/, and /u/, were systematically different with respect to language. F_2 values were significantly higher for all English speakers for all of the vowels than the Spanish speakers. Yang (1996) also found a cross-linguistic variation between English and Korean adult for the production of common vowels. For the vowel /a/ English speakers had lower F_2 values than the Korean speakers, and for the vowel /u/ English speakers had higher F_2 values than the Korean speakers. Both the findings suggested that the notion of “shared” vowels does not justify for the minute differences in vowel production between different languages.

Al-Tamimi and Ferragne (2005) studied on two languages: Arabic (2 dialects: Moroccan-MA & Jordanian Arabic-JA) and French-FA, in the effect of vowel inventory size on the general organization of acoustic vowel spaces. A list of items (with C_1VC, C_1VCV, and C_1VCVC) was recorded for 15 subjects in the age range of 20 to 30 years. C_1 was one of the 3 common phonologically consonants between the two languages: /b, d, k/ and each vowel. The speakers were asked to pronounce these items as presented in words, syllables, and in isolation. The results suggested that the French (FA) vowel space is greater than that of Jordanian Arabic (JA) or Moroccan (MA). Secondly, only in two conditions (Syllable and in Isolation, but not in Word), the point vowels tend to have approximately the same position in the acoustic vowel spaces across the 3 languages.

Chung et al. (2012) examined the vowel space area across five languages (Cantonese, American English, Greek, Japanese, & Korean) in cross-linguistic variability for the position of three shared vowels. Word repetition task was used for eliciting the vowels /a/, /i/, and /u/. The results suggested that the vowel space of each language in relations to their size and shape of the vowel space, formed by the three-point vowels were both systematically different from each other. In Cantonese, vowel space area was greater in size than those of other languages. While comparing the shape of the triangle, the Cantonese, Korean and Greek language were found to have almost an equilateral triangle, where English and Japanese were noted, the similar positions of /i/ and /u/ in F_2 and /a/ and /u/ in F_1 dimension was observed.

2.5 Acoustic Vowel space area across dialects

A regional dialect is spoken in a particular geographical region which is a unique practice of language, is also known as a regiolect or topolect (Nordquist, 2019). If the distinct regional speech form is transferred from a parent to a child, that dialect is said to be a child's dialect.

Clopper and Pisoni (2005) studied the acoustic of vowel systems in six regional varieties of American English (New England, Mid-Atlantic, North, Midland, South, & West). The acoustic duration, the first (F_1) and second (F_2) formant frequencies were measured for 48 individuals of both genders for the productions of 11 vowels in five repetitions. The results suggested that consistent variation particularly regarding the production of low vowels and high back vowels is due to the region of origin indicating that the vowel systems are preferable to categorize in terms of the region of origin.

Al Tamimi and Ferragne (2005) investigated the impact of vowels on the size of the vocalic space from French and two Arabic dialects: Moroccan and Jordanian Arabic. The results suggested that the French language has a greater vowel space compared to the other two Arabic dialects, which means that the size of vocalic space is influence by the vowel inventory of a language. The analysis indicates that a greater vowel space area can be observed for a language with greater vowel inventory size. Robert and Ewa (2010) investigated the vowel space areas of two dialects of the United States (Wisconsin: upper Midwestern dialect & North Carolina: southern dialect) as a function of generational differences and dialect. The results suggested that the vowel space area, based on the midpoint of the corner vowels was smaller in North Carolina speakers than the Wisconsin speakers.

Jacewicz et al. (2007) investigated the vowel space areas on the vowel system across the three regional dialects of American English: south-central Wisconsin, western North Carolina, and central Ohio. The results suggested that although the formant frequency values vary across the dialects, the vowel space area is relatively constant across the dialects. A similar study by Fox and Jacewicz (2008) investigated the total vowel space areas of three regional dialects of American

English: south-central Wisconsin, central Ohio, and western North Carolina are affected by regional variation or not. The results suggested the vowel space size of the quadrilateral areas as a function of dialect was significant difference and it was observed that Wisconsin had the largest area followed by Ohio and North Carolina. This finding contradicts with the previous finding that vowel space areas are constant across the dialects (Jacewicz et al. 2007).

Few studies have explored vowel space areas across different dialects in Indian languages. Krishna and Rajashekhar (2012) studied the vowel space of typical individuals across the dialects of Telugu (Coastal, Rayalaseema & Telangana). The results suggested that the three dialects of Telugu showed a significant difference in vowel space areas across dialects. Larger vowel space was observed in females and individuals from the Telangana region. Kapali (2015) studied the formants in two dialects of Kannada (Mangalore & Dharwad). The results suggested that F_1 of /a/ was significantly higher in speakers of Mangalore dialect and F_1 of /i/ and /u/ indicated no difference between the two dialects. F_2 of /i/ was higher in Mangalore dialect speakers compared to Dharwad dialect speakers and no significant difference in F_2 of /a/ and /u/ between the two dialects; females had higher F_1 and F_2 compared to males; Mangalore dialect speakers had more vowel duration than Dharwad dialect speakers.

Anitha (2015) compared the vowel space of two tribal languages of Waynad district (Paniya & Kuruma) and spoken Malayalam of Kerala. The results suggested that adult speakers of Malayalam had larger vowel space areas than the tribal language speakers of Kerala; the vowel space area was larger in phonetic context of velars followed by bilabials and retroflex; larger vowel space areas for females than males were obtained. Rini (2016) studied on vowel space across different regional dialects (Kozhikode, Thrissur, Ernakulam, & Thiruvananthapuram) of Malayalam.

The results suggested that the vowel space areas vary across dialects of Malayalam. The mean vowel space area was largest in Ernakulam dialect followed by Kozhikode and Thiruvananthapuram dialect respectively. The smallest vowel space area is documented in the Thrissur dialect. Males had lower VSA values compared to females. This finding contradicts with Jacewicz (2007) that there were no differences of VSA across the three dialects of American English: Central Ohio, south-central Wisconsin, and western North Carolina. Sahana (2016) studied vowel space areas across four regional dialects of Kannada (Mysuru, Mangaluru, Dharwad, & Kalaburagi). The results suggested that there was a significant effect of the dialects on mean VSA. The vowel space area was highest in the Mangaluru dialect which is in support of the earlier study by Kapali (2015) who found higher F_1 and F_2 in the Mangalore dialect. The second largest VSA was for the Mysuru dialect, followed by the Dharawad dialect, and the least was in Kalaburagi dialect.

2.6 Acoustic Vowel space area across speech disordered population

Based on the values of vowel formant frequency and vowel space measurements, speech research was commonly used to determine the impact on several disorders such as stuttering (Prosek et al. 1987) and dysarthria (Turner, Tjaden, & Weismer, 1995), to detect changes in speech perception and production with cochlear implants (Lane et al. 2001) etc.

Whitehill, Ciocca, Chan, and Samman (2006) studied on partial glossectomy speakers by examined the vowels acoustic characteristics and to investigate the acoustic variables that include the F_1 range, F_2 range, first formant (F_1), second formant (F_2), and vowel space area. Results indicated that mean F_1 values and ranges showed no significant groups difference. Compared to the control speakers, partial glossectomy speakers exhibit significant lesser mean F_2 values for the vowel /i/, and small ranges of F_2. These data indicate a restricted range of lingual movement for the vowel production along the anterior-posterior dimension. Significantly, lesser vowel space areas for the glossectomy speakers support the centralization hypothesis of vowel formant.

Capellan and Dohen (2015) carried out the acoustic analysis of vowel production of 8 French speakers with Down syndrome from the age range of 19 to 34 years in the context of vowel-consonant-vowel (VCV). The results suggested greater variability in the production VCV for people with DS compared to “ordinary” people (OS). The F_0 for both genders in DS speakers are higher compared with OS speakers. This finding contradicts the previous study of 2 adults with Down syndrome in vowel production. The results suggested that decreased acoustic vowel space area decreased articulatory working space, and decreased speed of articulatory movement was found for three of the four tongue points analyzed for Down syndrome speakers relative to the control speakers (Bunton & Leddy, 2010).

Lee, Anne, John, and Simmons (2017) investigated on acoustic and vowel space in 11 speakers with dysarthria secondary to amyotrophic lateral sclerosis (ALS) and 11 speakers without dysarthria. The results suggested that the acoustic vowel space in dysarthria is considerably lesser relatively than the speakers without dysarthria, assuming to be reduced and lesser tongue range movement in dysarthria speakers.

Hung and Tsai (2017) analyzed the speech performance of hearing aid users of Mandarin-speaking individuals for vowel production and compared it with the control group (NH). A total of 28 participants with different types of hearing loss were included. Intelligibility of Speech was assessed by measuring the vowel space area of corner vowels /a, u, i/ of the Mandarin Chinese. Results suggested that HL groups have more compressed articulatory working space than NH group, suggesting a less comprehensible speech. This finding supports the previous study by Angelocci et al. (1964) studied on the vowel formants of deaf and control groups, from the age range 11 to 14 years old boys for the production of 10 vowels in a sentence. The results suggested the fundamental frequency for all the vowels was higher for the deft subjects compared to the control subjects, suggesting that the deaf group did not have clearly defined articulatory vowel target areas.

Akhilesh et al. (2018) studied on vowel space area (VSA) to distinguish the hypernasal speech from normal speech. The results suggested that the detection of hypernasality using the VSA features and the Melfrequency cepstral coefficient feature, resulting in a decreased VSA for speech judged as hypernasal relative to normal speech production. Similar findings by Nikitha et al. (2017) studied on vowel space area (VSA) to explore the severity analysis of hypernasality in cleft lip and palate speech. The results suggested that the reduction of vowel space in moderate-severe hypernasality group is more pronounced than the normal group. In the context of /p/ vowel space area is larger, followed by /t/, and /k/ in cleft lip and palate group.

Whitfield and Mehta (2019) studied the characteristics of clear speech production for participants with and without Parkinson’s disease (PD) and to measure the working vowel space area by reading the passage in 15 speakers with Parkinson’s disease and 15 control participants. The results suggested that the vowel space area is lesser for participants with Parkinson’s disease compared to the control participants.

To summarize the review, it can be stated that the vowel space area has been investigated by numerous researchers across languages, dialects, age, gender, and different speech disordered population. The vowel space area is a graphical method to characterize speech sounds, such as vowels and their position in both “acoustic” and “articulatory space. Most of the studies on vowel space area across age were found to increase with increase in age. However, some authors stated that the vowel space area (VSA) is smaller in adults compared to children. Across gender, the vowel space area (VSA) was found higher in females than males. Researchers on vowel space area have also found a significant difference across dialects and few studies found no significant difference. Vowel space area (VSA) in the disordered population (Glossectomy, Down syndrome, Hearing Impairment, Parkinson’s disease, etc) is found to have a smaller vowel space area (VSA) and this suggests the less precise motion of their tongue range.

CHAPTER III

Method

The study aimed to investigate and compare the vowel space areas across two regional dialects of Khasi language (Maram & Nongstoiñ) spoken in the state of Meghalaya.

3.1 Participants

A total of 40 native speakers of Khasi, between the age range of 20-30 years old from West Khasi Hills district, Meghalaya were selected for the study. The participants were divided into two groups (Group 1: Maram, Group 2: Nongstoiñ) and each dialectal group includes an equal number of males and females.

3.2 Inclusion criteria for participants

- Native speakers of either Maram/ Nongstoiñ (two dialects of Khasi) with no major influence of the other dialects.
- Knows to read and write Khasi language
- Have been residing in Meghalaya and exposed to the dialect for the last 15 years
- Uses the dialect at home and on regular basis.
- Individuals with no history of any speech, language, hearing, or any neurological or cognitive impairment.
- Individuals with no structural or functional deficits on oro-motor examination

3.3 Stimuli

A total of 30 meaningful words of Khasi with the word forms of $C_1V_1C_2$ or $C_1V_1C_2V_2$ were selected from the Khasi-English dictionary by Nissor Singh (1906).

The words selected included three corner vowels /a/ (mid-central vowel), /i/ (high front vowels), and /u/ (high back vowel**)** and all these vowels are short vowels. The vowels that are occurring in the medial position (V_1) were the target vowel. C_1 and C_2 were consists of stop consonants such as /k, t, d, p, b/. The target word were embedded in the carrier phrase *"/ mɨnta ŋan oŋ* ________/'', that is "now I'll say _______" in order to obtain the natural stress and intonation, inferred Appendix 1.

3.4 Instrumentation

Olympus Multi-Track Linear PCM Recorder (Model No: LS-100) was used for recording the speech samples. The recorder was kept approximately 10 cm away from the mouth of the participants and the stimuli were presented using a laptop computer system.

3.5 Procedure

The sample was collected from the geographical regions. Written consent was obtained from the participants before the recording. The participants were made to sit restfully in a relaxed position in a quiet room and the sample was recorded individually. The participants were instructed that the stimuli will be shown on a laptop in a PPT form and he/she will have to utter the words containing target vowels with the carrier phrase three times in random order and the inter stimuli interval was approximately 2 seconds.

3.6 Data Analysis

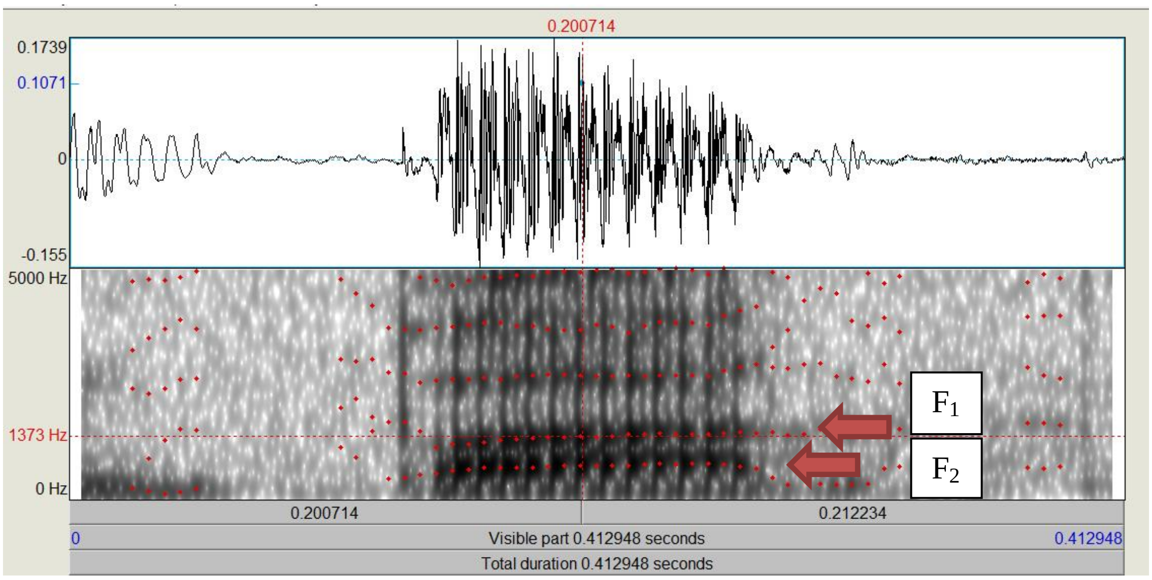
The acoustic analysis was carried out using PRAAT Version 6.1.01 (Boersma and Weenink, 2019) to obtain the first (F_1) formant and second (F_2) formant frequencies and formant frequencies values were entered in a MATLAB (Department of Electronics, AIISH, Mysore) based program to obtain the vowel triangle and vowel space area (VSA).

3.6.1 *Acoustic Analysis*

The data recorded were transferred to a personal computer and the acoustic analysis software PRAAT (Version 6.1.01) was used to analyze the speech samples. The vowels /a/, /i/, /u/ were located in the medial position for each target words. The first formant (F_1) and second formant (F_2) frequencies for each target vowel were measured at the mid-point of the vowel at a sampling frequency of 22000 Hz. The average of each formant for three occurrences of each vowel was considered for further analysis. For example, three occurrences of vowel /a/ were identified and the formant frequencies (F_1 & F_2) were obtained for each occurrence. These three values were averaged to obtain the average values of formants. Illustration of the first F_1 and second F_2 formant frequencies is shown in figure 3.1.

Figure 3.1

Illustration of measurement of formant frequencies (F_1, F_2) for vowel /a/.

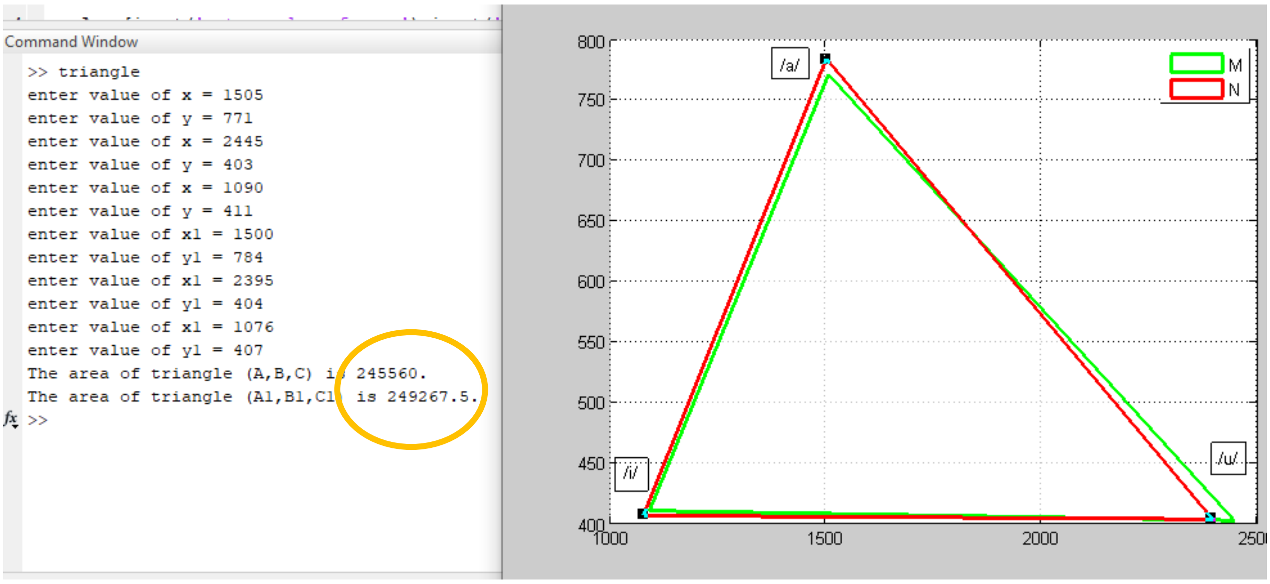


3.6.2 *MATLAB Analysis*

To obtain the vowel triangle and vowel space area, the average formant frequency values of the target vowels (/a/, /i/, /u/) were entered in a MATLAB (7.9.0.529) based program. On the X-axis the second formant frequency (F_2) was plotted, and on the Y-axis the first formant frequency (F_1) was plotted. As this is a custom made program, it can plot two vowel triangles and calculate the vowel space area (VSA). To obtain the vowel triangle the average formant values (F_1 & F_2) of 20 subjects in each dialect were calculated. A total of 12 formant frequency values were fed into the MATLAB based program i.e., six formant frequency per triangle (F_1 & F_2 of the corner vowels /a/, /i/, and /u/). Once the values were fed, two overlapping triangles were obtained. Two triangles are color-coded differently for each dialect as shown in Figure 3.2.

Figure 3.2

An illustration of the vowel triangle and vowel space area in MATLAB



Note: M=Maram dialect and N= Nongstoiñ dialect

3.8 Statistical Analysis

SPSS (version 20) software was used for statistical analysis. Shapiro-Wilk test of normality was administered to test the normality of the data. Further appropriate parametric tests were applied.

3.9 Inter and Intra judge reliability

Fifteen percent of the randomly selected samples were subjected to Inter and Intra judge reliability tests. To check the inter judge reliability three speech language pathologists including the researcher performed the acoustic analysis of the parameters independently. However, for the intra-judge reliability, the investigator herself analyzed the randomly selected samples at two different time periods.

3.9.1 Intra and Inter-Judge Reliability in Maram dialect

The intra-judge and inter-judge agreement were analyzed using Cronbach's alpha test for all the spectral parameters and score for intra-judge reliability ranged from 0.986 to 0.994 for all the parameters indicating good internal consistency. Cronbach's alpha scores for inter-judge reliability ranged from 0.857 to 0.994 for the spectral parameters in the Maram dialect indicating good to excellent internal consistency across the measurements.

3.9.1 Intra and Inter Judge Reliability in Nongstoiñ dialect

The intra-judge and inter-judge agreement were analyzed using Cronbach's alpha test for all the spectral parameters and the score for intra-judge reliability ranged from 0.750 to 0.997 for all the parameters indicating good internal consistency. Cronbach's alpha scores for inter-judge reliability ranged from 0.75 to 0.988 for the spectral parameters in the Nongstoiñ dialect indicating good to excellent internal consistency across the measurements.

CHAPTER IV

Results

The study aimed to explore and compare the vowel space areas (VSA) of two Khasi regional dialects (Maram & Nongstoiñ), an Austro-Asiatic language spoken in the state of Meghalaya. The study also focused on the vowel space areas (VSA) variation in the two dialects with respect to gender. The objectives of the study are as follows.

- To obtain a vowel triangle using first (F_1) and the second (F_2) formant frequencies of the corner vowels /a/, /i/, /u/ and calculate the vowel space area in Maram speaking adults of 20-30 years of age.
- To obtain a vowel triangle using first (F_1) and the second (F_2) formant frequencies of the corner vowels /a/, /i/, /u/ and calculate the vowel space area in Nongstoiñ speaking adults of 20-30 years of age.
- To compare the vowel space area of Maram speaking individuals with VSA of Nongstoiñ speaking individuals.
- To compare the vowel space area between males and females in the two dialects of Khasi.

Data were collected from 40 Khasi native speakers, from two dialectal regions between the age range of 20-30 years old. The participant's task was to utter the words containing target vowels with a carrier phrase presented in a PPT form on a laptop. The words included three corner vowels /a/, /i/, and /u/. The first formant (F_1) and second formant (F_2) frequencies were extracted using PRAAT (Version 6.1.01) software and the vowel space area (VSA) based on the first formant (F_1) and second formant (F_2) frequencies were obtained using a MATLAB (7.9.0.529) based program.

The data were further subjected to statistical analysis using SPSS software (Version 20).

The results of the study are explained under the following heads

4.1 Mean and Standard Deviation (SD) of F_1, F_2, and VSA in two dialects of Khasi (Maram and Nongstoiñ).

4.1.1 Formant frequency (F_1)

4.1.2 Formant frequency (F_2)

4.1.3 Vowel space area (VSA)

4.2 Statistical Comparison of Vowel Space Area

4.2.1 Vowel space area (VSA) across dialects and gender

4.2.2 Across male participants of both dialects

4.2.3 Across female participants of both dialects

4.1 Mean and standard deviation (SD) of formant frequencies (F_1 and F_2) and vowel space area (VSA) in two dialects

Descriptive statistical analysis was performed, using SPSS (version 20) software, to obtain the mean and standard deviation (SD) values of the first formant (F_1) and second formant (F_2) frequencies of the corner vowels /a/, /i/, and /u/ and the vowel space area (VSA).

4.1.1 Formant frequency (F_1)

Descriptive statistics was administered to obtain the mean and standard deviation (SD) of the first formant frequency (F_1). The results indicated that mean F_1 was higher in vowel /a/ for the participants of the Maram dialect (M=784, SD=91). For vowel /i/ mean F_1 was found to be almost the same for participants of both dialects (Maram, M=784, SD=91, Nongstoiñ, M=771, SD=74). For vowel /u/, F_1 was higher for the Nongstoiñ dialect (M=412, SD=30). Standard deviation (SD) of F_1 was maximum for vowel /a/ in both dialects as shown in Table 4.1.

Table 4.1

Mean in Hz and standard deviation (SD) of Formant frequency (F_1) in two dialects of Khasi (Maram & Nongstoiñ)

		Maram		**Nongstoiñ**	
		Mean (Hz)	SD	Mean (Hz)	SD
F_1 of Vowel /a/	Total	784	91	771	74
	Males	704	34	704	33
	Females	864	45	838	27
F_1 of Vowel /i/	Total	404	29	404	43
	Males	380	10	374	30
	Females	428	20	433	32
F_1 Vowel /u/	Total	408	23	412	30
	Males	401	11	397	33
	Females	414	30	426	18

Considering males and females, both F_1 and F_2 are higher in female participants as expected. In male participants results indicated that for vowel /a/, F_1 was found to be similar in both dialects (Maram, M=704, SD=34, Nongstoiñ, M=704, SD=27). However, for vowels /i/ and /u/, F_1 was higher for the participants of Maram dialect. For female participants, F_1 for vowel /a/ was higher for the participants of Maram dialect and F_1 of vowels /i/ and /u/ were higher in the Nongstoiñ dialect. Standard deviation (SD) was higher in females in both groups as shown in Table 1.1.

4.1.2 Formant frequency (F_2)

Descriptive statistics was administered to obtain the mean and standard deviation of second formant frequency (F_2) in both dialects. The results indicated that mean F_2 were higher for all vowels /a/, /i/, and /u/ for the participants of Nongstoiñ dialect (/i/ M=1505, SD=212, /i/ M=2445, SD=216, /u/ M=1090, SD=71). Standard deviation (SD) of F_2 was maximum for vowel /i/ in both dialects as shown in Table 4.2.

Table 4.2

Mean in Hz and Standard Deviation (SD) of Formant frequency (F_2) in two dialects of Khasi (Maram & Nongstoiñ)

		Maram		**Nongstoiñ**	
		Mean (Hz)	SD	Mean (Hz)	SD
F_2 of Vowel /a/	Total	1500	164	1505	212
	Males	1350	34	1313	74
	Females	1651	74	1698	79
F_2 of Vowel /i/	Total	2395	213	2445	216
	Males	2209	91	2266	130
	Females	2581	106	2625	101
F_2 of Vowel /u/	Total	1077	69	1090	71
	Males	1069	77	1057	54
	Females	1084	62	1123	73

In males, results indicated that for vowel /a/ and /u/, F_2 were higher in the participants of Maram dialect (/a/ M=1350, SD=34, /u/ M=1069, SD=77) compared to males of Nongstoiñ dialect. However, for vowels /i/ F_2 was higher for the participants of Nongstoiñ dialect. For female participants, F_2 were higher for all vowels /a/, /i/, and

/u/ in Nongstoiñ dialect (/a/ M=1698, SD= 79, /i/ M=2625, SD=130, /u/ M=1123, SD=73). Standard deviation (SD) was higher in females in both dialects as shown in Table 4.2.

4.1.3 Vowel space area (VSA)

Descriptive statistics were run to obtain the mean and standard deviation (SD) of the vowel space area (VSA). The results indicated that the mean vowel space area (VSA) was higher in the Maram dialect (M=255.66, SD=92.84). In males, the vowel space area (VSA) was larger for the male participants of the Nongstoiñ dialect (M=184.733, SD=21.58). In female participants, the vowel space area (VSA) was larger for the Maram dialect (M=334.11, SD=57.04). The standard deviation (SD) was higher in Maram dialect for both the gender as shown in Table 4.3.

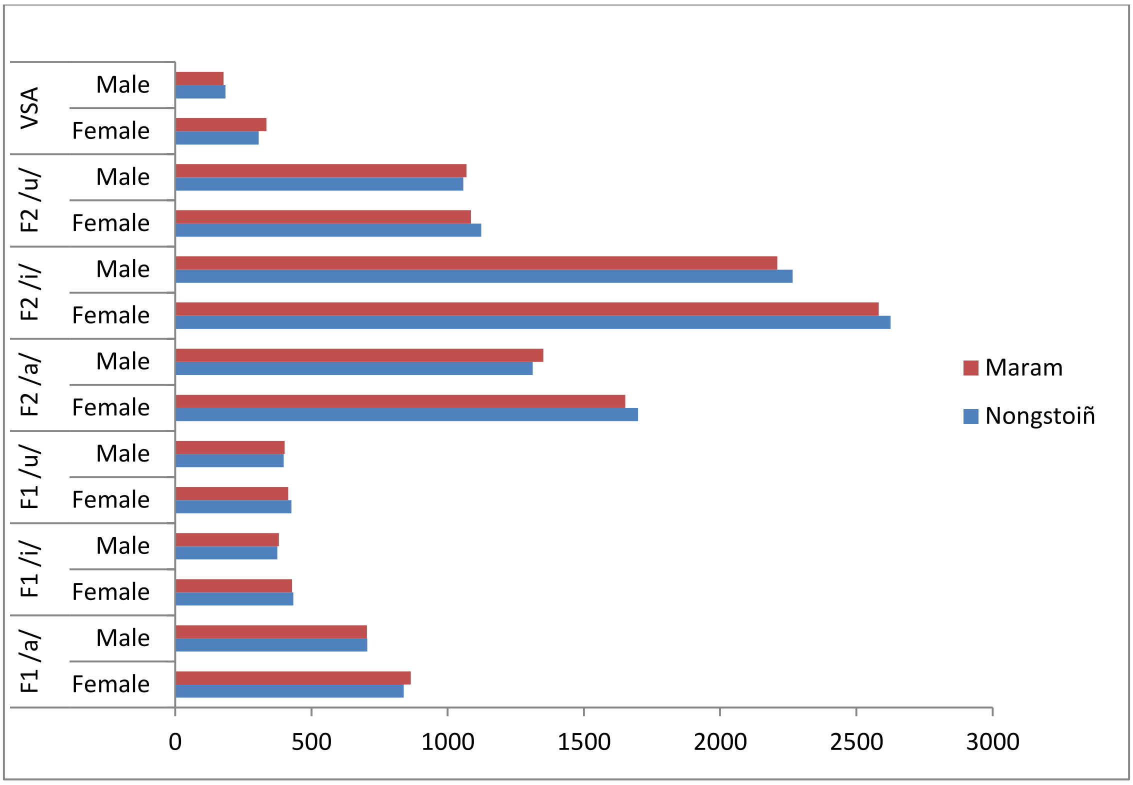
Table 4.3

Mean in KHz^2 and standard deviation (SD) of vowel space area (VSA) in two dialects of Khasi (Maram & Nongstoiñ)

		Maram		**Nongstoiñ**	
	Gender	Mean (KHz^2)	SD	Mean (KHz^2)	SD
Vowel Space Area	Total	255.68	92.84	245.59	72.69
	Males	177.22	35.65	184.73	21.58
	Females	334.11	57.04	306.45	49.57

Figure 4.1

Mean of F_1 and F_2 of the three corner vowels (/a/, /i/, and /u/) *and vowel space area (VSA) in two dialects of Khasi (Maram & Nongstoiñ).*



As the present study focused on the vowel space area (VSA) and not on the first formant (F_1) and second formant (F_2) frequencies, further statistical analysis for comparison across the two dialects was carried out for vowel space area (VSA). Shapiro-Wilks normality test was performed to check the normality of the vowel space area (VSA) for both Maram and Nongstoiñ dialect. Vowel space area (VSA) data was considered as normally distributed as the results of Shapiro-Wilks tests showed a significance of $p>0.05$. Therefore, the parametric test, Two-way ANOVA was selected for further statistical comparisons.

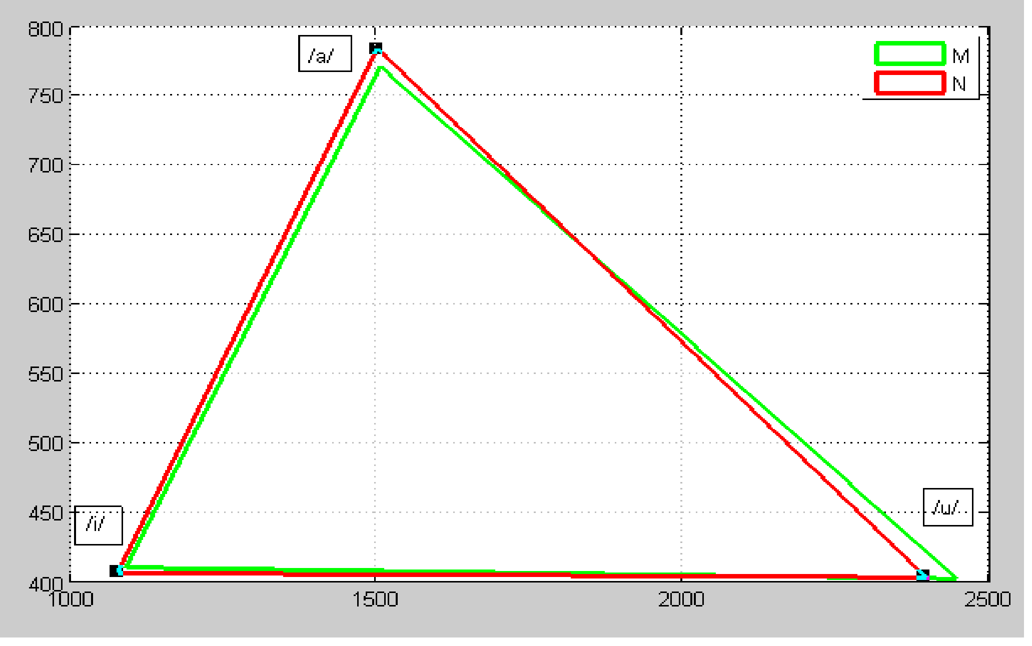
4.2 Statistical comparison of vowel space area (VSA)

4.2.1 Vowel space area (VSA) across dialects and gender

Two-way ANOVA was carried out to study the main effects of dialect and gender and their interaction effects. It was observed that no significant difference was seen for vowel space area (VSA) across the two dialects [$F(1,36) = .465$, $p>0.05$] as shown in Table 1.4. Hence, the null hypothesis stating there is a significant difference in the vowel space area (VSA) across two dialects of Khasi is rejected. However, it was observed that the Maram dialect had a marginally larger vowel space area (VSA) compared to Nongstoiñ dialects.

Figure 4.2

Mean vowel space area (VSA) across two dialects



Note: M=Maram dialect, N= Nongstoiñ dialect

Table.4.4

Comparison of Vowel space area (VSA) across dialects and gender in Khasi

	F-Value	p-value
Dialects	.545	.465
Gender	104.209	.000 **

** indicates, a significant difference (*p*≤0.005) across gender

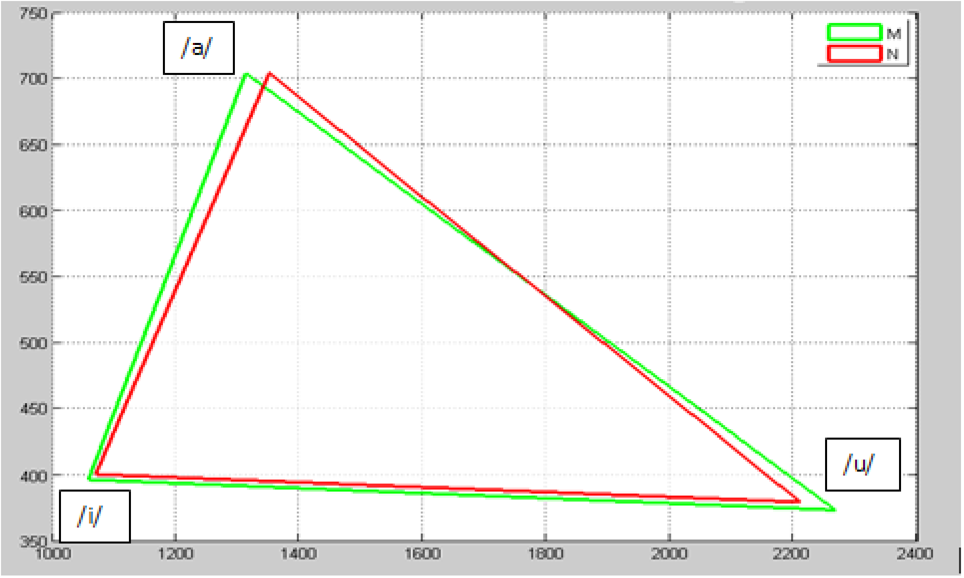
It was observed that gender [F (1,36)=104.2, p<0.05] had a significant difference in the vowel space area (VSA) across the two dialects (Table 1.4). Hence, the null hypothesis which states there is a significant difference in the vowel space area (VSA) across gender in two dialects of Khasi is accepted. It was observed that female participants had larger vowel space area (VSA) compared to male participants in both dialects.

4.2.2 Vowel space area (VSA) across male participants of both dialects

In males, the vowel space area (VSA) across the two dialects of Khasi (Maram and Nongstoiñ), was larger for the participants of the Nongstoiñ dialect (M=184.73, SD=21.58) compared to the participants of Maram dialect (M=177.22, SD=35.65), as shown in Table. 4.3.

Figure 4.3

Mean vowel space area (VSA) across males



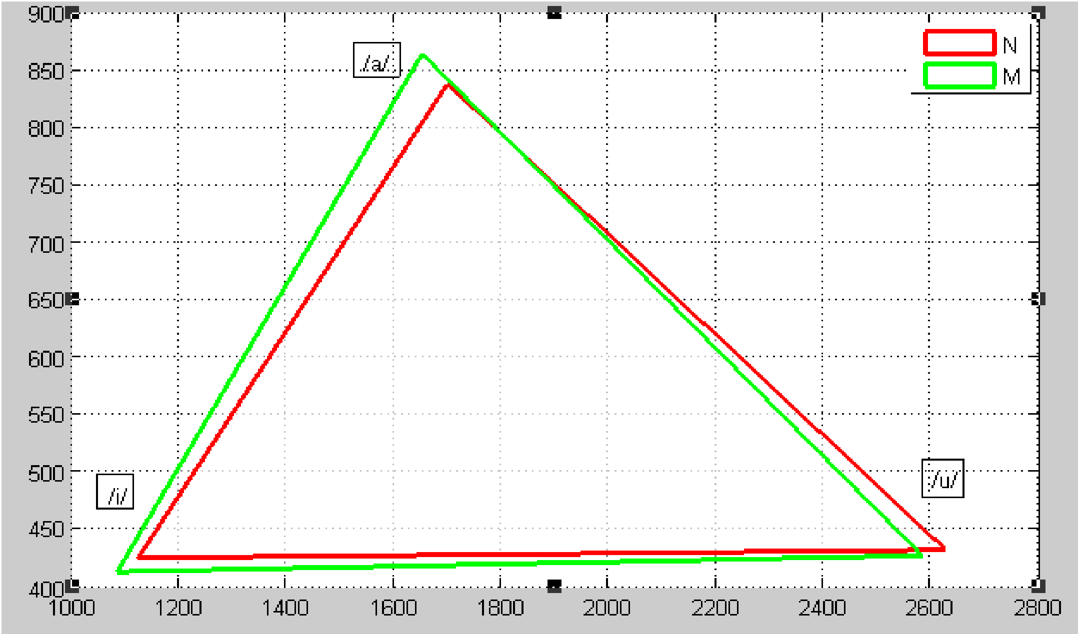
Note: M=Maram dialect, N= Nongstoiñ dialects

4.2.3 Vowel space area (VSA) across female participants of both dialects

For female participants, the vowel space area (VSA) across the two dialects of Khasi (Maram and Nongstoiñ), was larger in the Maram dialect compared to the participants of Nongstoiñ dialect.

Figure 4.4

Mean vowel space area (VSA) across females



Note: M=Maram dialect, N= Nongstoiñ dialect

In a nutshell, the results of the present study on comparison of vowel space area (VSA) across two dialects of Khasi (Maram & Nongstoin) revealed that mean VSA was higher in the former with no significant dialect effect but the gender effect was significant. Females had larger vowel space compared to males.

CHAPTER V

Discussion

The main objective of the study was to explore the vowel space area (VSA) and its variability with respect to the two regional dialects of Khasi (Maram & Nongstoiñ). A total of 40 participants were divided into two groups; Group 1: Maram, and Group 2: Nongstoiñ with equal numbers of males and females in each dialectal group. Vowel space area (VSA) was obtained for each participant and this data was subjected to statistical analysis. The results of the study revealed some interesting points. It was observed that the vowel space area (VSA) of the Maram dialect was marginally larger than Nongstoiñ dialect, but with no significant difference. Females were observed to have significantly higher values than males in both dialects.

The first finding was that there no significant effect on the mean of vowel space area (VSA) across dialects of Khasi. In support of the present study a similar study by Jacewicz et al. (2007) investigated the vowel space areas across three regional dialects of American English (south-central Wisconsin, western North Carolina, & central Ohio). The findings suggested that although the formant frequency values vary across the dialects, the vowel space area is relatively constant across the dialects.

However, contrary to this finding, Robert and Ewa (2010) studied the vowel space area across two dialects in the United States (Wisconsin: upper Midwestern dialect & North Carolina: southern dialect). The results suggested that smaller vowel space area in North Carolina speakers than that of the Wisconsin speakers. Fox and Jacewicz (2008) analyzed three regional dialects of American English (south-central

Wisconsin, central Ohio, & western North Carolina) in total vowel space areas. The finding suggested that difference across dialects is significant. A similar study by Al Tamimi and Ferragne (2005), found a larger vowel space area (VSA) for French when compared to the two dialects of Arabic: Moroccan and Jordanian. A number of studies on the comparison of vowel space area (VSA) in Indian languages have also supported the finding of significant dialectal differences. Krishna and Rajashekhar (2012) examined the vowel space of typical individuals across the dialects of Telugu (Coastal, Rayalaseema & Telengana). The results suggested that Telugu's three dialects show a significant difference in vowel space areas across dialects. Anitha (2015) compared the vowel space of two tribal languages of Waynad district (Paniya & Kuruma) and spoken Malayalam of Kerala. The results suggested that adult speakers of Malayalam had larger vowel space areas than the tribal language speakers of Kerala. There is no significant finding between the two dialects (Paniya & Kuruma). Rini (2016) studied the vowel space area across different regional dialects (Kozhikode, Thrissur, Ernakulam, & Thiruvananthapuram) of Malayalam. The results suggested that the vowel space areas vary across dialects of Malayalam. The mean vowel space area (VSA) was largest in Ernakulam dialect followed by Kozhikode, Thiruvananthapuram, and the least was in Thrissur dialect. Sahana (2016) studied the vowel space areas across four regional dialects of Kannada (Mysuru, Mangaluru, Dharwad, and Kalaburagi). The results suggested that there was significant main effect of dialects on mean vowel space area (VSA). The vowel space area was highest in Mangaluru, the second largest in Mysuru, followed by the Dharawad, and the least was in Kalaburagi dialect.

Using two theories, the present finding of no variability in the vowel space area (VSA) can be clarified. The first theory, the quantal theory (Stevens, 1989), implies that the corner vowels /a/, /i/, and /u/ across languages have the same position in the acoustic vowel space i.e., there are certain shared vowels in languages across the world. On the contrary, dispersion theory (Liljencrants & Lindblom 1972, Lindblom 1986, 1990) notes that vowels of the language are organized rather in a perceptually distinct manner. Hence more the number of vowels in a language, the larger will be the vowel space area (VSA). In the current study, the number of vowels was equal in both dialects, with no significant difference in mean vowel space area (VSA) but was marginally larger in the Maram dialect. Also, there was no variation in vowel locations across the two dialects of the same language. Hence, the present study supports the quantal theory.

The lack of significant difference in the vowel space area (VSA) in the Maram and Nongstoin dialect can also be related to the geographical proximity of the two regions where these dialects are spoken in the state of Meghalaya.

In the present study, the Maram dialect had marginally larger mean and standard deviation (SD) of vowel space area (VSA) than the Nongstoiñ dialect**.** F_1 for vowel /a/ was higher for the participants of the Maram dialect, indicating reduced tongue height movement associated with more opening of the mandible. Nongstoiñ dialect established higher F_2 for vowel /i/, indicating these speakers had more tongue advancement and more lip retraction (Chiba & Kajiyama, 1958, pp. 115–154: Fant, 1960, pp. 209–211: Lindau, 1975, 1978, 1979: Linker, 1982: Jackson, 1988; Kent, Weismer, Kent, Vorperian, & Duffy, 1999: Hixon, Weismer, & Hoit, 2008).

The second finding was that there was a significant effect of vowel space area (VSA) across gender. Female vocal tracts tend to be shorter compared to males, and female formant frequencies tend to be higher. Mean and standard deviation

(SD) of the vowel space area (VSA) were larger in females compared to males in both dialects. This is consistent with preceding studies (Diehl et al.1996; Whiteside, 200; Simpson, 2001; Jacewicz et al. 2007; Simpson, & Ericsdotter, 2007; Smiljanic et al. 2006; Krishna & Rajashekhar, 2012; Jyotsna, 2015; Anitha, 2015. Simpson (2001) who found that posterior male lingual pallets moved maximum distance at a higher speed than females, resulting in reduced vowel space. Fant (1966, 1975) has suggested that the distinctive anatomical difference between the gender: in adult males the pharynx takes up a greater proportion of the overall length of the vocal tract compared to adult females. Nordstrom (1977) study on vocal tract modeling showed that even when gender differences are taken into account relative to pharynx length, female values for F_1 and F_2 are not well predicted based on the corresponding male values. Goldstein (1980) similarly resolved that structural differences between males and females are described as only part of the vowel formant frequency differences. Traunmuller (1984) to a certain extent comes closer to the agreement for F_2 and F_3 male and female differences, but not for F_1. Fant (1966, 1975), Nordstrom (1977), and Goldstein (1980) attribute to gender differences in articulatory behavior the anatomically unexplained formant differences (or, in the case of /u/, formant similarities). Other evidences that gender differences are partially behavioral rather than anatomical in vowel formant frequencies (Mattingly, 1966: Sachs et al. 1973: Henton, 1992). The reduced vowel space area (VSA) in males suggested that they are likely to have less clear speech than females (Bradlow et al.1996; Ferguson & Kewley-Port, 2007).

CHAPTER VI

Summary and Conclusions

Vowels are speech sounds that form an integral part of the sound system of any language. Each language is unique in terms of its vowel inventory. Any change in the vocal tract configuration can lead to significant changes in the vowel quality. Initially, the tendency was to study the individual formant frequencies of the vowels. Later the notion of acoustic vowel space came into representations to view the vowel inventory of a language. Vowel space area is a graphical method that represents vowels in terms of their location in both "acoustic" and "articulatory" space. Several studies cross-linguistic investigations revealed that the general organization of vowel inventories is ruled by auditory and articulatory limitation and demonstrated differences in vowel space area (VSA) across languages. It was observed that vowel space area (VSA) shows differences across dialects though few reported no difference across the dialects. The current study aimed at investigating and comparing the vowel space area (VSA) in two dialects of Khasi language (Maram & Nongstoiñ) spoken in the state of Meghalaya. Both these dialects are spoken in the district of West Khasi Hills.

A total of 40 native Khasi speakers between the age of 20-30 years were considered for the study. The participants were divided into two groups (Group 1: Maram and Group 2: Nongstoiñ dialect speakers) and each dialectal group included an equal number of males and females. A total of 30 meaningful words in the word forms of $C_1V_1C_2$ or $C_1V_1C_2V_2$ were used as the stimuli. The participants were asked to utter the meaningful words embedded in a carrier phrase, which was recorded using an Olympus digital voice recorder. The recorded samples were acoustically analyzed using PRAAT (Version 6.1.01) software to obtain the first formant (F_1) and second formant (F_2) frequencies and the values of the formant frequencies were entered in a MATLAB based program to obtain the vowel triangle and vowel space area (VSA). For statistical analysis SPSS (version 20) software was used.

The statistical results revealed, mean and standard deviation (SD) was marginally larger in the Maram dialect compared to the Nongstoin dialect but there was no statistically significant difference in vowel space area (VSA) between the two dialects of Khasi. Vowel inventory can also be thought of as the reason for no variability in vowel space area (VSA) as vowels are shared in the Khasi language. The lack of significant difference in vowel space area (VSA) in Maram and Nongstoin can also be related to the geographical proximity of the two regions where these dialects are spoken in the state of Meghalaya.

Another finding was that there was a significant effect across gender. It was noticed that females had larger vowel space area (VSA) in both the dialects of Khasi. Most studies have supported this view due to anatomical differences. However, there are other evidences that gender differences are partially behavioral rather than purely structural in vowel formant frequencies. Also, it is theorized that males have less clear speech compared to females.

To conclude, the outcomes of the current study showed no difference in vowel space area (VSA) across two dialects of Khasi (Maram and Nongstoiñ). Females had larger vowel space area (VSA) compared to males in both dialects. Statistically there was no significant effect of dialect but it was present for gender.

6.1 Future Directions

The current study can be replicated on

- Across age groups
- Other regional dialects of Khasi
- In individuals with several speech disorders of Khasi language

6.2 Limitations of the present study

- The present study included a limited sample size
- Participants of the study were selected from only one district of Meghalaya (West Khasi Hills District).

6.3 Implications of the study

- The findings of the study will provide more insight into the acoustic characteristics of the vowels of two regional dialects of Khasi, a North-Eastern language
- The effect of gender on acoustic characteristics of vowels can be observed.
- The information is useful in assessment and intervention for individuals with communication disorders speaking these dialects of Khasi language.
- It enables the researcher to document the vowel space of Khasi language.
- The data can be used to compare the vowel space of Khasi with English and other Indian languages.
- It serves as a reference for future acoustic studies in Khasi language.

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APPENDIX-I

Stimuli for vowels /a/, /i/, and /u/ and its meaning

Words in IPA	**Meaning**	**Words in IPA**	**Meaning**	**Words in IPA**	**Meaning**
/a/		**/i/**		**/u/**	
/bad/	With, And	/tip/	Know	/duk/	Poor
/ban/	To suppress	/pisa:/	Money	/kuna:/	Fine
/tam/	Pick	/kinɛ/	These	/duna/	Lack
/kanɛ/	This	/kita/	Those	/dum/	Dark
/kabu/	Opportunity	/bit/	Resemble	/pulɛ/	Read
/kanɔ/	Which	/kino/	Which	/pura/	Full
/kam/	Act, Work	/pin/	Pin	/kut/	Short
/tari/	Knife	/tika:/	Injection	/kup/	Cover
/pan/	Ask	/kit/	Carry	/kum/	Like
/para:/	Brother	/tim/	Scold	/dur/	Picture

APPENDIX-II

Sample of Consent form

All India Institute of Speech and Hearing, Manasagangothri,

Mysore, 570006

I Ms. Rishisha Lyngkhoi, 2nd M.Sc. SLP fellow, am doing research as a part of my dissertation on **"Comparison of Vowel Space Area in Two Dialects of Khasi"**. During the course of research I have to collect only speaking samples. There are no risks or discomforts involved during the study. Audio recording will be done during sample collection and these recordings will be kept confidential. The participation in the study is voluntary and there is no compulsion.

Informed Consent

I have been informed about the study and understand its purpose and participation in it. I give my consent for my participation in this study. I understand that I have the right to refuse participation as a subject or withdrawn my concern at any time. I give my consent my participation in this study.

I, ______________________________, the undersigned, give my consent for participation in the study.

(AGREE/DISAGREE)

Signature of the Participant
(Name and Address)

Signature of Investigator
(Name and Designation)

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