Research Inventy: International Journal of Engineering And Science
Vol.7, Issue 9 (September 2017), PP -09-13
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

A Study on the Intensity of Vowels of Disyllabic Words in Sundanese

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Abstract : *In this study, the effects of syllable position, syllable type and vowels on the intensity of disyllabic words in Sundanese are analyzed. It is shown from the result that, in Sundanese, for disyllabic words, the first syllable tends to be stressed, so the intensity values of vowels in the first syllable are larger than that in the second syllable. As the CVC syllable is phonologically heavier than the CV syllable, the intensity of CVC syllable is higher than that of the CV syllable. The intensity value of low vowel, /a/, is larger than that of high vowel /i/ and /u/, which is due to the fact that low vowels have a higher intrinsic intensity than high vowels.*
Keywords: *Syllable, vowel, intensity, stress*

Date of Submission: 09-09-2017 Date of acceptance: 20-09-2017

I. INTRODUCTION

The present study deals with the intensity of vowels in Sundanese. Intensity is defined as the energy carried by the sound waves per unit area. The international system of unit of intensity is watt per square meter, and one application is the noise measurement of sound intensity in the air at a listener's location as a sound energy quantity. Intensity is significant in cueing prosody [1-9]. Supra-segmental properties are fundamental features of speech. They can not only improve the naturalness of synthesized sound in speech engineering, but also improve the performance of machine speech recognition in voice controlled logistic systems. In the scope of linguistics, stress is the relative emphasis that may be specified on certain syllables in a word, or on certain words in a phrase or sentence, and the term can be also used for similar patterns of phonetic prominence inside syllables. The stress located on syllables within words is normally called word stress or lexical stress, and the stress located on words within sentences is called sentence stress or prosodic stress. Sentence and word stress are crucial prosodic features, and one of the properties usually used for stress detection is the intensity of syllables [10].

It is reported that there is an effect of vocal intensity condition and vowel type on cepstral analysis measurements. Awan et al [11] investigated sustained vowel samples of /i/, /a/, /u/, and /ae/, produced by 92 male and female subjects between the ages of 18 and 30 years, at three different vocal loudness conditions: (1) 'comfortable pitch and loudness', (2) 'as softly as possible without whispering', and (3) 'as loudly as possible without screaming the voice'. Vowel samples were analyzed for vocal intensity, fundamental frequency, and relative amplitude of the smoothed cepstral peak prominence. It was found that there were significant main effects of loudness condition and gender, and results also indicated that vowel type had a significant effect on intensity. Tahiry et al [12] examined the short and long Arabic vowels /a/, /a:/, /i/, /i:/, /u/ and /u:/ with a new approach, based on three methods: formant frequencies extraction, spectral moments and energy bands. Compared to other languages, one of the characteristics of Arabic language is that long vowels can be pronounced with different duration length. The formant frequencies are the most important features in characterizing vowels in different languages. However, formants are not very effective for vowels identification, especially when duration increases. Spectral moments and energy bands are proved to be useful in the identification of Arabic vowels.

For the purpose of classifying tense and lax vowels in English, Lee et al [13] investigated energy trajectory and voice quality measurements, together with conventional formant and duration properties. Tense and lax vowels are produced with different articulating configurations, which can be identified by measuring acoustic cues such as energy peak location, energy convexity, open quotient and spectral tilt. Using the proposed features on the TIMIT database, they conducted an analysis of variance, observed dialect effects, and found that an overall 85.2% classification rate is obtained, resulting in improvement over the application of only conventional acoustic features. The present study aims at investigating the intensity pattern of vowels in disyllabic words in Sundanese. It is to present the variation of the intensity of vowels /a/, /i/ and /u/ in different syllable structures at both the initial and final syllables of the words.

II. METHODOLOGY

This study focuses on the intensity of vowels in disyllabic words in Sundanese, and the intensity values of three vowels, /a/, /i/ and /u/, are analyzed. The vowels may occur in the first syllable or the second syllable of a word, and the two common syllable types in Sundanese are CV and CVC syllables. Therefore, vowels analyzed in this study include those in the first and the second syllables, as well as those in the CV and the CVC syllables.

In some languages, word stress is fixed, on the first syllable, or on the final syllable of a word. The vowels may occur in either the first or the second syllable in a word in Sundanese, so the effect of syllable position on vowel intensity will be analyzed. It is known that intensity may vary with syllable type, so the effect of syllable type on intensity will be explored. As vowels have their intrinsic intensity, the effect of vowels on intensity will also be analyzed. Intensity values are extracted using Praat [14], and an ANOVA is performed for the comparison of the measurements of the three factors. Statistic is done in SPSS.

III. RESULTS

3.1 Main effect

Figure 1 shows the intensity of vowels under the effects of syllable positions, syllable type and vowel. It is indicated from ANOVA results that, as far as main effect is concerned, the effects of all the three factors are significant, syllable position: $F(1, 1859) = 275.7$, $p < 0.001$, syllable type: $F(1, 1859) = 363.4$, $p < 0.001$, vowel: $F(2, 1858) = 11.2$, $p < 0.001$, with intensity value of the first syllable larger than the second syllable, that of the CVC syllable larger than the CV syllable, and the intensity value of vowel /a/ the largest, that of vowel /i/ the least.

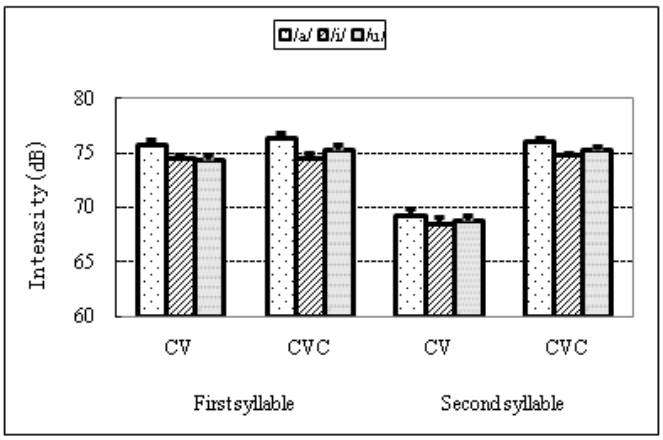

Fig. 1 Onset durations under the effect of focus and positions

In the following sections, the effects will elaborated in detail.

3.2 The effect of syllable position

3.2.1 CV syllable

In this study, vowel intensity of disyllabic words is investigated, and the target vowels may occur in the first syllable, in the second syllable of a word. There are two syllable types, CV syllable and CVC syllable. In this section, the effect of syllable position of the CV syllable type will be analyzed. ANOVA results show that the effect of syllable position is significant. The analysis results are, /a/: $F(1, 494) = 216.7$, $p < 0.001$, /i/: $F(1, 231) = 580.9$, $p < 0.001$, /u/: $F(1, 256) = 332.1$, $p < 0.001$, with intensity values of vowels in the first syllable larger than in the second syllable.

3.2.2 CVC syllable

For the CVC syllable, the results are quite different. It is displayed from ANOVA analysis that the effect of syllable is not significant for all the three vowels, /a/: $F(1, 452) = 0.383$, $p = 0.536$, /i/: $F(1, 190) = 0.01$, $p = 0.982$, /u/: $F(1, 231) = 0.437$, $p = 0.509$. Analysis shows that, in the CVC syllable, for all the three vowels, /a/, /i/, and /u/, there is no significant difference between the intensity values in the first and the second syllable.

3.3 The effect of syllable type

3.3.1 The first syllable

In this section, the intensity values of vowel in the CV and the CVC syllable will be compared. For vowels in the first syllable of the word, ANOVA results show that the effect of syllable type is significant for vowel /i/: $F(1, 162) = 4.72$, $p = 0.036$, with intensity value larger in the CVC syllable then in the CV syllable. However, for the other two vowels, there is no significant effect, /a/: $F(1, 513) = 0.022$, $p = 0.883$, /u/: $F(1, 208) = 1.494$, p

= 0.223.

3.3.2 The second syllable

Coming to vowels in the second syllable of the word, the result is different from that for the case of the first syllable. It is presented from ANOVA results that the effect of syllable type is significant for all the three vowels, /a/: $F(1, 433) = 254.1$, $p < 0.001$, /i/: $F(1, 259) = 463.1$, $p < 0.001$, /u/: $F(1, 279) = 437.3$, $p < 0.001$, with intensity values of vowels in the CVC syllable larger than in the CV syllable.

3.4 The effect of vowel

3.4.1 The first syllable

In this section, the intensity values of various vowels will be compared. In the first syllable of the word, ANOVA results display that the effect of vowel is significant. The result for the CV syllable is $F(2, 701) = 10.6$, $p < 0.001$. Post Hoc results show that the intensity value of /a/ is larger than /i/ ($p < 0.001$) and /u/ ($p = 0.001$), while there is no difference between /i/ and /u/ ($p = 0.992$). For the CVC syllable, the analysis result is $F(2, 183) = 6.72$, $p = 0.038$. Post Hoc results show that the intensity value of /a/ is larger than /i/ ($p = 0.034$). However, on significant difference is found between /a/ and /u/ ($p = 0.605$) or between /i/ and /u/ ($p = 0.609$).

3.4.2 The second syllable

As for the second syllable, it is displayed from ANOVA results that, either for the CV syllable or for the CVC syllable, the effect of vowel is significant. The analysis result is, for the CV syllable: $F(2, 218) = 8.08$, $p < 0.001$. Post Hoc results show that the intensity value of /a/ is larger than /i/ ($p = 0.01$), and that of /u/ is also larger than /i/ ($p = 0.008$). However, there is no significant difference between the intensity value of /a/ and /u/ ($p = 0.893$). For the CVC syllable, the analysis result is $F(2, 691) = 10.3$, $p < 0.001$. Post Hoc results show that the intensity value of /a/ is larger than /i/ ($p < 0.001$). However, no significant difference is found between the intensity value of /a/ and /u/ ($p = 0.081$), or between /i/ and /u/ ($p = 0.141$).

IV. DISCUSSION

In this study, the effects of syllable position, syllable type and various vowels on intensity of disyllabic words are analyzed. It is found from the main effect results that the intensity values of vowels in the first syllable are larger than those in the second syllable. It is shown from this result that, in Sundanese, for disyllabic words, the first syllable tends to be stressed than the second.

In phonology, stress is relative emphasis given to a certain syllable in a word, or to a certain word in a phrase or sentence. This emphasis is usually caused by such characteristics as increased intensity or vowel length, full articulation of the vowel, and changes in pitch. The terms stress and accent are often used synonymously in this context, but they are sometimes distinguished, with accent being more strictly sound-based. For example, when emphasis is produced through pitch alone, it is called pitch accent, and when produced through length alone, it is called quantitative accent. When caused by a combination of various intensified properties, it is called dynamic accent. The stress placed on syllables within words is called word stress or lexical stress. Some languages have fixed stress, meaning that the stress on virtually any multi-syllabic word falls on a particular syllable, such as the first or the penultimate. Other languages have variable stress, where the position of stress in a word is not predictable in that way. However, some languages, such as French and Mandarin, are sometimes analyzed as lacking lexical stress entirely. There is a tendency for the first syllable to be stressed for Sundanese, so the intensity value of the first syllable is larger than the second.

It is also found in this study that the intensity value of CVC syllable is larger than that of the CV syllable. This is due to the fact that the CVC syllable is heavier than the CV syllable. In linguistics, syllable weight is the concept that syllables pattern together according to the number and duration of segments in the rime. A heavy syllable is a syllable with a branching nucleus or a branching rime, although not all such syllables are heavy in every language. A branching nucleus generally means the syllable has a long vowel or a diphthong, which is usually abbreviated as CVV. A syllable with a branching rime is a closed syllable, that is, one with a coda, one or more consonants at the end of the syllable, and this type of syllable is abbreviated as CVC. In some languages, both CVV and CVC syllables are heavy, while a syllable with a short vowel as the nucleus and no coda, a CV syllable, is a light syllable. In other languages, only CVV syllables are heavy, while CVC and CV syllables are light. In yet other languages, CVV syllables are heavy and CV syllables are light, while some CVC syllables are heavy, and other CVC syllables are light. The distinction between heavy and light syllables plays an important role in the phonology of some languages, especially with regard to the assignment of stress. For instance, in the Sezer stress pattern in Turkish observed in place names, the main stress occurs as an iamb, one syllable to the left of the final syllable. However, when the foot contains a heavy syllable in the first syllable while the second syllable is light, the iamb shifts to a trochee, because there is a requirement that main stress fall on a heavy syllable whenever possible. Compared to light syllable, heavy syllable tends to stressed, so the intensity value of CVC syllable is larger than the CV syllable.

As for intensity of different vowel, results show that the intensity value of low vowel, /a/, is larger than that of high vowel /i/ and /u/. Generally speaking, low vowels have a higher intrinsic intensity than high vowels,

i.e., the intensity of high vowels is damped by the shape of the vocal tract (Lehiste & Peterson 1959), and low vowels have a longer intrinsic duration as the jaw must be lowered to produce a low vowel.

The principal vowel features are Palatality, Labiality and Sonority or intrinsic intensity, which is correlated inversely with Vowel Height, with low vowels the most sonorous and high vowels least. Palatality, labiality and the height features are both binary and gradient. They are binary, in the sense that they are either present or absent in a vowel, for example, /o/ is labial and /a/ is non-labial, /i/ is high and /e/ is non-high. Either the presence of these features or their absence can be referred to in phonological processing. But if present, each feature may be present to a greater or lesser degree, depending on the other features with which it simultaneously combines. The phonetic aspects of this claim would seem to be obvious, and the conditions on the application of phonological processes confirm it. These features and their varying strengths are manifested in the susceptibility of vowels to different phonological substitutions.

Vowel-intrinsic intensity is negatively correlated to vowel-intrinsic fundamental frequency, so that vowels with high intrinsic pitch have low intrinsic intensity, and vice-versa. Given the negative correlation between the two intrinsic properties of vowels, words containing vowels with high intrinsic intensity are associated with more power than words containing low intrinsic intensity vowels. As the intrinsic intensity of low vowels is higher than that of the high vowels, the intensity value of /a/ is larger than that of /i/ and /u/.

Detailed analysis shows that, for CV syllable, intensity values of all the three vowels in the first syllable larger than in the second syllable. However, for the CVC syllable, there is no significant difference between the first and the second syllable. As is mentioned above, in Sundanese, there is a tendency for the first syllable to be stressed, and the CVC syllable is phonologically heavier than the CV syllable. As CV syllable is light syllable, and as the second syllable tends to be unstressed in Sundanese, vowels in CV syllable tend to be reduced in the second syllable. It is known that in many languages, such as Russian and English, vowel reduction may occur when a vowel changes from a stressed position to an unstressed position. In English, unstressed vowels may reduce to schwa-like vowels, though the details vary with dialect. The effect may be dependent on lexical stress, for example, the unstressed first syllable of the word 'photographer' contains a schwa, whereas the stressed first syllable of 'photograph' does not. It may also be dependent on prosodic stress, for example, the word 'of' is pronounced with a schwa when it is unstressed within a sentence, but not when it is stressed. Vowels in the CV tend to be reduced in the second syllable, so the intensity value is smaller than in the first syllable. However, CVC syllable is phonologically heavy syllable, it will not reduce in the second syllable, so there is no significant difference between the intensity values between the first and the second syllables for the CVC syllable.

For the effect of syllable type, it is found that in the second syllable, for all the three vowels, the intensity value of CVC syllable is larger than that of the CV syllable. However, in the first syllable, there is only significant effect of syllable type for vowel /i/, while no significant effect is found for vowels /a/ or /u/. As is mentioned above, CVC syllable is phonologically heavy, and CV is light. The second syllable tends to be unstressed, so in the second syllable, the vowel of the light syllable tends to be reduced. When vowels in the CV syllable get reduced, the difference between the CV syllable and the CVC syllable is increased. Therefore, in the second syllable, the intensity value of CVC syllable is larger than that of CV syllable. For vowels of the first syllable, they are not reduced in the CV syllable, so there is no significant difference between the intensity of vowel /a/ and /u/. The intrinsic intensity of vowel /i/ is the least, and when it occurs in the light syllable, it may be less strong than in the heavy syllable. Therefore, in the first syllable, the intensity value of /i/ of the CV syllable is smaller than in the CVC syllable.

Regarding the intrinsic intensity of different vowels, results indicate that the intensity of /a/ is higher than that of /i/ or /u/, and there is also the tendency that the intensity of /u/ is higher than that of /i/. Detailed analysis shows that, either in the first syllable or in the second syllable, the results are quite similar with each other. This means that there is no interactive effect of syllable position and vowel intrinsic intensity. However, it is not the case for syllable type, in the CV syllable, the difference among vowels is large, while in the CVC syllable, the difference is small. CVC syllable is phonologically heavy, while CV is light. In the heavy syllable, the vowels will be more prominent, and the intrinsic difference between the vowels be reduced. Therefore, in the CVC syllable, the intrinsic difference among vowels is not quite obvious.

V. CONCLUSION

This study deals with the effects of syllable position, syllable type and vowels on the intensity of disyllabic words in Sundanese. Results show that there is a tendency for the first syllable to be stressed in Sundanese, so the intensity value of the first syllable is larger than the second. Syllable weight is the concept that syllables pattern together according to the number and duration of segments in the rime. A heavy syllable is a syllable with a branching nucleus or a branching rime. Compared to light syllable, heavy syllable tends to stressed, so the intensity value of CVC syllable is larger than the CV syllable.

Vowel-intrinsic intensity is negatively correlated to vowel-intrinsic fundamental frequency, so that vowels with high intrinsic pitch have low intrinsic intensity, and vice-versa. Words containing vowels with high

intrinsic intensity are associated with more power than words containing low intrinsic intensity vowels, so the intensity value of /a/ is larger than that of /i/ and /u/. Vowel reduction may occur when a vowel changes from a stressed position to an unstressed position, and vowels in the CV tend to be reduced in the second syllable, so the intensity value is smaller than in the first syllable. The intrinsic intensity of vowel /i/ is the least, and when it occurs in the light syllable, it may be less strong than in the heavy syllable. Therefore, in the first syllable, the intensity value of /i/ of the CV syllable is smaller than in the CVC syllable.

ACKNOWLEDGMENT

The research reported here is partially supported by China National Social Science Fund, No. 16ZDA211.

REFERENCES

[1] A. Cutler, "Lexical stress". In The Handbook of Speech Perception, D. B. Pisoni, & R. E. Remez Eds. Oxford, UK: Blackwell, 2005, pp. 264–289.
[2] D. B. Fry, "Duration and intensity as physical correlates of linguistic stress". Journal of the Acoustical Society of America, vol. 27, 1955, pp.765–768.
[3] S. Bolozky, "Remarks on rhythmic stress in Modern Hebrew". Journal of Linguistics, vol. 18,(02), 1982, pp. 275–289.
[4] P. Lieberman, "Some acoustic correlates of word stress in American English". Journal of the Acoustical Society of America, vol. 32(4), 1960, pp. 451–454.
[5] M. Liberman, & A. Prince, "On stress and linguistic rhythm". Linguistic Inquiry, vol. 8, 1977, pp. 249–336.
[6] J. Morton, & W. Jassem, "Acoustic correlates of stress". Language and Speech, 8(3), 1965, pp. 159–181.
[7] V. J. van Heuven, & M. de Jonge, "Spectral and Temporal Reduction as Stress Cues in Dutch". Phonetica, vol. 68(3), 2011, pp. 120–132.
[8] C. Shih, & H. Y. D. Lu, "Effects of talker-to-listener distance on tone". Journal of Phonetics, vol. 51, 2015, pp. 6-35.
[9] P. Ingo, G. Kunter & M. Schramm, "Acoustic correlates of primary and secondary stress in North American English". Journal of Phonetics, vol. 39, 2011, pp. 362–374.
[10] L. Czap, and J. M. Pinter, "Intensity Feature for Speech Stress Detection", 16th International Carpathian Control Conference, 2015, pp. 91-94.
[11] S. N. Awan, A. Giovinco, and J. Owens, "Effects of Vocal Intensity and Vowel Type on Cepstral Analysis of Voice", Journal of Voice. Vol 26(5), pp. 670.e15-670.e20.
[12] K. Tahiry, B. Mounir, I. Mounir, and A. Farchi, "Energy bands and spectral cues for Arabic vowels recognition", International Journal of Speech Technology. vol. 19(4), pp. 707-716.
[13] S. M. Lee, and J. Y. Choi, "Tense-Lax Vowel Classification with Energy Trajectory and Voice Quality Measurements". IEICE Transactions on Information and Systems, vol. 95(3), 2012, pp. 884-887.
[14] P. Boersma, "Praat, a system doing phonetics by computer", Glot International, 2001, 5:9/10, pp. 341–345.