International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 12, Issue 10 (October 2016), PP.44-48

Research on the Acoustic Realization of Lateral in Sundanese

Maolin Wang
College of Chinese Language and Culture / Institute of Applied Linguistics, Jinan University, Guangzhou, China

Abstract:- In this study, the duration, intensity and formant values are investigated on the lateral in Sundanese, and it is found that, lateral is lengthened at word final position, which is due to the final lengthening mechanism. The lateral is more lenis-like word-medially, so its intensity is greatly increased at this position. Consonants are usually strengthened at word initial position, where they are more fortis-like, so the intensity value is small at this position. Lateral at word final position is usually velarized, so the first formant value gets increased, and the second formant gets decreased.

Keywords:- Lateral, duration, intensity, formant

I. INTRODUCTION

This study deals with the acoustic realization of lateral in Sundanese. Laterals are common in languages, and in the production of a lateral, the tongue and the roof of the mouth get close, leaving a passage for the air to escape. The air originated from the lungs flows through the passage from one or both sides of this central closure. The tongue and the roof are not closely contacted, and the size of the passage is wide enough, so that the flow does not create friction noise as it passes out [1]. There is closure between the centre of the tongue and the roof of the mouth where the contact is to be made. Due to the closure along the centre, the way for the air to escape is through the sides of the tongue. The lateral is therefore somewhat different from other sounds, in which there is normally less contact between the articulators. Laterals are normally voiced, with the vocal folds in the normal position to produce vibrations, similar to the production of vowels. They are mostly produced with tongue tip or blade contact in the dental or alveolar region [2].

The lateral may occur initially, medially and finally, and its distribution is therefore not limited. The realization of the lateral before vowels sounds different from that in other contexts. There is a lateral phoneme in English, and it has two allophones in many dialects. One of them is found before vowels, as in 'lady' or 'fly', called clear /l/, and is pronounced as the alveolar lateral approximant in a neutral position of the body of the tongue. The other variant is called dark /l/, found before consonants or at word-finally position, as in 'bold' or 'tell', which is pronounced as the velarized lateral approximant, with the tongue in a spoon-like shape. Its back part is raised, which gives the sound a w-like resonance. The realization of clear or dark /l/ will occur in particular contexts: a clear /l/ will never precede consonants or precede a pause, but only precede vowels, and a dark /l/ will never occurs before vowels. In traditional English phonology, it is assumed that this difference is categorical [3], however Recasens and Espinosa [4] argues that this is rather a gradual than a binary distinction, because of a gradual two-part tongue movement, in which the apical is associated to the initial position whereas the dorsal associated to the coda position. This pattern is also found by cross-linguistic acoustic analyses of laterals, which shows gradual transitions between alveolar and velarized laterals [5]. However, in the Viennese dialects, the velarized lateral is not restricted to the syllable-final position, but is also produced in the word-initial position, as is found in other language varieties that feature an alveolar and a velarized lateral.

The main difference between the two lateral allophones is that, the back vocal cavity is lengthened in velarized laterals, resulting in a more fronted tongue tip position and a more retracted tongue dorsum. Consequently, the F2 value is lowered as compared to the alveolar lateral, and this is the most reliable indicator for the difference between the alveolar and the velarized laterals [6]. For velarized laterals, the F2 value generally ranges from approximately 900 Hz to 1200 Hz, whereas for alveolar laterals, the F2 value ranges from approximately 1300 Hz to 1400 Hz for male speakers [7]. In some languages, like Albanian, the clear and dark /l/ belongs to different phonemes. In many British dialects, the dark /l/ may be vocalized, through the reduction or loss of contact between the tip of the tongue and the alveolar ridge, resulting a rounded back vowel or glide. A similar process has happened during the development of many other languages, including Brazilian Portuguese, Old French, and Polish.

Previous research work shows that, the dental velarized lateral involves substantial tongue body retraction, similar to results found in studies of 'dark' /l/ [4, 5, 6, 8]. In Scottish Gaelic, the lateral is produced with quite a retracted tongue tip contact, with little audible tongue body retraction [9]. It is similar to the clear /l/ in other languages, which has little tongue body raising [8]. Auditory analysis shows that there are four distinct

variants in the palatalized lateral data: palatalized lateral, lateral with no palatalization, palatal glide and lateral followed by palatal glide.

Results show overall maintenance of the three-lateral system, but with substantial variation in the production of palatalized laterals, which some young Glaswegians do not produce [10]. For Gaelic /l/, palatal and dental contact is shown static palatographic study, leading Shuken [11] to conclude that this lateral is palatalized rather than palatal. This result is also confirmed in Ladefoged et al. [9]. Formant values of Scottish Gaelic laterals are displayed in Ni Chasaide [12], whose study refers to data from Gaoth Irish. It is shown in this study that, for Gaelic velarized /l/, the F1 values is quite high, while the F2 value is quite low. Palatalized /l/ has the lowest F1 and highest F2, and alveolar /l/ is in between the two extremes. The three formant value is not found to vary significantly between the lateral categories. These results are in line with previous studies of lateral acoustics, for example Carter and Local [6].

It is also reported that many aboriginal Australian languages have three or four lateral approximants, similar to various dialects of Irish. There are rare lateral consonants including retroflex laterals, which can be found in many Languages of India and in some Swedish dialects. Voiceless alveolar lateral fricative can be found in many Native North American languages. In Adyghe and some Athabaskan languages, there are both voiceless and voiced alveolar lateral fricatives, but with no approximant. Many of these dialects also have lateral affricates. In some languages there are palatal or velar voiceless lateral fricatives or affricates, such as Dahalo and Zulu [1].

The present study will investigate the acoustic effect of position on the production of the lateral in Sundanese. It is aimed to present the variation of the lateral at word initial, medial and final position, and acoustic parameters like duration, intensity and formant values will be examined.

II. METHODOLOGY

A. Studying materials

In Sundanese, the lateral may occur at word initial, word medial and word final positions. Examples of lateral at these three positions are shown in Fig. 1 to 3. The word shown in Fig. 1 is ‘lebu’ (dust). Fig. 2 is ‘bulan’ (the moon), and that in Fig. 3 is ‘kidul’ (south). In this study, there are122 words having lateral at initial position, 269 words lateral at word medial position, and 92 words lateral at word final position. The total number of words is 483.

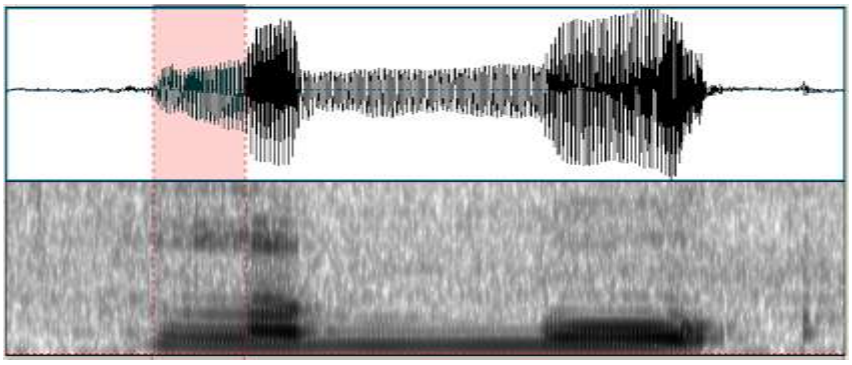


Fig. 1. Example of lateral at word initial position (lebu)

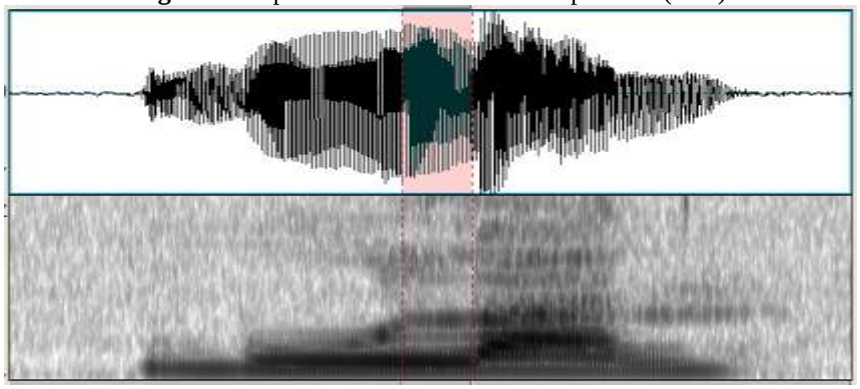


Fig. 2. Example of lateral at word medial position (bulan)

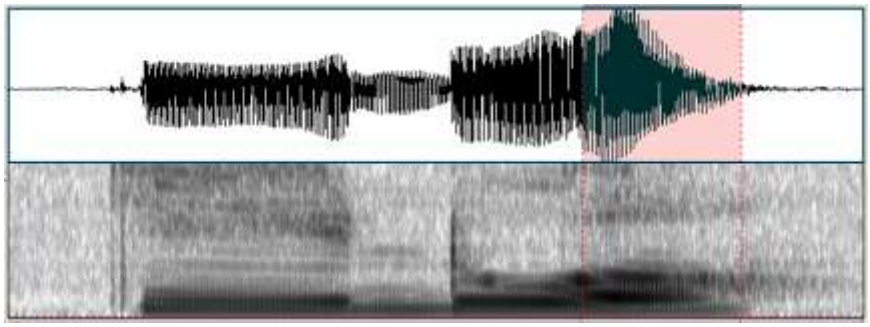


Fig. 3. Example of lateral at word final position (kidul)

B. Procedure and measurements

This study aims to give an acoustic investigation of lateral in Sundanese, so the duration, intensity and formant values are analyzed. Duration is the length of a segment, syllable or word. In this study, the lateral is analyzed, so the duration of lateral, as a segment, is measured. As is shown in Fig. 1 to 3, the lengths of the marked parts are their duration. Intensity refers to the energy of a segment. If a segment sounds louder, its intensity value is high. Fig. 4 demonstrates the waveform and intensity contour of the word 'langit' (sky). From the intensity contour, it is shown that the intensity value of the lateral is smaller than the vowel. As for formant value, it is determined by the shape of the vocal tract. Generally speaking, the first formant (F1) and the second formant (F2) are more important than the higher ones, so the values of these two formants are extracted. Fig. 5 presents the waveform and formant of the word 'kilat' (lightning), from which it is shown that the F1 of lateral is higher than /i/, lower than /a/, and the F2 is lower than either /i/ or /a/.

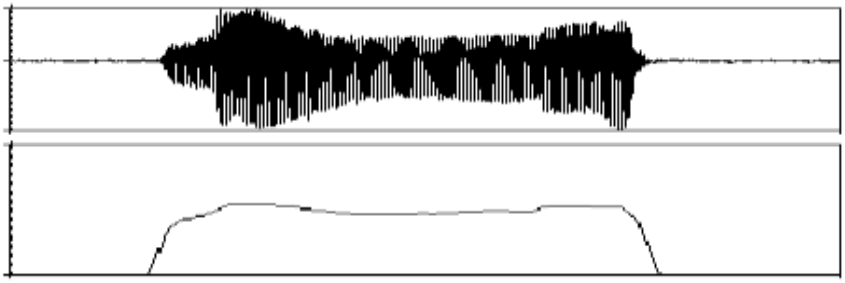


Fig. 4. Waveform and intensity contour of 'langit' (sky)

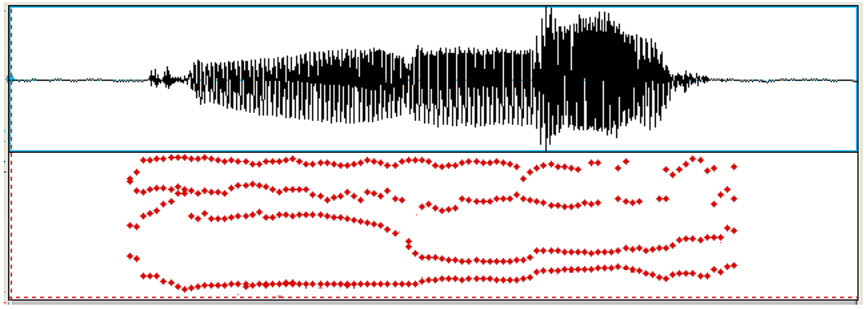


Fig. 5. Waveform and formant of 'kilat' (lightning)

As the lateral in Sundanese may occur at word initial, medial and final position, the three parameters are measured at these three positions. That is, for lateral at the three positions, the duration is measured respectively, and intensity and formant values are extracted using Praat [13]. An ANOVA is performed for the comparison of the measurements of the three positions, and S-N-K test is done for further analysis. Statistic is done in SPSS.

III. RESULT

A. Duration

Fig. 6 presents the mean duration of the lateral at initial, medial and final position of word. Results from ANOVA show that there is significant difference for the durations of lateral at the three positions: F(2,

481) = 197.9, $p < 0.001$. Further S-N-K test result demonstrates that they fall into three subsets, with lateral the longest at word final position, shortest at word medial position, and intermediate at word initial position.

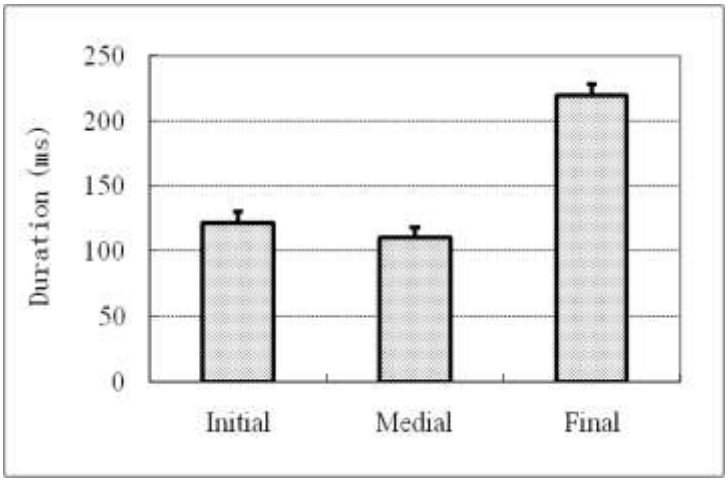


Fig. 6. Duration of lateral at word initial, medial and final position

B. Intensity

In Fig. 7, the average intensity values of lateral at the three positions are displayed, and ANOVA result shows that significant difference exists for the intensity values: $F(2, 481) = 413.3$, $p < 0.001$. It is displayed from further S-N-K test result that, similar to that of duration, the intensity values fall into three subsets, with intensity values the largest at word medial position, smallest at word initial position, and intermediate at word final position.

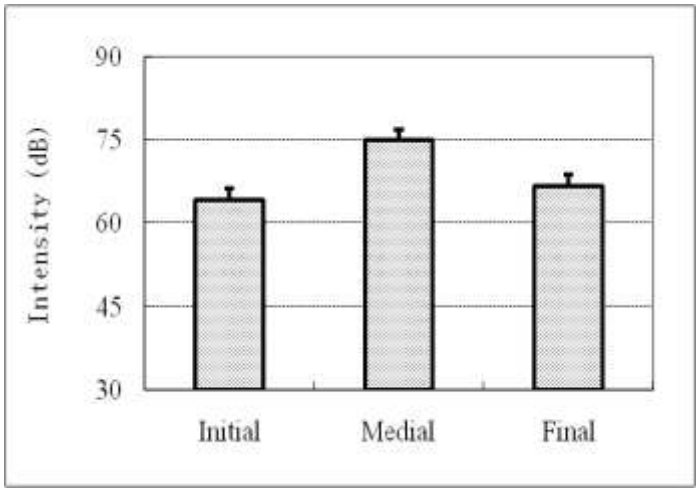
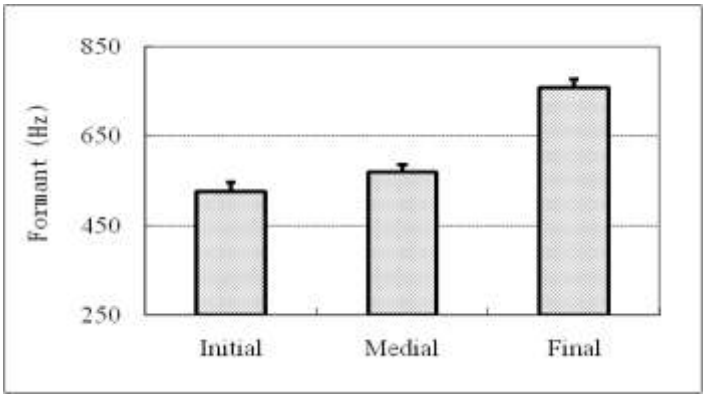


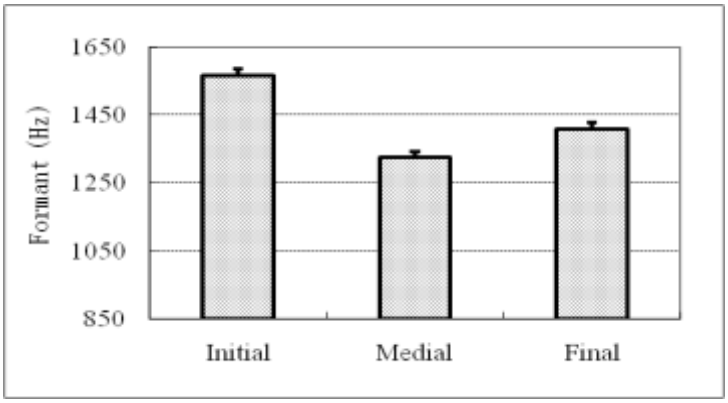
Fig. 7. Intensity of lateral at word initial, medial and final position

C. Formant

In this subsection, the formant values are analyzed. Fig. 8 displays the mean formant values of F1 (a) and F2 (b) of the lateral at the three positions. ANOVA results show that there are significant differences for both F1 and F2 of lateral at the three positions, F1: $F(2, 481) = 55.8$, $p < 0.001$; F2: $F(2, 481) = 20.4$, $p < 0.001$. Further S-N-K test result displays that, the F1 values fall into three subsets, with the values the highest at word final position, lowest at word initial position, and intermediate at word medial position. While for F2, S-N-K test result shows that the values fall into two subsets, with F2 value higher at word initial position, lower at word medial and final position. However, there is no significant difference between the F2 values at word medial and word final position.



(a) F1



(b) F2

Fig. 8. F1 (a) and F2 values of lateral at word initial, medial and final position

IV. DISCUSSION

Results from the previous section shows that, for duration, lateral is the longest at word final position, shortest at word medial position, and intermediate at word initial position. It has been reported that speech gestures tend to be lengthened in domain-final position [14], and experimental evidence for domain-final lengthening has been found for all segments in the syllable final position. When a segment is at the final position, there is no following segment, leaving enough room for the final segment to be lengthened. Therefore, lateral is the longest at the word final position. As for lateral at the word initial position, it has been found that in a domain, initial consonants are more strongly articulated than domain-medial ones. Consonants at the initial position are articulated with extreme and longer constrictions, i.e., with increased temporal magnitude of gestures, which is called 'initial strengthening' [15]. However, compared to the final lengthening, the room for initial lengthening is limited, as there are subsequent segments, and there is no room for word medial segment to be lengthened. As a result, word final lateral is the longest, medial lateral is the shortest, and the initial one is intermediate.

The intensity pattern is different from that of duration, results display that the intensity value is the largest at word medial position, smallest at word initial position, and intermediate at word final position. When the lateral occurs word-medially, it is actually in the inter-vocalic position, that is, it is between two vowels. It has been found that, in the inter-vocalic position, consonants tend to be more lenis-like, less strong in articulation. For example, in most languages, inter-vocalic voiceless consonants may get voiced. When a voiceless consonant gets voiced, its intensity value will be increased. Therefore, at word medial position, the intensity of the lateral is the largest. As is mentioned above, at the initial position, a segment is generally strong in articulation. When a consonant is strong, it is more fortis-like, and the intensity of a fortis is usually small. Coming to the lateral at the word final position, similar to that in English, it is velarized at this position, also called 'dark' /l/. A velarized lateral sound w-like, and generally sounds louder than the alveolar lateral. Therefore, the intensity value of lateral is the largest at word medial position, smallest at initial position, and intermediate at final position.

Regarding the formant values of the lateral, it is found that, for F1, it is the highest at word final position, lowest at word initial position, and intermediate at word medial position. At word final position, a lateral usually gets velarized. When a lateral is velarized, the tongue body will be substantially retracted, and the

F1 value tends to be greatly increased, which has been confirmed in for Gaelic velarized /l/ [12]. Therefore, the F1 value is high at word final position. At the word initial position, the lateral is produced as an alveolar consonant, with no preceding segments affecting it, so the F1 value is low. At the word medial position, the lateral is affected by the preceding segment, so the F1 will be a little increased. As a result, the F1 value of the lateral is the highest word finally, lowest word initially, and intermediate word medially. As for the F2 value, result shows that it is higher at word initial position, and lower at word medial and final position. When the lateral is at word initial position, it is an alveolar consonant, and the F2 value is basically high. For the word-final lateral, which is velarized, the back cavity is lengthened and the tongue tip is more fronted, resulting in lowered F2 [6]. Regarding lateral at the word medial position, as it is affected by both the preceding and following segments, its F2 is also lowered. Therefore, the F2 value is higher word initially, and lower at word medial and final position.

V. CONCLUSION

The acoustic signal is analyzed on the lateral in Sundanese in this study. It is shown that, as there are no following segments, lateral is greatly lengthened at word final position. Evidence demonstrates that consonants are articulated with extreme and longer constrictions at the initial position, so lateral is second longest at the word initial position, leaving those at the medial position the shortest. For a lateral at the word medial position, it is actually in the inter-vocalic position, and it will get more lenis-like, resulting in greatly increased intensity value. However, when a lateral occurs at word initial position, it is usually strengthened, being more fortis-like, and the intensity value is the smallest. At word final position, a lateral is normally velarized, with tongue body retracted, and the F1 value is the highest. When it is at word initial position, there is no preceding segments affecting it, so the F1 value keeps its normal condition, being the lowest. Regarding F2 value, which is basically high, it keeps high at the word initial position. Lateral is velarized at word final position, and the F2 value gets lower.

ACKNOWLEDGMENT

The research reported here is partially supported by the Innovation Fund of Jinan University, No. 15JNLH004.

REFERENCES

[1]. I. Maddieson, Lateral Consonants, In: M. S. Dryer and M. Haspelmath (eds.) The World Atlas of Language Structures Online. Leipzig: Max Planck Institute for Evolutionary Anthropology, 2013.
[2]. P. Ladefoged and I. Maddieson, The sounds of the world's languages. Oxford: Blackwell, 1996.
[3]. M. Halle and K. P. Mohanan, "Segmental phonology of model English", Linguistic Inquiry, vol. 16, pp. 57-116, 1985.
[4]. D. Recasens and A. Espinosa, "Articulatory, positional and coarticulatory characteristics for clear /l/ and dark /l/: Evidence from two Catalan dialects", Journal of the International Phonetic Association, vol. 35, pp. 1–25, 2005.
[5]. D. Recasens, "A cross-language acoustic study of initial and final allophones of /l/". Speech Communication, vol. 54, pp. 368–383, 2012.
[6]. P. Carter and J. Local, "F2 variation in Newcastle and Leeds English liquid systems". Journal of the International Phonetic Association, vol. 37, pp. 183–199, 2007.
[7]. D. Müller, Developments of the Lateral in Occitan Dialects and their Romance and Crosslinguistic Context. PhD Dissertation, Toulouse and Heidelberg, 2011.
[8]. B. Gick, F. Campbell and L. Tamburri-Watt, "Towards universals in the gestural organization of syllables: A cross-linguistic study of liquids". Journal of Phonetics, vol. 34, pp. 49–72, 2006.
[9]. P. Ladefoged, A. Turk, K. Hind and S. J. Skilton, "Phonetic structures of Scottish Gaelic". Journal of the International Phonetic Association, vol. 28, pp. 1–41, 1998.
[10]. C. Nance, "Phonetic variation in Scottish Gaelic laterals", Journal of Phonetics, vol. 47, pp. 1–17, 2014.
[11]. C. Shuken, An instrumental investigation of some Scottish Gaelic consonants, PhD thesis. University of Edinburgh, 1980.
[12]. A. Chasaide, Laterals of Gaoth-Dobhair Irish and of Hiberno English. In D. Ó Baoill (Ed.), Papers in Celtic phonology, Coleraine: New University of Ulster, pp. 54–78, 1979.
[13]. P. Boersma, "Praat, a system doing phonetics by computer", Glot International, 2001, 5:9/10, pp. 341–345.
[14]. T. Cho, Manifestation of prosodic structure in articulatory variation: Evidence from lip movement kinematics in English. In: L. Goldstein, D. Whalen and C. T. Best (Eds.), Laboratory phonology 8, Berlin: Mouton de Gruyter, pp. 519–548, 2006.
K. De Jong, "The supra-glottal articulation of prominence in English: Linguistic stress as localized hyper-articulation". Journal of the Acoustical Society of America, vol. 97(1), pp. 491–504, 1995.