Reduplication and word stress in Vietnamese.

Thu Nguyen & John Ingram

Linguistic Program, E.M.S.A.H.
University of Queensland, Australia
thunguyen@uq.edu.au

Abstract

In this paper acoustic properties of two types of reduplicative compound (full and tone sandhi reduplications) were examined to show acoustic evidence of assymetrical prominence relations (van der Hulst, 2005), in support of a hypothesis that Vietnamese reduplications are phonetically right headed and that tone sandhi is a reduction phenomenon occurring on prosodically weak positions (Shih, 2005). The results show phonetic evidence of prosodic constituency at the level of the bisyllabic word in Vietnamese.

1. Introduction

Vietnamese is a contour tone language, which is strongly syllabic in its phonological organization and morphology. However, reduplication is also a highly productive word formation process, with disyllabic word forms predominating, raising the question of whether there exists a distinctive level of phonological structure identifiable with the phonological word. In traditional accounts of Vietnamese phonology, the existence of stress at the word level has been a matter of unresolved controversy (Thompson, 1965; Nguyen Dang Liem, 1970; among others).

In this paper, acoustic parameters including syllable duration (onset, nucleus and coda), F0 range, F0 contour, vowel intensity, spectral tilt and vowel formant structure are analyzed to determine: (1) which syllable of the two (base or reduplicant) is more prominent and (2) how the tone sandhi forms differ from their full reduplicated counterparts, in forms such as:

1a. *Pha trà cho* ***đậm đậm*** fully reduplicated
1b. *Pha trà cho* ***đầm đậm*** partially reduplicated
| |
Reduplicant base

1.1. Tone and tone sandhi in Vietnamese

Vietnamese has 6 tones divided into two groups on the basis of register; high tones: level (*ngang*: high level), rising (*sắc*: high rising), broken fall-rise (*ngã*: fall glottalised and abrupt rise) and low tones: falling (*huyền*: low gradual falling), dropping (*nặng*: low dropping), and curve (*hỏi*: gradual fall and rise) (Vuong & Hoang, 1994; among others).

It is generally claimed that there is no tonal neutralisation due to "sandhi" in Vietnamese, a phenomenon that occurs in other tone languages like Chinese and Thai. Tonal variation due to the influence of neighbouring tones can, however, be observed and is described as a type of tonal assimilation or coarticulation. Tonal coarticulation in Vietnamese introduces considerable variation in both slope and height of fundamental frequency and its preservative or progressive effects are greater than its anticipatory or regressive effects, (Han & Kim, 1974). Nevertheless, in spite of the claimed absence of tone sandhi in Vietnamese by most linguists, it cannot be denied that tone sandhi occurs in a subset of Vietnamese reduplication words (Thompson, 1965).

Vietnamese has no system of culminative word stress; nevertheless, it is widely accepted that there is stress in the sense of accentual prominence at the phrasal level (Thompson, 1965; Nguyen Dang Liem, 1970). Duration, intensity, full tonal realisation of accented syllables have been observed to be important parameters for describing stress in Vietnamese (Do The Dung, 1986; Chaudhary, 1983; Hoang Tue & Hoang Minh, 1975; Gsell, 1980). Generally, these studies examined stress in the sense of phrasal- level accentual prominence but do not address the question of stress at the word level, which is the aim of this study.

1.2. Reduplication

Reduplication is a productive process in Vietnamese. Almost every adjective and adverb has its reduplicated form. There are 5000 entries in the recently published dictionary of Vietnamese reduplicants (Vien Ngon Ngu, 1995), which, compared to a regular dictionary of 50,000 entries, is a significant amount (approximately 10%) (Aves, 1999). Phonologically, there are four main types of reduplication: full reduplications: copying of full segmental composition and tone, and partial reduplications with three main sub categories: (1) same rhyme and tone but with alternate onset consonant, (2) same segmental composition but with alternate tones, and (3) same onset consonant but alternate tones and rhymes. There is a constraint on tone harmony in reduplications that the tone of the copying (reduplicant) syllable must be in the same register as that of the base form: a phonological patterning of high tones: level (*ngang*: high level), rising (*sắc*: high rising), curve (*hỏi*: gradual fall-rise) and that of three low tones: falling(*huyền*: gradual falling), dropping(*nặng:* low dropping), and broken(*ngã*: fall glottalised and abrupt rise). In

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addition, many full reduplications undergo tone sandhi, which is also constrained by the within-register tone harmony. For example, the full reduplication *đỏ đỏ* (red red = rather red) with the same curve (fall-rise) tone has an alternative form with a tone sandhi: *đo đỏ* with a combination of two high-register tones: a level and a curve tones. In reduplications with syllables ending in stop consonants, when the first syllable of the word undergoes tone sandhi, the final stop consonant is replaced by its correspondent homorganic nasal (e.g., p-m: *đẹp đẹp* vs. *đèm đẹp*, t-n: *tốt tốt* vs. *tôn tốt*).

It is widely agreed among Vietnamese linguists that in these bisyllabic words, the right-edged component is the base or the stem, thus carries the semantic weight and is therefore more prominent (Ho Le, 2002; among others). There are reduplications with a reverse direction of tone sandhi (e.g., *héo héo* (SacSac tones: tree leaves becoming dry) –> *héo* ***hẹo*** (SacNang tones: becoming very dry) as opposed to ***heo*** *héo* (Ngang Sac: rather dry)). This study investigates only the right-to-left sandhi forms of the full reduplications. Apart from a few reduplications that have only one form (e.g., *nòng nọc, lông lốc* which have no full form counterparts *nọc nọc* or *lốc lốc*), most full reduplications and their right-to-left sandhi forms are in free variation and both indicate the same meaning (Thompson, 1965; Nguyen Tai Can, 1981).

1.3. Hypotheses

In order to test the hypothesis that both full and sandhi disyllabic reduplications are prosodically right-headed, a list of disyllabic reduplications of adjectives and adverbs was constructed, consisting of disyllabic words with the same segmental composition and tones (e.g., *sáng <u>sáng</u>*: bright bright) and their tone sandhi counterparts (i.e those with the same segmental composition but with alternate tones: e.g., *sang <u>sáng</u>*: fairly/rather bright). In addition, in order to provide a counterargument for the word-boundary effect (if the 2nd syllable is found to have longer duration than the 1st syllable), the base syllable of the reduplication (underlined above) is embedded in the initial position of two other control/baseline words of different segmental makeup: (1) in a word with the same tone on both syllables (e.g., *<u>sáng</u> chói*: dazzlingly bright with the same rising tone) and (2) in a word with two different tones (e.g., *<u>sáng</u> choang*: very bright). The design of the linguistic material, as shown in the following table, aims to test two hypotheses:

Table 1. Design of linguistic material

Full reduplication		Tone sandhi reduplication		Control condition 1 Base+same tone		Control condition 2 Base+diff. tone	
sáng	sáng	sang	sáng	*sáng*	chói	*sáng*	choang
Rn1	Bn2	Rs1	Bs2	Baa1		Bab1	

R = reduplicated syllable, B = base syllable, number 1-2 = syllable position 1st and 2nd, aa = same tone, ab = different tone.

H1: If the reduplicated syllable (Rn1 and Rs1) is less acoustically prominent (indicated by shorter duration, less tone range, smaller intensity and a reduced or centralised vowel) than its corresponding base syllable in the reduplication forms (Bn2, Bs2) but not less prominent than the control syllables (Baa1 and Bab1), the difference in acoustic cues in the constituent syllables of the reduplication form (Rn1 vs. Bn2 and Rs1 vs. Bs2) may be due to word-boundary effect.

H2: If the reduplicated syllable (Rn1 and Rs1) is less acoustically prominent (indicated by shorter duration, less tone range, smaller intensity and a reduced or centralised vowel) than both its corresponding base syllable in the reduplication forms (Bn2, Bs2) and the control syllables (Baa1 and Bab1), the stronger acoustic cues on the base syllable (Bn2 and Bs2 compared to Rn1 and Rs1 respectively) is due to accentual effect.

2. Method

2.1 Linguistic materials

There were 6 reduplications for each of the five Southern tones (6 ngang-ngang, 6 sac-sac, 6 huyen-huyen, 6 hoi-hoi, 6 nang-nang) and six for each of the 3 tone sandhi counterparts of the sac-sac (6 ngang-sac), hoi-hoi (6 ngang-hoi), and nang-nang (6 huyen-nang). Note: Northerners have 6 tones, but the Southern dialect has 5 due to the merging of two contour tones (hoi and nga). The total number of items:

((5 reduplicated tones x 6) x 2 control words) + (3 tone sandhi x 6)) x 10 speakers = 780 items.

These reduplications were then embedded in an imperative carrier sentence in such a way that they all appeared utterance medial and between the same adjacent syllables (the same preceding preposition and following imperative particle) so as to avoid final lengthening effect and tone coarticulation effect. All carrier sentences of reduplications have the same grammatical structure.

V + O + *prep* + **adjective/adverb reduplication** + *imperative part.*
1). Pha trà cho **đậm đậm/đầm đậm** đi nhé
(NangNang tones)/ (HuyenNang tones)
Make tea so as to strong strong particle
(Make tea rather strong)
2). Sơn tường cho **xanh xanh** (NgangNgang tones) đi nhé
Paint wall so as to blue blue particle
(Paint the wall rather blue)

2.2 Subjects

Ten speakers (5 males and 5 females) of Southern Vietnamese (Saigon dialect) participated in the study. They were all students aged 20-30 years at the University of Queensland who came from HoChiMinh city and had been in Australia from 4 months to 1.5 years.

2.3 Procedures

The utterance list of sentences was arranged in a pseudo-random order. Subjects were asked to speak the sentences as if they were instructing an imagined silent listener to do something. This was designed to elicit natural and rather spontaneous speech from subjects. Before the recording, subjects were provided sufficient time for familiarization and practice. They then spoke the sentence aloud in their normal speaking manner. The recording was made in a quiet room

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using a sound recording and editing computer software (Praat) at 20 kHz sampling rate and 16 bit precision.

2.4. Measurements

The reduplication words were then segmented via the Emu Speech Tools, (Cassidy, 1999). First, the Emu Labeller was used to mark the edges of the target syllables and vowels, relying primarily on the spectrographic display in the Labeller. Then Emu-R was used to extract vowel duration, vowel formant and fundamental frequency. The following acoustic parameters were measured: (1) duration of vowels, onset and coda, (2) vowel formant at vowel mid point, (3) Fundamental frequency (F0) at 10 equidistant points on the tone contour of each syllable rime, (4) F0 range(=F0 max-F0min), (5) Vowel intensity (db) at vowel mid point, (7) Spectral tilt (H1-A3): third formant is compared with the first harmonic (Stevens and Hanson's model, 1995)

2.5. Analysis

The statistical analysis involves the acoustic parameters (listed above) as the dependent variables and four factors: (1) syllable positions (Rn1, Bn2, Rs1, Bs2, Baa1, Bab2) and tone types (level[ngang], falling[huyen], rising[sac], dropping[nang], and curve[hoi]), words (30 test items) and speakers (10 speakers). In order to account for the effect of speaker differences and intrinsic segmental as well as tonal differences among the 30 test items, a restricted maximum likelihood (REML) applied to a mixed model ANOVA was performed on each of the acoustic parameters. The fixed effects included syllable positions (Rn1, Bn2, Rs1, Bs2, Baa1, Bab2) and tone types (five tone types) and their two-way interactions. The random effects were speakers and words. A Tukey post-hoc test was then conducted to determine the significant differences among levels of the main fixed factors and their interaction effects, particularly the pair-wise comparison among the six syllable positions.

3. Results

3.1 Duration

The ANOVA results on duration showed significant main effect for syllable positions across all syllable constituents (onset: F(5,1516)=9.01, p<.0001, vowel: F(5,1516)=91, p<.0001, coda: F(5,1100)=35, p<.0001 and whole syllable: F(5,1516)= 66.5, p<.0001) while no significance effects were found for tone types or interactions of syllable positions and tone types.

As shown in figure 1, there was a marginally significant effect for onset; the control syllables had longer onset than both syllable constituents of the reduplication form (Baa1~Bab1>Rn1~Rs1~Bn2~Bs2, p<.01). The vowel of the reduplicant syllables was significantly shorter than the control syllables, which were shorter than the corresponding base syllables (Rn1~Rs1 <Baa1~Bab1<Bn2~Bs2, p<.01). The coda of the reduplicant syllables was significantly shorter than the corresponding base syllables and the control syllables (Rn1~Rs1 <Baa1~Bab1~Bn2 ~Bs2, p<.001). Taken together, in terms of whole syllable duration, the reduplicant syllables were significantly shorter than the corresponding base syllables and the control syllables (Rn1~Rs1<Baa1~Bab1<Bn2~Bs2, p<.0001). This result suggests that the shortening of the reduplicated syllables in comparison to their base syllables was not due simply to an absence of a phrase final lengthening effect, but to an accent-related shortening at the level of the (compound) word.

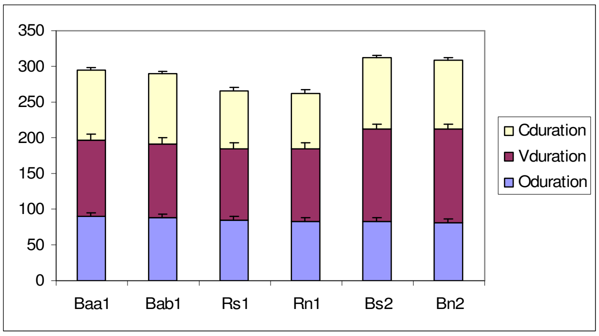

Figure 1: Mean duration (ms) of Onset, Vowel and Coda across six syllable positions.

3.2. Intensity

The ANOVA results on intensity (db) showed a significant main effect for syllable position (F(5,1516)=20, p<.001) while no significance was found for tone types or the interaction effect between syllable positions x tone types. Post-hoc pair-wise comparisons showed that the reduplicant syllable with the sandhi tone had significantly greater intensity than the other five syllables. However, this result suggests an effect due to tonal variation rather than a prominence effect since this tone sandhi syllable had a different tone from five other syllables of the same tone. A detailed analysis by tone types (for each sandhi pair: level-curve, falling-dropping, level-rising) showed that the significant effect held for only two tone pairs: level-curve and falling-dropping (Rs1>Bs2) but not for the level-rising sandhi form (Rs1~Bs2: insignificant). Therefore, this intensity effect can be explained as an artefact due to tonal variation because the curve and dropping tones contain creaky voice of lower intensity(db) than other tones (Vu Thanh Phuong, 1981)

3.3 Spectral tilt

It would be expected that spectral tilt is inversely related to syllable prominence. Four spectral parameters (H1H2, H1A1, H1A2, H1A3) were measured. A significant main effect for syllable position was found for all four parameters (H1H2: F(5,1516)= 4.8, p<.001; H1A1: F(5,1516)=14, p<.0001; H1A2: F(5,1516)= 13, p<.0001; H1A3: F(5,1516)= 9, p<.0001); while no significant effect for tone types or interaction effect between syllable positions x tone types was found. Post-hoc pair-wise comparisons shows that the reduplicant syllable with the sandhi tone had significantly higher spectral tilt than all other syllables (H1H2, H1A1, H1A2, H1A3: Rs1> Rs2~Baa1~Bab1~Rn1~Bn2). This tone sandhi syllable had a different tone from five other syllables of the same tone. A detailed analysis by tone types (for each sandhi pair: level-curve, falling-dropping, level-rising) showed that the significant effect held for all three tone pairs: the sandhi syllables had a higher spectral tilt value than their

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corresponding base syllables, suggesting that the sandhi syllables were less prominent or less loud than their base syllables. This result, on the one hand, suggests that the significant difference may be due to tonal variation (tone sandhi) but, on the other hand, seems to imply an underlying prominence reduction by means of tone sandhi (i.e., tone sandhi enhances the prominence difference in sandhi reduplications).

3.4. Vowel formants

An ANOVA analysis was performed on the Euclidean distance between vowel pairs: Rs1-Bs2: components of the tone sandhi form, Rn1-Bn2: components of the full reduplication, Rs1-Bab1 and Rn1-Bab1: Euclidean distance between the sandhi and non-sandhi reduplicant vowel and the control vowel in word-initial position respectively. A preliminary analysis found no significant difference between the vowels of the two word-initial control syllables (Baa1 and Bab1) and thus only one of them (Bab1) was included in the analysis and the vowel plot for spatial clarity of graphical presentation.

The ANOVA results and the formant plot (fig. 2) showed three main things. First, the vowel of the reduplicant syllables (Rs1 and Rn1) tended to be more centralised than their base syllables (Bs2 and Bn2 respectively). Second, the vowel of the word-initial control syllables (Bab1) seemed to cluster with those of the base syllables. Third, the Euclidean distance between components of the tone sandhi form was significantly larger than that between components of the full reduplication (Rs1-Bs2> Rn1-Bn2, $p<.03$). This is further supported by the fact that the Euclidean distance between the sandhi vowel and the control vowel was significantly larger than that between the non-sandhi reduplicant vowel and the control vowel (Rs1-Bab1> Rn1-Bab1, $p<.03$). The results indicate that: (1) the reduplicant syllables were centralised/reduced in comparison with the base syllables and (2) the sandhi vowels were more reduced/more centralised than the non-sandhi reduplicant vowels.

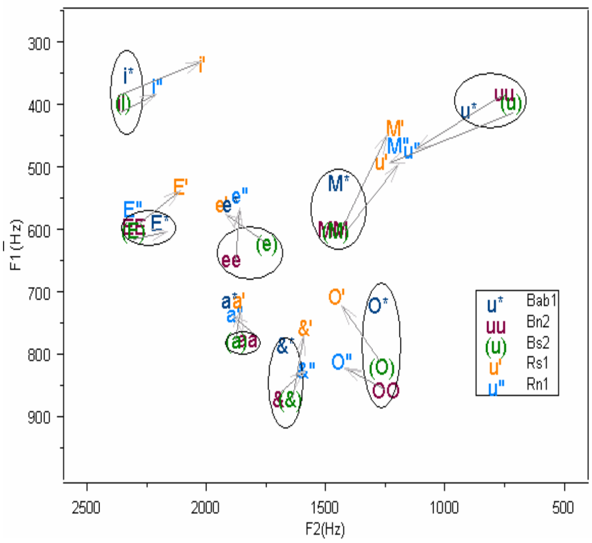

Figure 2. Formant plot of vowels in six positions. Symbols: u*: Bab1,uu: Bn2, (u): Bs2, u': Rs1, u": Rn1.

3.5. F0 range and contours

Since only reduplications with the three dynamic tones (curve, dropping, rising) have a sandhi counterpart while those with the two even tones(level and falling) do not, the data was split into two separate data sets(a curve-dropping-rising set and the level-falling set) and submitted to two separate ANOVAs. Post-hoc pairwise comparisons among syllable positions were also conducted. Figure 3 showed the pair-wise comparison of mean F0 range among syllable positions for the three dynamic tone types (vertical bar) and the mean F0 contour plotted on normalised duration (horizontal line).

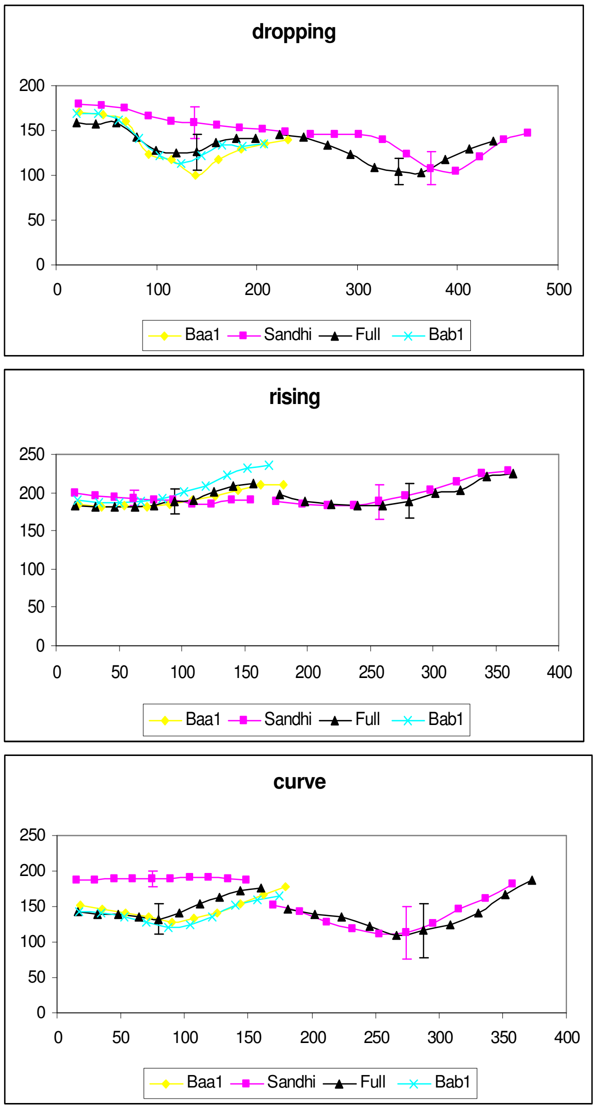

Figure 3. The average F0 contours and F0 range of the six syllable positions under investigated. Vertical bar: mean F0 range (Hz). Horizontal lines: mean F0 contours (Hz). X- axis: tone duration (ms). Y- axis: mean F0 in Hz. Baa1 and Bab1: tones of the two word-initial control syllables, sandhi: tones of the partial reduplication words with a sandhi tone, full: tones of the full reduplication words: points 1-10: the 1st syllable, points 11-20: the second syllable.

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The statistical analysis of F0 range and F0 contour (Fig.3) showed four main things. First, the base syllables (Bs2, Bn2) tended to have longer tone / F0 contours than both the reduplicant syllables (Rs1, Rn1) and the word-initial control syllables (Baa1, Bab1), consistent with the result on syllable duration presented in section 3.1 above. Second, the base syllable of the rising and curve tone tended to have a larger F0 range than their reduplicant counterparts (Rising: Bs1<Bn1< Bs2~Bn2~Baa1~Bab1, p<.01; Curve: Bs1<Bn1< Baa1~Bab1<Bs2~Bn2, p<.001). By contrast, the F0 contour of the base syllable with falling and dropping tone, though falling lower, had a smaller F0 range than their initial reduplicant counterparts as a result of a flatter contour with lower F0 onset (Falling: Baa1~Bab1~Rn1>Bn2,p<.0001); Dropping: Baa1~Bab1~Rs1~Rn1~Bs2~Bn2, ns.). Third, there was no significant difference in terms of F0 range and F0 contour between the two control syllables even though they were followed by two different tones: one followed by the same tone and the other followed by a different tone (Baa1 and Bab1). Even though the two control syllables were similar to reduplicant syllables in terms of a shortened tone length, they were generally more similar to the base syllables in terms of F0 range and fuller tonal shape. This result suggests that the reduplicant syllables had a "reduced" tone shape in comparison to that of the base syllables. Fourth, the examination of tone contour in tone sandhi minimal pairs: dropping-dropping vs. falling-dropping, and rising-rising vs. level-rising, and curve-curve vs. level-curve(figure 3) shows that in tone-sandhi words, the tone contour of the second syllable tends to start from the ending point of the tone contour in the previous syllable. In other words, there is a smoother transition between tones in tone-sandhi words. For example, in level-dropping word (fig 3a), a sandhi counterpart of dropping-dropping, the second dropping tone falls further from the previous falling tone. In level-rising (fig. 3b), a sandhi of rising-rising, the second rising tone begins rising from where the previous level tone ends. Similarly, in a level-curve word (fig. 3c), a sandhi form of curve-curve, the second curve tone falls from where the level tone ends. In contrast, in non-sandhi full reduplication forms such as dropping-dropping, rising-rising and curve-curve, the second tone contour repeats the whole process of the first. This shows that there is tonal coarticulation in sandhi forms compared to their non-sandhi counterparts, which may stem from ease of articulation, a tendency to avoid tone clashes.

4. Discussion

First, in terms of whole syllable duration, the reduplicant syllables were significantly shorter than the control syllables which were shorter than corresponding base syllables (Rn1~Rs1<Baa1~Bab1<Bn2~Bs2). The point of discussion here is whether the lengthening of the base (second) syllables in comparison to the reduplicant syllables is due to a "word boundary lengthening" effect (boundary tone) or to a temporal effect of accentual prominence. The above result suggests that the shortening of the reduplicated syllables in comparison to their base syllables was not due to lack of final lengthening or being in a non-final position but due to a reduction. This is further supported by the insignificant difference between the coda of the word-initial control syllables in comparison with the word-final base syllables. In sum, the results reject hypothesis 1 and support hypothesis 2.

Second, the reduplicant syllable with a tone sandhi had greater spectral tilt than the base syllables, suggesting that the sandhi syllables were less prominent or less loud than their base syllables. This result, on the one hand, suggests that the significant difference may be due to tonal variation (tone sandhi) but, on the other hand, seems to imply an underlying prominence reduction by means of tone sandhi.

Third, the results on vowel formant change showed that the vowels of the reduplicant syllables were centralised in comparison with that of the base syllables and the sandhi vowels were more centralised than the full (non-sandhi) reduplicant vowels while the vowels of the word-initial control syllables clustered in the same space as the base vowels, suggesting that the reduplicant vowels were reduced to promote right-headed prominence effect which was further enhanced by tone sandhi.

Fourth, the results on F0 showed that the base syllables tended to have longer tone/ F0 contour, larger F0 range and more fully realised tone contour than the reduplicant syllables particularly in the two dynamic tone pairs (higher and more sharp rise of the second rising tone in the rising-rising reduplication, a deeper fall and higher rise in the second curve tone in curve-curve words). In addition, even though the two control syllables were similar to reduplicant syllables in terms of a shortened tone length, they were generally more similar to the base syllables in terms of F0 range and fuller tonal shape. This F0 result suggests that the reduplicant syllables had a more "reduced" tone in comparison to that of the base syllables. Furthermore, comparative examination of the pitch contours between fully reduplicated syllables and their sandhi counterparts showed a smoother transition in tonal contour of the latter, suggesting tone-sandhi may result from one or more of the following: a) phonologized tone assimilation to avoid tone clash, b) tonal coarticulation, in the interests of ease of articulation, and possibly also, c) 'de-accenting' to promote right syllable perceptual salience (headedness).

In brief, the results of the acoustic analysis provide evidence supporting hypothesis 2 that the difference in duration, spectral tilt, vowel formant and F0 values between the reduplicant syllables and the base syllables is due to an accentual effect rather than a word boundary effect. In other words, the reduplicant syllables were shown to be acoustically reduced in comparison to the base syllables. Furthermore, the difference between the sandhi forms in comparison with their full (non-sandhi) reduplications in terms of spectral tilt, vowel quality in addition to the tone change suggests that tone sandhi in reduplication words is a form of 'de-accenting' to promote right syllable perceptual salience (headedness). However, this needs to be confirmed in a perceptual study.

5. Conclusion

In conclusion, the acoustic parameters examined in this study suggest that the second syllable of Vietnamese reduplicated forms is more acoustically prominent. In other words, if there is a word stress pattern in these Vietnamese disyllabic reduplications, it will be right-headed. This prominence pattern is further supported by the tone sandhi which is confined to first syllables, and which can be explained on both phonetic and phonological grounds. First, phonetically, tone

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sandhi is motivated by tonal assimilation and preferential preservation of tonal contrast on the second syllable. Second, phonologically, tone sandhi has been postulated to occur on weak syllables (Ngo, 1984; Rose, 1990; Chen, 2000); particularly as found in this study, tone sandhi is accompanied by vowel reduction and less articulatory effort (spectral tilt), suggesting that "tone sandhi is a reduction phenomenon occurring on prosodically weak positions"(Shih, 2005). The results show phonetic evidence of prosodic constituency at the level of the bisyllabic word in Vietnamese and has implication for theory of prosodic structure. However, the status of the prosodic unit - whether it constitutes a stress foot or a phonological word – is yet to be determined and awaits further study.

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