ON THE ROLE OF RHYTHM UNITS:
CASES OF ENGLISH AND KOREAN

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1. Introduction

The purpose of this paper is to show the necessary interaction of phonetics and phonology when we seek to describe certain phonological rules. In particular, I will try to show that some phonological phenomena occurring across word boundaries tend to be affected by phonetic information, e.g., speed or pause, depending on individual speakers' ways of speaking and thus will attempt to identify the phonological domain to reflect this phonetic information.

To do this, I propose the term "rhythm unit[1]," constructed on the basis of intonational contour and phonetic information can be used to describe some phonological phenomena.

In particular, I present that the phonological domain of American English /t/-flapping is neither the phonological phrase nor the utterance as assumed by Nespor and Vogel (1986) and Vogel (1987)[2] and that it can be explained in terms of the

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1) This term "rhythm unit" is similar to Lee's (1965) rhythm unit, Nespor and Vogel's (1986) and Selkirk's (1984) phonological phrase, Koo's (1987) minor phrase, and Pierrehumbert's (1988) and Jun's (1993) accentual phrase.

2) Prosodic structure theory is divided into main two approaches on the basis of the presence or absence of isomorphy between a syntactic domain and a phonological domain: the direct syntactic approach and the indirect syntactic approach. Indirect syntactic theorists(Selkirk, 1986; Selkirk and Shen, 1990; Nespor and Vogel, 1986) propose that phonological rules have access to prosodic phrases constructed on the basis of syntax, but not necessarily identical to existing syntactic phrase. The properties of prosodic hierarchy assumed by the indirect syntactic theorists are as follows:

(1) Properties of Prosodic Structure (Selkirk, 1986: 384):

   a. It consists of prosodic (phonological) categories of different types, e.g. Syllable (Syl: σ), Foot (Ft: Σ), Prosodic Word (Pwd: ω), Phonological Phrase (Pph: φ), Intonational phrase (IP), Utterance (U).

   b. For any prosodic category, a sentence is exhaustively parsed into sequences of such categories.

   c. The prosodic categories are ordered in a hierarchy (in the order given above), and in phonological representation they are strictly organized into layers according to that hierarchy, i.e. prosodic constituents of a same category are not nested.

   d. The hierarchical arrangement of prosodic categories forms a well-formed bracketing.

rhythm unit. It is also suggested that Korean lenis stop voicing and Korean post-obstruent tensification can be well explained in terms of the rhythm unit.

Finally, I conclude that we need the phonological domain "rhythm unit" to reflect phonetic information when we are to describe some phonological rules.

2. The Notion of Rhythm Units

The notion of "rhythm unit" posited in this paper to be a phonological domain, is borrowed from Lee (1987), who regards it as a unit superimposed on the intonational contour. In his M.A. thesis (1965) he originally uses this term as a stress group, and then develops it into a rhythmic unit (or rhythm unit) in subsequent papers (1973, 1974 and 1987). According to Lee, in spoken Korean, it is found that an utterance or a stretch of speech, be it long or short, is usually divided into one or more shorter units. The boundaries of these units are worked by certain phonetic features of a clearly definable nature. Such a phonetic unit into which an utterance can be decomposed is called a "rhythmic unit."

An intonational phrase usually consists of one or more rhythm units. There are several phonetic markers to show this. In English, the rising tone found medially in a sentence is the one of the markers which shows that an intonational contour consists of more than one rhythm unit. Likewise, for Korean, one of the salient markers of the rhythm unit boundary is the final phrase boundary tone. Lee (1990) identifies four phrasal tones: level, falling, rising, and rise-falling whose analysis is based on stress and native speakers' intuition. Koo (1986) and Jun (1993) however identify only one phrasal tone, rising, whose analyses are based on pitch and experimental machines.

Usually the timing of a sentence may provide supporting evidence for its division into rhythm units. Typically there is lengthening or pause at the end of a rhythm unit.

3. The Rhythm Units As A Phonological Domain

In this chapter, I attempt to show that the phonological domain of American English /t/-flapping and Korean lenis stop voicing is a rhythm unit. In addition, it is suggested that Korean post-obstruent tensification is well explained within the domain of rhythm unit.

3.1 American English /t/-Flapping

In this section, I show that the phonological domain of American English /t/-flapping is the rhythm unit, not the utterance as assumed by Nespor and Vogel (1986) and Vogel (1987).

The first step is to observe the environments in which American English flapping occurs. I then discuss the phonological domain of American English flapping.

Flapping is very common in many forms of American dialects, but is unusual in British English (Ladefoged (1986: 653) and Kahn (1976: 95)). In American English, /t/ is flapped between vowels. This can be briefly formalized as follows:

(3) American English /t/-Flapping:
    /t/ → [-stiff v.c. +sonorant] / V ___ V

Flapping may occur within words or across them. Within words, flapping can apply intervocalically, when the second syllable is stressless. Examples follow:

(4) within words:
a. between vowels, when the second vowel is stressless:

computer	→	compu[ɾ]er
fighting	→	figh[ɾ]ing
refrigerator	→	refrigera[ɾ]or
motivation	→	mo[ɾ]ivation

Flapping is blocked, when it is not placed between vowels as in the following examples:

actor	→	ac[tʰ]or (*ac[ɾ]or)
optic	→	op[tʰ]ic (*op[ɾ]ic)

However, there are also cases where though it is placed between two vowels, when the second vowel is stressed, /t/ does not become [ɾ]. This is shown below:

institution	→	insti[tʰ]ution (*insti[ɾ]ution)
potential	→	po[tʰ]ential (*po[ɾ]ential)

Now let's consider the following environments in which flapping occurs: it occurs between [r] and a stressless vowel as in (b):

b. between /r/ and stressless vowel:

     dirty   →   dir[ɾ]y
     started   →   star[ɾ]ed

However, it is blocked between [l] which shares many phonetic features with [r] and a stressless vowel as in the following examples:

     Baltic   →   Bal[tʰ]ic (*Bal[ɾ]ic)
     boulder   →   boul[d]er (*boul[ɾ]er)

In order to account for the environment in which the flapping occurs, Kahn (1976) and Hammond (1982) suggest that [r] is [-consonantal]. This makes it different from [l] or other sonorants, in that a segment is [+consonantal] if there exists an obstruction in the central passage of the oral part of the vocal tract. One of the characteristics of English [r] is that at no time during its articulation is there any obstruction.[3] I accept their position. Thus I state the flapping rule as follows:

(5) /t/-Flapping:
    /t/ → [-stiff v.c +sonorant] / [-cons] ___ [V, -stress]

American English flapping can occur across words, as well. /t/ is usually positioned in the coda of the final syllable of the first word as in (6).

(6) across words:

    What a husband.   → ...wha[ɾ]a...
    We generally leave *it* up to her.   → ...i[ɾ]up...
    Just as he was looking for someone to *hit*, Ann walked in.   → ...hi[ɾ]Ann...
    Meet a fat fighting slim food amazing meal.   → Mee[ɾ]a...

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3) This is from Kahn (1976: 95-96) and Hammond (1982: 217). Contrary to them, Chomsky and Halle (1968: 68) identifies [r] as [+cons].

The following examples show that when it is positioned in the onset of the first syllable of the second word the flapping is blocked:

(7)   If you tested this candidate very very early.   → ...you [tʰ]ested...
       I will try talking to her parents.   → ...try [tʰ]alking...
       One tablespoon of amazing meal has only ten calories   and just about a
       half gram of fat.   → ...only [tʰ]en...

To exclude the case of (7), Kahn creates his own version of the following rule by adding a "word Juncture <#(#)>" following /t/:

(8) /t/ → [ɾ] / [-cons] __ ₐ<#(#)> [+syllabic, ᵦ<-stress>]
                                    Condition: ~a → b

According to Kahn (1976: 55), where /t/ is initial, it does not flap even if the requirements of (6) are met: *buy tomatoes* cannot be pronounced [bay ɾə...].
However, as we can see from (9), flapping in (6) occurs optionally:

(9)   What a husband.   → ...Wha[ɾ]a... / ...Wha[tˀ]a...
      We generally leave it up to her.   → ...i[ɾ]up... / ...i[tˀ]up...
      Meet a fat fighting slim food amazing meal.
                                     → ...Mee[ɾ]a... / ...Mee[tˀ]a...

Also let's consider the following examples.   Contrary to (7) the flapping occurs optionally, even though /t/ is in the onset of the first syllable of the second words. This is especially true of the non-lexical item 'to'.

(10)   Jim, make yourself at home and feel free *to* ask anything.
                                     → ...free [ɾ]o... / ...free [tʰ]o...
       That's too old a story *to* recall.   → ...story [ɾ]o... / ...story [tʰ]o...
       What can I do *to* soothe his hurt feelings?   → ...do [ɾ]o... / ...do [tʰ]o...

I have shown the phonetic environments of /t/-flapping both within words and across word boundaries.   However, across a word boundary, this phenomenon is affected by the speakers' ways of speaking.   So, our task in this section is to find out the appropriate phonological domain of /t/-flapping.

The experimental data are made up of 14 sentences[4].

Three subjects read 14 sentences (or phrases) for American English /t/-flapping[5].

Prior to the experiment, I assumed that /t/-flapping can be affected by each individual's speech.

I obtained the following results by means of experiments:

First, there were many variabilities in phonological groupings among subjects: for example, in the case of the sentence *"You get enough practice at the Noraebang"*, two subjects, who include one in the recording and one subject from New York , pronounced /t/ between *get* and *enough* as [ɾ], whereas one subject from California pronounced it as [t']. Also, in the case of the sentence *"Meet a fat fighting slim food amazing meal"*, two subjects who included one AFKN announcer and one subject from New York pronounced /t/ between *meet* and *a* as [ɾ], but one subject from California pronounced it as [t'].

Secondly, Nespor and Vogel (1980: 46) claimed that the phonological domain of

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4) The experimental data are as follows:

　(2)　1. What a husband!

　　　2. I generally leave it up to her.

　　　3. Well, buy him a drink and he might let it slip out.

　　　4. Wait a minute.

　　　5. First flowers, then candy, a new dress, a new car...where would it end?

　　　6. It is.

　　　7. You get enough practice at the Noraebang.

　　　　　　　　　　　　[from Mar., 1996, Time Record Tape]

　　　8. Just as he was looking for someone to hit, Ann walked in.

　　　9. Joe is liable to get hit. Ann doesn't stand for any nonsense.

　　　　　　　　　　　　[from Kahn, 1976, pp. 55-56]

　　　10. Meet a fat fighting slim food amazing meal.

　　　11. I'll try talking to her parents but if nothing changes will have to get involved.

　　　　　　　　　　　　[from Feb., 13th, 1996, AFKN News]

　　　12. Please wait. I'll be right back.

　　　13. It's hot. Open the window.

　　　14. Don't shout. It's rude.

　　　　　　　　　　　　[from Nespor and Vogel, 1986, p. 46]

5) The following is the information about them:

Name	Sex	Age	Dialect	Education
Stephen	M	28	New York	M.A.
Farzana	F	48	California	M.A.
Trecia	F	25	Iowa	B.A

flapping is the utterance, but the flapping did not occur across an intonational phrase boundary. For example, in the sentence "*Just as he was looking for someone to hit, Ann walked in.*", the two subjects pronounced /t/ between *hit* and *Ann* as [t$^{?}$], not [ɾ], when they produced it as two intonation contours. So we can say that the phonological domain of flapping is not the utterance.

Thirdly, flapping did not occur across a rhythm unit. For example, in the sentence "*That's too old a story to recall.*", the two subjects pronounced /t/ of *to* as [t^{h}] , not [ɾ], when they produced it as two rhythm units.

Thus, I conclude that the phonological domain of /t/-flapping is the rhythm unit.

On the basis of the above results, I reformulate the phonological rule of American English /t/-flapping of (5).

(11) American English /t/-Flapping:
      /t/ → [-stiff v.c] / (...[-cons] ___ [V, -stress]...)γ

                             (γ indicates a rhythm unit boundary)

3.2   Korean Lenis Stop Voicing

In Korean, lenis stop voicing becomes voiced between two voiced sounds. I restate the rule informally in (12) below:

(12) Korean Lenis Stop Voicing:
    /p, t, k/ → [b, d, g] / [+voiced] ___ [+voiced]

The following are some cases in which Korean lenis stop voicing occurs:

(13) Within words:

    a. a[b]ŏji
    b. kŏji[g]a
    c. kangaji[g]a

(14) across words:

    a. kŭ [g]ŭrimŭn
    b. tŭrŏgashinŭngŏ [b]wanni?

c. pon [g]ŏjiga

Kang (1992) and Cho (1990) claim that the phonological domain of Korean lenis stop voicing is the phonological phrase. The following examples in (15) below shed a new light on the situation:

(15) a. kŭ [k]ŭrimŭn maeu [p]issada.
     b. kŭ [g]ŭrimŭn maeu [p]issada.
     c. kŭ [k]ŭrimŭn maeu [b]issada.
     d. kŭ [g]ŭrimŭn maeu [b]issada.

According to Kang (1992) and Cho (1990), we can expect that only one possible phrasing as in (15d) is produced and thus the only phonetic output form would be "kŭ gŭrimŭn maeu bissada." However, as shown in (15), four groupings are possible.

According to these findings, the phonological domain of Korean lenis stop voicing is indeed a rhythm unit. Thus, I reformalize the phonological rule of Korean lenis stop voicing as follows:

(16) Korean Lenis Stop Voicing:
     /p, t, k/ → [b, d, g] / (... [+voiced] ___ [+voiced]...)γ

3.3   Korean Post-Obstruent Tensification

In Korean, obstruents become tense when preceded by obstruents:

(17) Korean post-obstruent tensification:
     [-son] → [+tense] / [-son] _____

Korean post-obstruent tensification occurs within words or compounds as follows:

(18) within words (or compounds):

     shinda 'wear shoes'   →   [šint'a]
     kuksu 'noodle'   →   [kuks'u]
     kukpap 'soup'   →   [kukp'ap]

Also *it* occurs across words (or phrases) as follows:

(19) padak takkara 'clean the floor'   →   [padakt'ak'ara]
        paduk tuja 'Let's play chess'   →   [padukt'uja]
        kkottchipkugyŭnggaja   →   [k'oĵipk'ugyəŋgaja]
        'Let's go to see the store which sell foweres.'

However, post-obstruent tensification is affected by speakers' speech rate. When a speaker produces the examples in (19) as two rhythm units, instead of one, tensification is blocked. For example, if the sentence "padak takkara" is grouped into two rhythm units "*padak*" and "*takkara*", the initial /t/ of *takkara* does not undergo tensification. Thus, we can suggest that the phonological domain of Korean post-obstruent tensification is a rhythm unit:

(20) Korean post-obstruent tensification:
        [-son] → [+tense] / (...[-son] _____...)γ

4. Conclusion

In this paper, I have tried to determine a phonological domain which reflects the phonetics-phonology connection. In other words, I attempted to show that some phonological phenomena occurring across a word boundary tend to be affected by an individual's speech patterns and that we need a specific phonological domain to reflect it.

To do this, I have proposed the term "rhythm unit." In particular, I have shown that American English /t/-flapping can be adequately explained in terms of a rhythm unit. I have also suggested that Korean lenis stop voicing and Korean post-obstruent tensification can be well explained in terms of the rhythm unit.

Finally, I conclude that we need the phonological domain "rhythm unit" to reflect phonetic information when we are to describe some phonological rules.

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