

Categorical Perception in intonation

Ho-Young Lee

Dept. of Linguistics, Seoul National University

hylee@snu.ac.kr

Abstract

According to Pierrehumbert (1980), two level tones — H and L — are enough in representing intonation of intonational languages. But in Korean, high fall and low fall boundary tones, both of which must be represented as HL% in intonational phonology as in Jun (1993, 1999), are distinct not only acoustically but also functionally. The same is true in the case of high level and mid level boundary tones, which must be represented as H% in intonational phonology. In this paper, I conducted two identification tests to provide crucial evidence that H and L are not enough in intonational phonology. The results of the identification tests show that categorical perception occur between high level and low level as well as between high fall and low fall. Based on this fact and the results of the acoustic analyses in Lee (1999, 2000), I strongly propose to adopt one more level tone — M — to represent Korean boundary tones.

I. Introduction

One of the major tenets of Pierrehumbertian intonational phonology is that intonation can be satisfactorily represented by assuming only two level tones — High and Low. This tenet has been applied to represent intonation of several languages like English (Pierrehumbert 1980), Japanese (Poser 1984, Pierrehumbert and Beckman 1988), Bengali (Hayes and Lahiri 1991), German (Féry 1993), Italian (Grice 1995), and so on.

Jun (1993, 1999) was the first attempt to represent Korean intonation within the framework of intonational phonology. Since she followed the above-mentioned tenet strictly, she neglected the

distinction between high fall and low fall boundary tones, which I proposed in Lee (1990). But as can be seen in Figure 1, the sentence “Seoul-e gasso (Seoul-to went)” is perceived as a question if high fall boundary tone is imposed on the last syllable, whereas this sentence is perceived as a statement if low fall boundary tone is imposed. And the difference in peak frequency between these two tones is 79Hz. In Lee (1999, 2000), I measured and compared peak frequencies of high fall and low fall boundary tones based on quantitative acoustic data. In these studies, the difference in peak frequency between these two tones was proved to be statistically significant. It follows that high fall and low fall boundary tones are distinct functionally as well as acoustically.

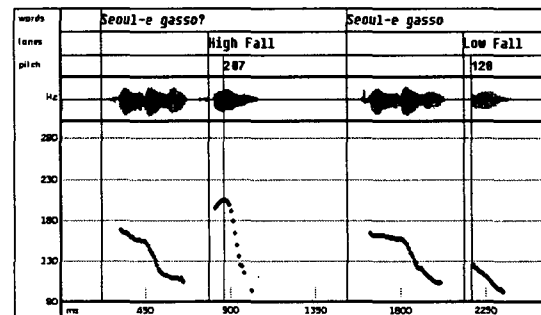


Figure 1. High fall and low fall boundary tones

The same is true in the case of high level and mid level boundary tones. As can be seen in Figure 2, the sentence “Seoul-e gasso (Seoul-to went)” is perceived as a statement if mid level tone is imposed on the last syllable, whereas this sentence is perceived as a question if high level boundary tone is imposed. And the difference in peak frequency is 156Hz. This difference was proved to be statistically significant in Lee (1999, 2000). It follows that high level and mid level boundary tones

are also distinct not only functionally but also acoustically.

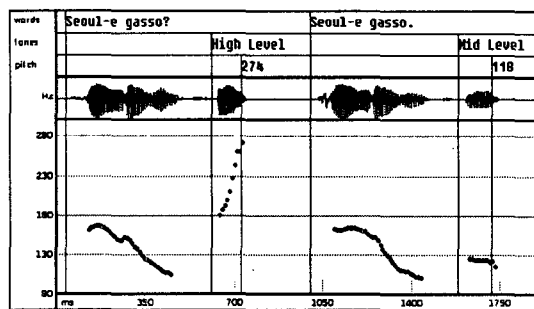


Figure 2. High level and mid level boundary tones

Within the framework of intonational phonology, both high fall and low fall boundary tones must be represented as HL% and both high level and mid level boundary tones as H% as in Jun (1993, 1999). But as noted above, the high fall and low fall boundary tones are distinct functionally and acoustically. And so are high level and mid level boundary tones. Hence in this paper, I will strongly argue that H and L are not enough in intonational phonology and therefore we need one more level tone — Mid tone — to represent distinct Korean boundary tones satisfactorily. I will provide more crucial evidence that high fall and high level are functionally distinct from low fall and low level by conducting a perception test

II. Experiment

For this experiment, “Seoul-e gasso (Seoul-to came)”, which can be used both as a statement (“I’ve come to Seoul.”) and as a question (“Have you come to Seoul?”), was used as a test sentence. I pronounced this sentence with high fall boundary tone on the last syllable for high fall and low fall identification test. And I pronounced this sentence with low level boundary tone on the final syllable for high level and mid level identification test. I recorded these utterances directly into KAY’s CSL 4400 using a Shure SM-48 microphone in a recording room.

I modulated the peak frequency of each boundary tone at 10 Hz intervals with Pitch Instruments’ WinPitch. 12 tokens were made for the high fall and

low fall identification test. As can be seen in Figure 3, straight lines were drawn from modulated peak frequencies to the bottom frequency, i.e. 90 Hz, to synthesize falling tones. The bottom frequency of the preceding syllable was 104 Hz. Although the delayed peak of the high fall was neglected in synthesizing the falling tones, the perceptual effect of the high fall was maintained as long as the peak frequency was sufficiently high.



Figure 3. Peak frequency was modulated at 10 Hz intervals for high fall and low fall identification test.

Another 12 tokens were made for the high level and mid level identification test. As can be seen in Figure 4, straight lines were drawn from the bottom frequency of the preceding syllable, i.e. 114 Hz, to modulated peak frequencies in order to synthesize level tones.

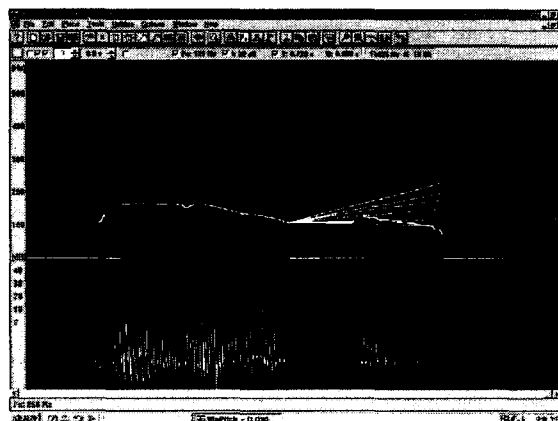


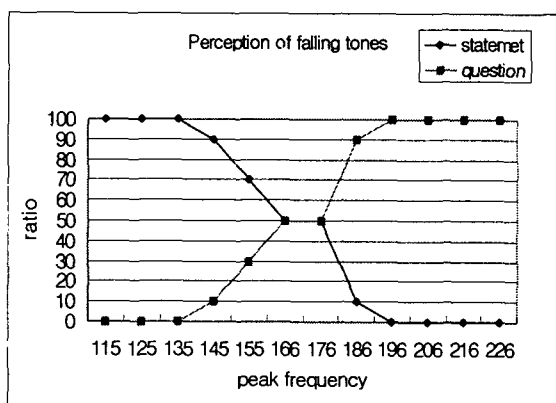
Figure 4. Peak frequency was also modulated at 10 Hz intervals for the high level and mid level identification test

Each 12 tokens were mixed and spaced at 3

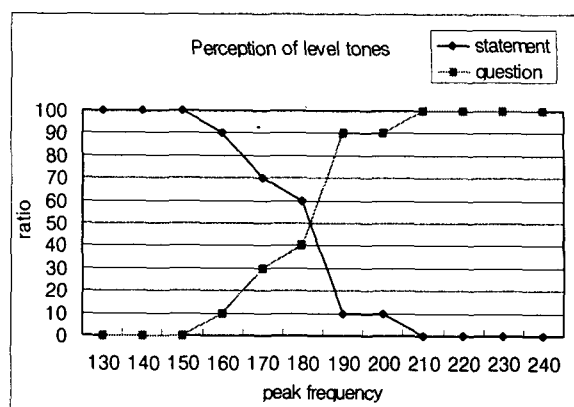
second intervals by using Cool Edit 2000. Two minute break was given between each test. All the tokens were presented once to 15 subjects. They were asked to check whether each token was perceived as a statement or as a question.

III. Results and discussion

In high fall and low fall identification test, categorical perception occurred when peak frequency reached 166~176 Hz. All the subjects perceived synthesized utterances as a statement until peak frequency reached 135 Hz. The number of subjects who perceived synthesized utterances as a question increased as the peak frequency increased. When peak frequency reached 196 Hz, all the subjects perceived synthesized utterances as a question.



Categorical perception also occurred in high level and mid level identification when peak frequency reached 180 Hz. All the subjects perceived synthesized utterances as a statement until peak frequency reached 150 Hz. The number of subjects who perceived synthesized utterances as a question increased as the peak frequency increased. When peak frequency reached 210 Hz, all the subjects perceived synthesized utterances as a question.



The fact that categorical perception was observed in the high level and low level identification test as well as in the high fall and low fall identification test constitutes crucial evidence that H and L are not enough in intonational phonology and thus we have to adopt one more level tone — Mid tone — to represent Korean boundary tones. Just as there are tone languages with two distinctive level tones (e.g. north Kyungsang dialect in Korea) and three distinct level tones (e.g. south Kyungsang dialect), we have to admit that there can be intonation languages that need more than two level tones to satisfactorily represent intonation.

In Lee (1999, 2000), I proposed to represent high fall boundary tone as HL%, not as HM%, in intonational phonology in spite of the fact that the bottom frequencies of high fall and low fall boundary tones were significantly different. In this experiment, the bottom frequency of both high fall and low fall was set at 90 Hz and synthesized high fall tones sounded very natural. This fact supports my earlier proposal that high fall boundary tone should be represented as HL%. I assume that the pitch target of the high fall is the same as that of the low fall but the former is normally undershot.

IV. Conclusion

In this paper, I conducted high fall and low fall identification as well as high level and low level identification test to provide crucial evidence that H and L are not enough in intonational phonology and therefore we have to adopt one more level tone —

M — to represent Korean boundary tones.

The results of the identification tests show that categorical perception occur between high level and low level as well as between high fall and low fall. Since the same sentence is perceived as a statement when low fall or mid level boundary tones are imposed on the final syllable and as a question when high fall or high level boundary tones are overlaid, we can confidently conclude that high fall and high level tones are functionally distinct from low fall and mid level boundary tones.

Within the framework of Pierrehumbertian intonational phonology including Jun (1993, 1999), it is impossible to represent the two distinct falling tones and the two distinct level tones differently. Hence I strongly propose to adopt one more level tone — M — to represent Korean boundary tones. Just as there are tone languages with two distinctive level tones and three distinct level tones, we have to admit that there can be intonation languages that need more than two level tones to satisfactorily represent intonation.

References

- Féry, C. (1993) *German intonational patterns*. Tübingen: Niemeyer.
- Grice, M. (1995) The intonation of interrogation in Palermo Italian: timing and height of pitch peaks. *Journal of Phonetics* 22. pp. 269~281.
- Hayes, B. and Lahiri, A. (1991) Bengali intonational phonology. *NLLT* 9. pp. 47~96.
- Jun, S.A. (1999) *K-ToBI (Korean ToBI) Labelling Conventions*, version 3.0., ms. UCLA.
- Jun, S.A. (1993) *The Phonetics and Phonology of Korean Prosody*. PhD dissertation. Ohio State University.
- Lee, H.Y. (1990) *The Structure of Korean Prosody*. PhD thesis. University of London.
- Lee, H.Y. (1999) An acoustic phonetic study of Korean nuclear tones (in Korean), *Malsori* 38. The Phonetic Society of Korea. pp. 25~39.
- Lee, H.Y. (2000) Acoustic Cues of Korean Nuclear Tones, *Language Research* 36-2. Language Research Institute, Seoul National University. pp. 325~338.
- Pierrehumbert, J. (1980) *The phonology and phonetics of English intonation*. PhD Thesis, MIT, published 1988 by IULC.
- Pierrehumbert, J. and M. Beckman (1988) *Japanese tone structure*. Cambridge, MA: MIT Press.
- Poser, W.J. (1984) *The phonetics and phonology of tone and intonation in Japanese*. PhD thesis, MIT.