CATEGORICAL OR CONTINUOUS PRODUCTION IN LEXICAL PITCH ACCENT CONTRASTS OF KOREAN

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ABSTRACT

The current research investigated the relation of categorization and production using imitation and production paradigm. More specifically, the imitation and production responses of this experiment were analyzed in order to find out individual speaker differences in lexical pitch accent categories of North Kyungsang Korean. A significant number of imitation and production responses favoured the categorical production account, although in general such responses are dependent on lexical pitch accent types. According to the current results, the lexical pitch accent contrasts seemed to show individually different patterns. That is, some participants showed strict categorical production, whereas others showed continuous effects in production of pitch contour in North Kyungsang Korean. On the basis of the relation of categorization and production in current research, the results revealed that the relation of categorization and production relies on individual speakers' cognitive systems.

Keywords: imitation, production, categorization, North Kyungsang Korean, individual differences

1. INTRODUCTION

Infants acquire their native language and dialect through imitation. Their imitating ability appears at the early stage of speech development, representing the social relation between infants and their mothers. The pioneering literature on imitation has mostly focused on categorical effects in the relation between imitation and perception (Chistovich et al. [1], Kent [5, 6], Repp & Williams [14], and Schouten [15]). The studies conducted by Chistovich et al. [1] and Kent [5, 6] raised the question whether imitation and perception of synthetic vowel continua show a continuous or categorical effect. Repp and Willams [14] implied that vowel imitation responses reflect the mutual influence between perception and production, even though their research did not observe strong categorical responses. Schouten [15] found out that, in an imitation and identification task, Dutch-English bilinguals show a categorical effect between imitation and identification responses for a synthetic vowel continuum.

The current research investigated about the relation of categorization and production, taking into account the effects of individual differences for both tasks. The categorical production in an imitation task when compared to a production task has been little examined for individual speakers with particular prosodic characteristics. Pierrehumbert and Steele [12] observed the categorical distinction in English intonation's imitation for some subjects, but others did not seem to show individually different imitation categories. Redi [13] and Dilley and Brown [2], in an imitation task, did not address individual differences; however, they discovered the existence of categorical effects on fundamental frequency (f0) variation in American English.

Categorical production related to prosodic properties may reflect a cognitive system as the same way speech perception does. Kaplan and Kaplan [3] mentioned that infants hear the intonation patterns of adults, and in the first year of their life, infants begin imitating adults' speech. Spring and Dale [16] suggested that one- to four-month-old infants discriminate the stress patterns with different fundamental frequency, intensity, and duration. To date, there have been fewer investigations of categorization in speech production than in speech perception. The relation in categorization between imitation and production may appear as a language-specific or dialect-specific property. Prosodic effects in categorical production need to be examined for the effects of individual variation when predicting different cognitive systems.

The current research focused on the lexical pitch accent of Korean (i.e., North Kyungsang Korean) in order to examine how prosodic characteristics are related to categorical production. North Kyungsang Korean is spoken in the southeast region of Korea. Native speakers from the North Kyungsang region in Korea can lexically distinguish the words using pitch accent (e.g., [kaci]: HL 'kind', LH 'eggplant', HH 'branch'). In previous studies (Kim [7], Kim [11], and Kenstowicz & Sohn [4]), categories of lexical pitch accent were analyzed within the phonological framework. That is, the assignment of lexical pitch accent was determined in terms of the association between the syllable and high tone. In recent

literature (Kim [8, 9, 10]), North Kyungsang Korean's lexical pitch accent categories have been examined by imitation responses using resynthesized pitch accent continua, and these studies showed that lexical pitch accent is imitated in the process of categorization relative to dialect-specific properties in North Kyungsang Korean. The current research aims at observing whether categorical or continuous production reflects individual imitation and production strategies in the relation of categorization and production.

2. METHODS

2.1. Participants

The eighteen participants were native speakers of North Kyungsang Korean. They were recruited from Daegu, the metropolitan city in the North Kyungsang region. Nine speakers participated in each imitation and production task. The participants were from nineteen to thirty-three years old and had no known history of hearing and speaking impairments.

2.2. Stimuli

Stimuli for the imitation and production tasks were three minimal pairs of disyllabic-words that differed in lexical pitch accent patterns. The minimal pairs were the following (i.e., [mo.i]: HL 'feed', LH 'conspiracy'; [mo.ɾe]: HL 'sand', HH 'the day after tomorrow'; [yaŋ.mo]: LH 'wool', HH 'adoptive mother'). For the production task, the three pitch accent minimal pairs were excerpted from carrier sentences. For the imitation task, using Praat, a pitch-synchronous overlap and add (PSOLA) algorithms were employed for resynthesizing the pitch accent continuum of the three pitch accent types.

2.3. Procedure

In the experiment, production tasks were followed by imitation tasks in a sequence. The production task contained six carrier sentences with pitch accent minimal pairs. The participants were asked to repeat the sentences six times in random order for the recording (i.e., 6 target words × 6 repetitions × 9 participants). The imitation task included 432 trials (i.e., 6 blocks × 72 trials) and presented stimuli in random order for the trials within a block. The participants were instructed to imitate what they heard.

2.4. Analysis

The production and imitation responses were analyzed in terms of normalized location for f0 peak times. Normalization for f0 peak times was obtained by computing the difference between the onset time (T1) of the entire word and f0 peak time (T2) on pitch contour divided by the duration of the word (D). The normalized values were calculated as in Pierrehumbert and Steele [12] and Dilley and Brown [2]. That is, in this analysis, normalized f0 peak times were computed as in (1).

(1) Normalized f0 peak times = (T2 - T1) / D

3. RESULTS

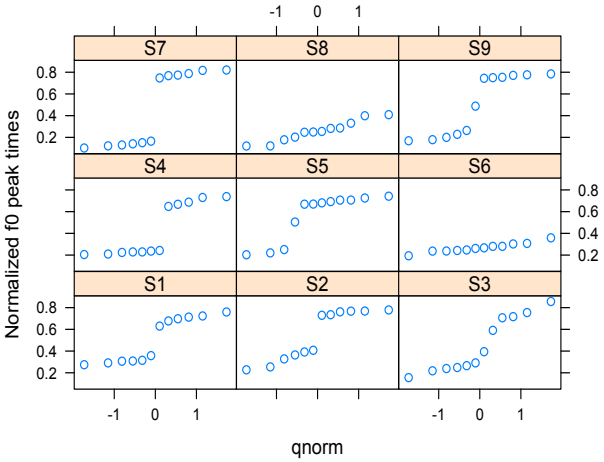
3.1 Production responses

For production responses, the output of each pitch accent pattern revealed that normalized f0 peak times have significant effects on HL-LH ($F(1,106) = 90.212$, $p<0.001$), HH-HL ($F(1,106) = 90.757$, $p<0.001$), and HH-LH ($F(1,106) = 35.58$, $p<0.001$). The results among individual speakers for each pitch accent pattern showed noticeable differences for HL-LH and HH-LH, but not for HH-HL (i.e., individual differences for HL-LH ($F(8,99) = 2.8569$, $p<0.01$), for HH-LH ($F(8,99) = 4.6999$, $p<0.001$, but not for HH-HL ($F(8,99) = 1.14$, $p=0.3436$). In order to represent individual-level variance, an Intraclass Correlation Coefficient was computed. The Intraclass Correlation Coefficient was 13% for HL-LH, 24% for HH-LH and 1% for HH-HL.

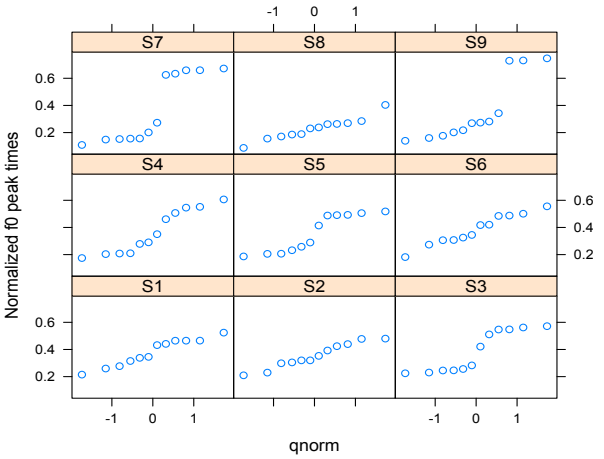
Figure 1 presents a quantile-quantile plot (i.e., probability plot) for each participant in order to examine the distribution of normalized f0 peak times. In Figure (1a), for HL-LH, there are clear distinctions (i.e., categorical effects) in the curves for S1, S2, S4, and S7. Even though the continuous curves for S3, S5, and S9 are shown, there are the shifts indicating categorical effects at the middle of the curves. However, S6 and S8 show more or less flat patterns. Figure (1b) for HH-HL displays more continuous curves for each participant than Figure (1a) does. There are distinctive curves only for S7 and S9. S3, S4, and S5 show continuous curves but there are categorical shifts at the middle of the curves. S1, S2, S6, and S8 show gradient curves from the left end to the right end. In Figure (1c) for HH-LH, S1, S4 S5, S6, and S7 do not show clear distinctions similar to those seen in Figure (1a), but there are shifts at the middle of the curves, indicating categorical effects. S2, S3, S8, and S9 show more or less continuous effects, though there are some intervals on the curves.

Figure 1: Quantile-quantile plots for normalized f0 peak times grouped by participants. For production responses, HL-LH, HH-HL, and HH-LH patterns were plotted.

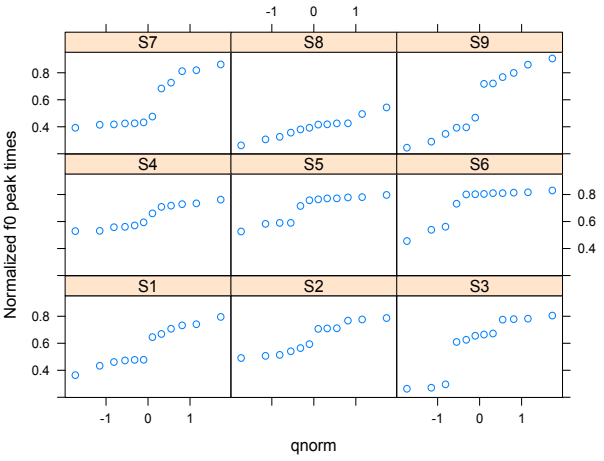
(a) HL-LH



(b) HH-HL



(c) HH-LH



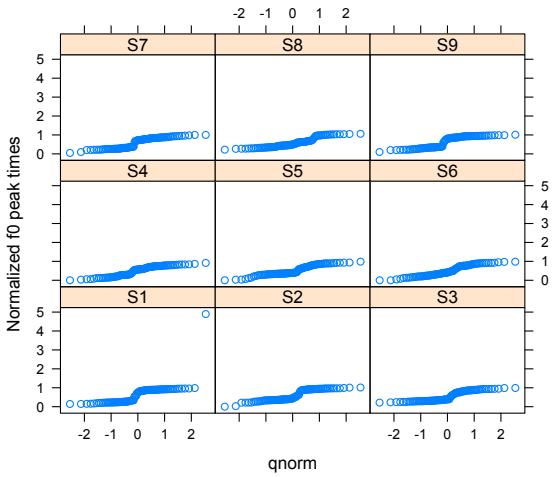
3.2. Imitation responses

With respect to imitation responses, the results showed a significant effect among individual speakers depending on pitch accent continuum. The output of the HL-LH continuum significantly differed for individuals ($F(8, 800) = 2.5575$, $p<0.01$). Moreover, individual participants showed noticeable differences ($F(8, 795) = 4.3782$, $p<0.001$) for HH-HL and ($F(8, 798) = 3.5164$, $p<0.001$) for HH-LH. Intraclass Correlation Coefficient for HL-LH showed 1.7% of the variance in normalized f0 peak times, 3.6% for HH-HL, and 2.7% for HH-LH.

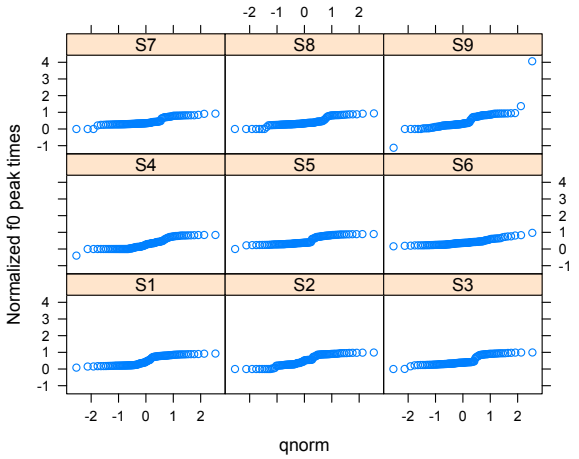
In Figure (2a) for HL-LH, participants such as S1, S2, S3, S7, and S9 showed abrupt shifts at the middle of the curves, indicating categorical effects. The plot displayed continuous shifts for S4, S5, S6, and S8, but the curve for each speaker was more or less different. On the other hand, in Figure (2b) for HH-HL, overall, the curves of individual speakers were gradient, but S1, S3, S4, and S5 were more distinct in the shifts of categorization than any other participants. S2, S7, and S9 seemed to have shifts on the curves, reflecting more or less continuous effects. But S6 and S8 tended to show almost flat patterns. In Figure (2c) for HH-LH, S3, S5, and S8 showed clear shifts, representing categorical effects. S4, S7, and S9 seemed to have more or less continuous curves. Finally, S2, and S6 showed flat lines, but S1 tended to show some kind of a dip at the middle of the curve.

Figure 2: Quantile-quantile plots for normalized f0 peak times grouped by participants. For imitation responses, HL-LH, HH-HL, and HH-LH patterns were plotted.

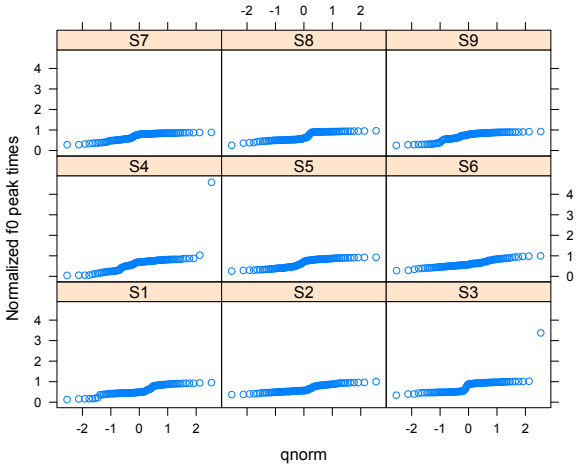
(a) HL-LH



(b) HH-HL



(c) HH-LH



4. CONCLUSION

Individual differences in the imitation and production responses appeared as categorical or continuous production depending on pitch accent patterns. For the HL-LH pattern, the responses showed more categorical shifts in production and imitation strategies than other pitch accent patterns, though the imitation responses showed less variation than the production responses did. For HH-HL and HH-LH, the imitation responses had significant individual differences, but the probability curves in imitation and production responses showed more continuous effects for individual speakers. For production responses, the HL-LH and HH-LH patterns significantly differed, but the HH-HL pattern was not statistically different and the individual curve patterns in this pitch accent type revealed continuous effects. To sum up, the relation of categorization and production in the imitation and production paradigm was the most distinctive for the HL-LH pattern for the North Kyungsang individual speakers.

5. REFERENCES

[1] Chistovich, L. Fant, G., Serpa-Leitao, A., Tjernlund, P. 1966. Mimicking of synthetic vowels. *Speech Transmission Laboratory – Quarterly Progress and Status Report* 2., Stockholm, 2, 1-18.

[2] Dilley, L. C., Brown, M. 2007. Effects of pitch range variation on f0 extrema in an imitation task. *J. Phonetics* 35, 523-551.

[3] Kaplan, E., Kaplan, G. 1971. The prelinguistic child. In J. Eliot (eds), *Human Development and Cognitive Processes*. New York: Holt, Rinehart and Winston, 358-381.

[4] Kenstowicz, M., Sohn, H. S. 1997. Focus and phrasing in Northern Kyungsang Korean. In Bertinetto, P. M. (eds), *Certamen Phonologicum III*. Torino: Osenberg & Sellier, 137-156.

[5] Kent, R. D. 1973. The imitation of synthetic vowels and some implications for speech memory. *Phonetica* 28, 1-25.

[6] Kent, R. D. 1974. Auditory-motor formant tracking: A study of speech imitation. *J. Speech Hear. Res*. 17, 203-222.

[7] Kim, G. R. 1988. *The Pitch Accent System of the Taegu Dialect of Korean with Emphasis on Tone Sandhi at the Phrasal Level*. Unpublished doctoral dissertation, University of Hawaii.

[8] Kim, J. S. 2012. F0 extrema timing of HL and LH in North Kyungsang Korean: Evidence from a mimicry task. *Journal of the Korean Society of Speech Sciences* 4, 43-49.

[9] Kim, J. S. 2012. Some aspects in mimicry of lexical pitch accent by children and adults. *Korean Journal of Linguistics* 37, 285-300.

[10] Kim, J. S. 2014. The continuous or categorical effects for HH vs. HL and HH vs. LH in lexical pitch accent contrasts of Korean. *Journal of the Korean Society of Speech Sciences* 6, 53-65.

[11] Kim, N. J. 1997. *Tone, Segments, and their Interaction in North Kyungsang Korean: A Correspondence Theoretic Account*. Unpublished doctoral dissertation, Ohio State University, Columbus, Ohio.

[12] Pierrehumbert, J., Steele, S. A. 1989. Categories of tonal alignment in English. *Phonetica* 46, 181-196

[13] Redi, L. 2003. Categorical effects in production of pitch contours in English. *Proc. 15th ICPhS*, Barcelona, 2921-2924.

[14] Repp, B. H., & Williams, D. R. 1985. Categorical tendencies in vowel imitation: Preliminary observations from a replication experiment. *Speech Communication* 4, 105-120.

[15] Schouten, M. E. H. 1977. Imitation of synthetic vowels by bilinguals. *J. Phonetics* 5, 273-283.

[16] Spring, D. R., Dale, P. S. 1977. Discrimination of linguistic stress in early infancy. *J. Speech Hear. Res*. 20, 224-232.