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The Internal Structure of an Identification Function in Korean Lexical Pitch Accent in North Kyungsang Dialect

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ABSTRACT

This paper investigated Korean prosody as it relates to graded internal structure in an identification function. Within Korean prosody, variants regarded as dialectal variations can appear as different prosodic scales, which contain the range of within-category variations. The current experiment was intended to show how the prosodic scale corresponding to the range of within-category differences relates to f0 contours for speakers of two Korean dialects, North Kyungsang and South Cholla. In an identification task, participants responded by selecting an item from two answer choices. The probability of choosing the correct response from the two choices was computed by a logistic regression analysis using intercepts and slopes. That is, the correct response between two choices was used to show a linear line with an s-shape presentation. In this paper, to investigate the graded internal structure of labeling, 25%, 50%, and 75% of predicted probability were assessed. Listeners from North Kyungsang showed progressive variations, whereas listeners from South Cholla revealed random patterns in the internal structure of the identification function. In this paper, the results were plotted using scatterplot graphs, applying the range of within-category variation and predicted probability obtained from the logistic regression analyses. The scatterplot graphs showed the different degree of the responses for f0 scales (i.e., variations within categories). The results demonstrate that the gradient structures of native pitch accent users become more progressive in response to f0 scales.

Keywords: Internal (gradient) structure, identification function, categorical boundary, within-category variations (differences)

1. Introduction

This paper investigates the graded internal structure of responses in an identification task, focusing on listeners representing two dialects, that is, North Kyungsang and South Cholla. When two different categories were described as two phonetic forms, the gradient structure between the two categories was measured as a scale of indicators of phonological behavior. The aim of the current paper is to describe the intermediate process of categorical perception between two phonetic items, both lexical pitch accent categories in North Kyungsang Korean. The endpoints of the items were resynthesized to create the stimuli. Specifically, the current study examines the range of within-category differences between the participants' responses to the endpoints.

Several previous works have analyzed North Kyungsang Korean using experimental equipment, such as a paradigm of categorical perception. For example, Kim and de Jong (2007) conducted an experiment about the categories of identification, mimicry, and production; in this paper, the categories were obvious for North Kyungsang speakers, whereas there was a loose relationship between identification, mimicry, and production for South Cholla speakers. A more specific perception experiment was described in Kim (2009, 2011), which investigated the relation of identification and discrimination for lexical pitch accent minimal pairs of North Kyungsang Korean. In Kim (2011), the identification scores revealed a divergence of categories for two alternative items, and the two dialect groups, North Kyungsang and South Cholla, showed a different peak for an ABX discrimination. An interesting result was shown from the participants'

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discrimination responses. That is, between-category discrimination had higher scores than within-category discrimination, and even for within-category discrimination, the scores were higher for North Kyungsang listeners than for South Cholla listeners. To extend the findings of Kim (2011), in the current paper, we investigate the gradient effect between two categories with the aim of describing the phonological behavior of native North Kyungsang speakers.

Several previous studies have addressed the graded internal function of the two categories, such as Miller (1997), McMurray et al. (2002), and McMurrary and Aslin (2005). The two phonetic categories differed between the endpoints of stimuli in categorical perception, but within-category differences also have been observed in recent research. Gradient sensitivity on the acoustic continuum has appeared as a within-category variation rather than a between-category distinction. Miller (1997) used a rating task to examine how good participants rated a stimulus such as [p] on a scale of 1 to 10. That is, the better the phonetic form, the higher the rating they were asked to give. The rating task revealed the participants' perceptual sensitivity to how good the phonetic form was. Building on this study, there was no discrete response between the two categories. Rather, between the categories, there was a gradient structure toward both endpoints of the stimuli, showing systematic variations in acoustic parameters. McMurray et al. (2002) investigated within-category differences employing an eye-tracking task. In an identification task designed to investigate voice onset time (VOT) perception, participants showed a steep slope between the two endpoints [b] and [p] as well as in their identification of words beginning with [b] and [p]. Using a similar method to study within-category variations, McMurray et al. (2002) used an eye-tracking task to examine the fixation to target, fixation to the related competitor, and fixation to an unrelated distractor. The result of fixation to the related competitor was progressively tracked along the time course. The patterns for fixation showed sensitivity for within-category variations. McMurray and Aslin (2005) investigated infants' perception ability using within-category differences. They utilized infants' association with the difference in systematic performance for the distinction of phonetic parameters. The infants were all eight months old, and the experiment considered their head-turn preference performance. In a VOT recognition test, the infants listened to 80 words beginning with either [b] or [p]. The experiment used synthesized stimuli; the endpoints of [b] and [p] were manipulated to have a difference of 5ms in VOT. The values of the two endpoints, [b] and [p], were 5ms and 40ms, respectively. The intermediate steps were varied between the values of the endpoints. The results also showed a gradient effect between the endpoints of the stimuli. Additionally, there was no difference between novelty preferring toward the competitor and familiarity preferring toward the target for the head-turn preference procedure. Thus, the experiment showed a graded internal structure. However, the results indicate that novelty preferring toward the competitor was faster than familiarity preferring toward the competitor in listening time. This result can be predicted in an identification task that presents non-sense words or words with high frequency.

The studies discussed above revealed within-category variations across adults and infants. More interestingly, the variations within categories vary systematically along an acoustic continuum. Kim (2009, 2011, 2012) described Korean categorical perception in a traditional paradigm but did not display the goodness of categories in an acoustic parameter. The current study investigates the performance of within-category differences in lexical pitch accent categories for native (i.e., North Kyungsang) and non-native (i.e., South Cholla) listeners. The three research questions are as follows: (1) How do the differences within categories reflect a local dialect effect? (2) What differences can be observed in within-category variations for both groups of dialect listeners? (3) Are the dialect variations in Korean based on systematic variations in the range of within-category variations reflecting Hertz, when it is assumed that fundamental frequency (f0) variations are associated with a change of Hertz? By answering these research questions, this study aims to show the variations of within-category phonetic forms. These f0 variations are associated with the acoustic parameter.

2. Experimental method

2.1 Participants

There were 12 participants from Daegu in North Kyungsang region and 10 participants from Kwangju in South Cholla region. Their age ranged from 19 to 33 in the North Kyungsang group and from 32 to 39 in the South Cholla group. All the participants were native speakers who had been raised in the town in which they currently lived. They received financial compensation for their participation. There were no hearing problems for participating in the experiment.

2.2 Stimuli

The stimuli were resynthesized using Praat (Boersma & Weenink, 1992-2009) and the target words were identical to the ones used in Kim (2009, 2011, 2012). The stimuli were [mo.i] with HL 'feed' and LH 'conspiracy', [mo.ɾe] with HL 'sand' and HH 'the day after tomorrow', [yaŋ.mo] with LH 'wool' and HH 'adoptive mother'. These three lexical minimal pairs were produced by a speaker of North Kyungsang Korean, and resynthesized into a nine-step continuum for each lexical pitch accent pattern, HL-LH/LH-HL, HH-HL/HL-HH, HH-LH/LH-HH.

2.3 Procedure

The experiment procedure was identical to those used in Kim (2009, 2011, 2012). There was an identification task with two answer choices. The participants were asked to select a phonetic form from the two possible responses. Beforehand, they were given instructions on how to respond and completed a pre-test practice session. They were well trained on how to label the two answer choices.

2.4 Statistical analysis

The current study used the predicted probability obtained from logistic coefficients, intercepts, and slopes. A series of analysis of variance (ANOVA) was conducted. The dependent variable was the value of predicted probability. The independent variable was the dialect group, North Kyungsang and South Cholla. A statistical analysis was conducted for individual participants as well as the two dialect groups. One-way and two-way ANOVA were run in the sequence of analysis.

3. Results

The results were intended to shed light on within-category differences for the three types of pitch accent minimal pairs as perceived by listeners representing two dialects of Korean. It was shown that the differences within categories progressively changed for each stimulus corresponding to 25%, 50%, and 75% of the predicted probability. The first analysis revealed an interaction of group and each range within categories, as well as a group effect and effect of range of within-category differences. The second analysis showed an effect of each stimulus between the two dialect groups. The final analysis showed there were no individual variances, but there was a small change, especially for the HL-LH pattern for North Kyungsang listeners and also for a few other patterns. We will look at these analyses in detail in this section.

3.1 The effect of within-category variations

The effect of differences within categories was analyzed as three-way factors: (1) the effect of group, (2) the effect of range of within-category differences, and (3) the interaction of group and the range of within-category differences. The group effect did not differ significantly across two minimal pairs (HH-HL and HH-LH), but the pattern HL-LH differed between the two dialect groups ($F(1, 128)=7.293$, $p < 0.00786$). Each range of within-category variations reflecting the percentages of each stimulus from its endpoint was significantly different for the HL-LH lexical pitch accent minimal pair ($F(1,128)=142.282$, $p < 0.001$), the HH-HL pattern ($F(1,128)=102.827$, $p < 0.001$, and the HH-LH pattern ($F(1,128)=194.717$, $p < 0.001$). The interaction of group and range of within-category differences also significantly differed for HL-LH ($F(1,128)=40.159$, $p < 0.001$), HH-HL ($F(1,128)=32.089$, $p < 0.001$), and HH-LH ($F(1, 128)=20.951$, $p < 0.001$. The values of within-category variations, as seen in Figures 1, 2, and 3, changed progressively at every stimulus point corresponding to 25%, 50%, and 75% from the endpoints of the stimuli. The percentages are presented as a 'scale' with even numbers in the figures. Figure 1 shows the HL-LH pattern and its range: 25%, of within-category differences were above 0.5 probability; 75% were below 0.5; and 50% were between 0.2 and 0.9.

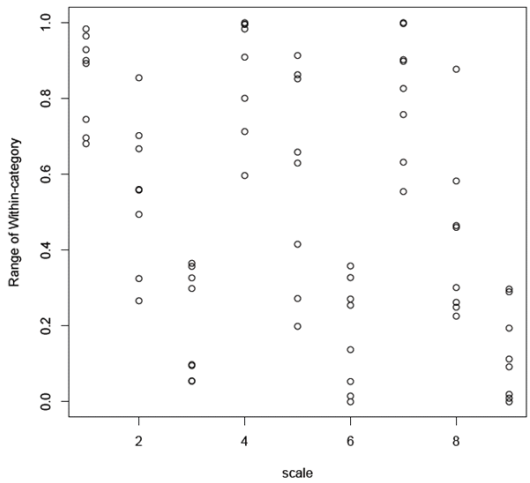

Figure 1. Range of within-category variation for the HL-LH pattern for North Kyungsang listeners. The responses, given on a scale, 1-9, were averaged to represent three participants.

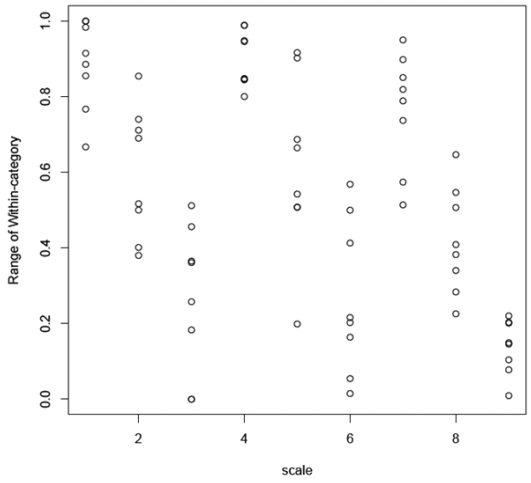

Figure 2. Range of within-category variation for the HH-HL pattern for North Kyungsang listeners

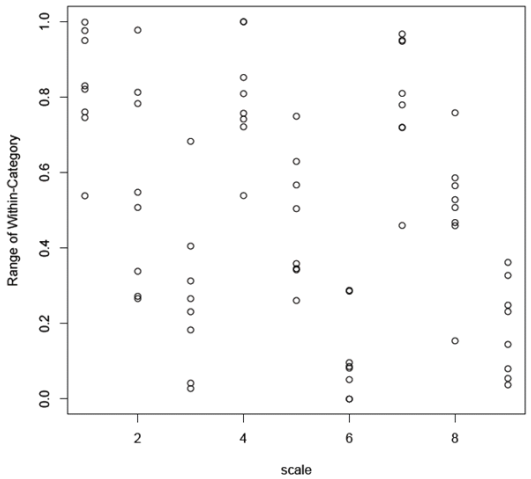

Figure 3. Range of within-category variation for the HH-LH pattern for North Kyungsang listeners

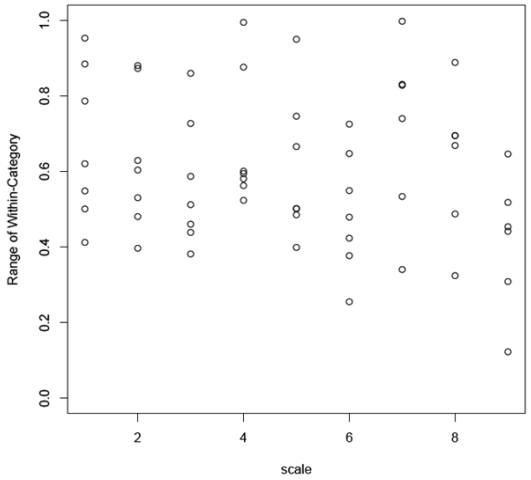

Figure 4. Range of within-category variation for the HL-LH pattern for South Cholla listeners

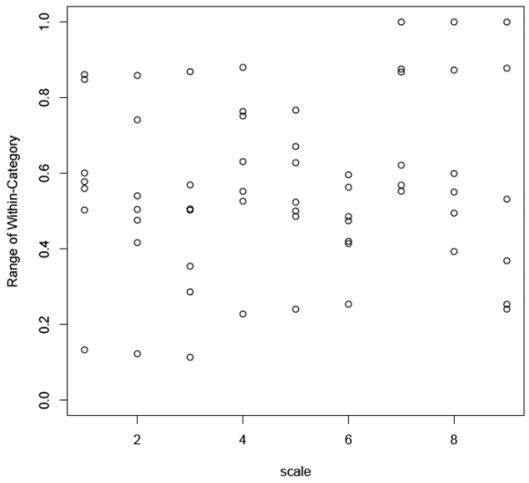

Figure 5. Range of within-category variation for the HH-HL pattern for South Cholla listeners

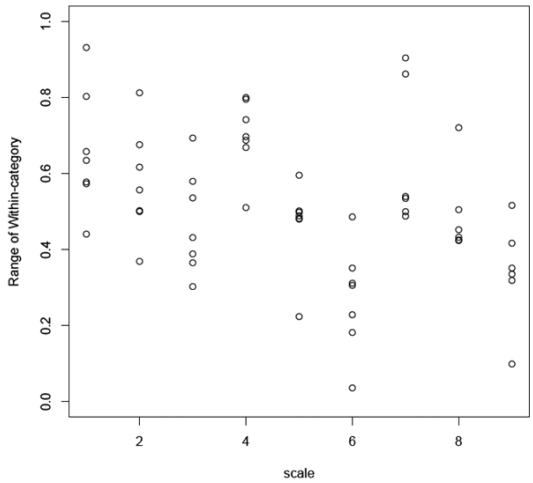

Figure 6. Range of within-category variation for the HH-LH pattern for South Cholla listeners

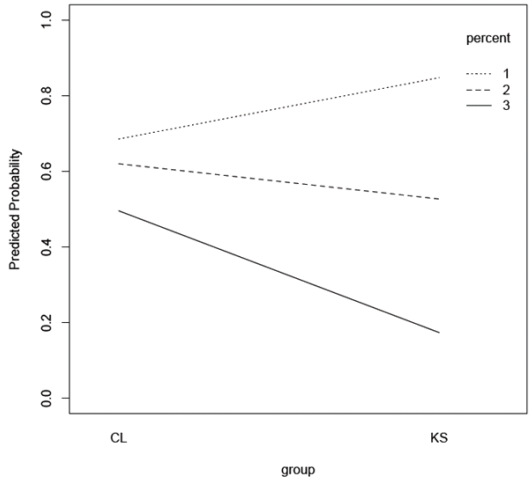

Figure 7. Predicted probability for HL-LH by range of within-category: "1" corresponds to 25%, "2" to 50%, and "3" to 75% of the range of within-category variation

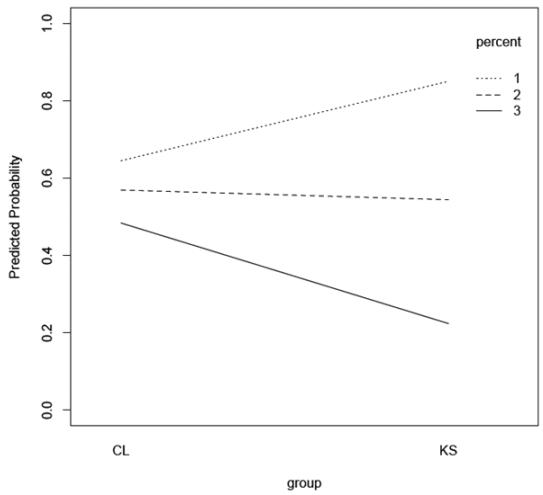

Figure 8. Predicted probability for HH-HL by range of within-category variation

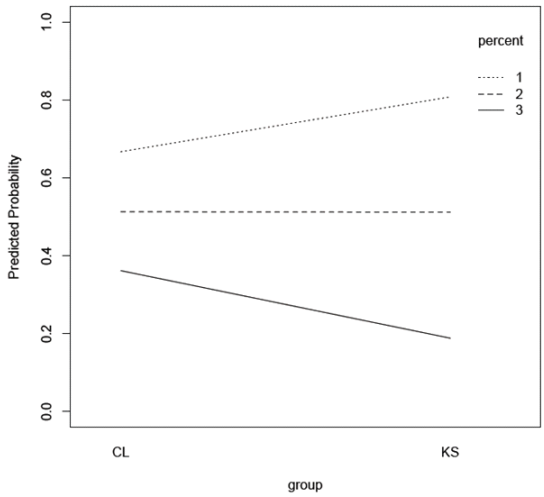

Figure 9. Predicted probability of HH-LH by range of within-category variation

Figures 4, 5, and 6 show the data of South Cholla listeners. The values in the range of within-category variations are mostly above 0.4, but some show an inconsistent distribution. Note that the points below 0.4 are not condensed.

Additionally, Figures 7, 8, and 9 show the interaction between group and range of within-category differences. The intervals of the predicted probability were greater for North Kyungsang listeners than for South Cholla listeners. The difference was greater for the HL-LH pattern than for the HH-LH pattern. The range of within-category variation was above 0.5 at 25%, and below 0.5 at 75%. Especially for the HH-LH pattern, the range of within-category variation, at 75%, was below 0.4. A gradient effect was shown between North Kyungsang and South Cholla listeners in the identification function. The graded internal structure was more obvious when the native listeners were compared to non-native listeners, than when listeners of one dialect were compared to one another.

3.2 The effect of each stimulus between groups

The effect of each stimulus significantly differed between the two dialect groups, and within-category differences were separated into each range of categories within each stimulus (i.e., stimuli 4, 5, and 6). These stimuli were investigated to explain the category boundary. The range was three (percentage) points from the endpoints, that is, 100%, 90%, and 80%. This study examined only 75%, 50%, and 25%, corresponding to the classification of within-category variation. The responses to stimuli 4 and 6 were significantly different (stimulus 4 for HL-LH: $F(1, 42)=10.01$, $p<0.01$, stimulus 6 for HL-LH: ($F(1,42)=49.42$, $p<0.001$, stimulus 4 for HH-HL: $F(1,42)=14.99$, $p<0.001$, stimulus 6 for HH-HL: $F(1,42)=18.67$, $p<0.001$, stimulus 4 for HH-LH: $F(1,42)=9.653$, $p<0.01$, stimulus 6 for HH-LH: $F(1,42)=12.71$, $p<0.001$) between the two dialect groups. On the other hand, the responses to stimulus 5 were not different (stimulus for HL-LH: $p=0.155$, stimulus 5 for HH-HL: $p=0.688$, stimulus 5 for HH-LH: $p=0.982$) between North Kyungsang and South Cholla listeners. Hence, the responses to each stimulus differed between the two groups for points other than 50% in the linear regression line but were not significantly different at the crossover.

3.3 Individual differences in within-category variations

The individual differences were statistically not significant for the types of pitch accent minimal pairs. However, two cases show significant results (stimulus 4 for HL-LH: $F(1,22)=4.492$, $p<0.05$, stimulus 6 for HH-LH: $F(1,22)=7.439$, $p<0.05$). It is unclear why the responses to these stimuli were significantly different for individuals, but the finding is evidence of the variations among individuals as within-category differences.

4. Discussion

This study examined the graded internal structure of lexical pitch accent categories between two groups of dialect speakers. The internal structure within categories showed a difference between native and non-native dialect listeners (i.e., North Kyungsang and South Cholla). The internal structure of the categorical perception of North Kyungsang listeners tended to recognize good exemplars to identify the phonetic categories,

whereas South Cholla listeners, who do not have contrastive pitch accent pairs, did not respond for good exemplars of lexical pitch accent. 25% and 75% were perceived as better exemplars than 50% in the predicted probability. Thus, the better stimulus for the phonetic categories seemed to be more perceived by North Kyungsang listeners. South Cholla listeners did not show this probability.

4.1. Within-category variations

This study revealed a phonetic property of graded internal structure between two dialect groups. The group effect did not show a difference between North Kyungsang and South Cholla listeners. However, there was one exception: For HL-LH, North Kyungsang listeners showed a pattern that differed from that of South Cholla listeners. The pattern HL-LH was more perceived by North Kyungsang listeners compared to South Cholla listeners. This pattern tended to be perceived better by native listeners because the shift of f0 in every stimulus was larger than in the other pitch accent patterns. This group effect for this pitch accent pattern is extended to individuals' perceptual behavior (see Section 4.2). The HL-LH pattern was perceived differently by listeners from the two dialect groups. North Kyungsang listeners seemed to be more sensitive to the shift of frequencies in this pair's manipulation.

The interaction between range of within-category differences and groups was significantly different. In other words, the range of within-category differences differed between two dialect groups. The difference for range of within-category differences was greater for North Kyungsang listeners than for South Cholla listeners. However, there was no difference between three types of pitch accent minimal pairs. The range of within-category variations can be graded in the internal structure of lexical pitch accent categories. Each stimulus point from the endpoints of the stimuli was separated for the analyses of within-category differences. The current study dealt with the points of 75%, 50%, and 25% from the stimuli endpoints. In the analysis, each stimulus differed at every percentage point. Especially, for 50%, there was no difference between the two groups of listeners. However, for 75% and 25%, the results were significantly different, indicating a difference between the two dialect groups. The divergence in the interaction of the effect of group and range of within-category variation was more or less a large difference depending on the values of each stimulus. The large difference was in stimulus 4 for HH-HL and, stimuli 4, 5, and 6 for HL-LH, HH-HL, and HH-LH. The responses to stimuli 4 and 6 for HH-HL showed greater sensitivity to the difference of f0. Additionally, stimulus 6 for the three types of pitch accent minimal pairs was more significant than the other patterns. In other words, 50% at the crossover were not perceived for any dialect listeners, even if that point was the category boundary. The more salient part of categorical perception was the endpoint of the stimuli in the identification function. The endpoints at two phonetic categories were reflected as separate categories in a phonological way. The percentages around 50% at the crossover were the center of within-category variations. Although there was an identification categorization at the center of within-category differences, the center did not show any perceptual difference in the current study. That is, there was no significant difference at the center between the two groups. Miller (1997) studied gradient internal structure using a rating task and assessed within-category goodness. Her approach was similar to the one used here. The current study assigned the gradient condition for the values of predicted probability at 75%, 50%, and 25%, that is, the distance from the endpoints of the phonetic categories. The statistical values revealed the tendency of gradient property in a series of percentages for each stimulus continuum. The gradient condition was significantly different except at the center of the within-category range. The better exemplar for a phonetic category was toward the endpoints representing a contrastive pitch accent pair. The process of recognizing a better category occurred progressively. The current study showed that the gradient effect of the range of within-category variations accepted the degree of exemplar close to a contrastive pitch accent minimal pair. The goodness rating suggested in Miller (1997) was based on participants' responses. The best exemplar had the highest scores when the participants were asked to identify the proper phonetic categories. In the current study, the statistical difference showed a gradient effect, especially for each stimulus effect between North Kyungsang and South Cholla listeners (e.g., stimulus 4 (i.e., 25%) for North Kyungsang vs. South Cholla).

In Figures 1, 2, and 3, which show the data of North Kyungsang listeners, the range of within-category variations is represented as the scale of distance from the endpoints of the stimuli. In this figure, the interval of the plot on the vertical range of within-category variation progressively changed at every percentage, 25%, 50%, and 75%. Figures 4, 5, and 6 show the data of South Cholla listeners, indicating inconsistency in each stimulus representing 25%, 50%, and 75%. For North

Kyungsang listeners, if the responses of 25% or 75% were better exemplars than the responses of 50%, the category goodness would have higher scores, as suggested in Miller (1997). As in Figures 1, 2, and 3 the gap of 25% and 75% for lexical pitch accent categories showed a consistent interval. The pattern at 50% displayed an intermediate status between 25% and 75%. Thus, the better goodness examples had a more regular pattern than the poor examples. Therefore, for South Cholla listeners, the patterns were irregular for every percentage, 25%, 50%, and 75%. There was no response for category goodness patterns, and the responses were not consistent for their category goodness. However, the responses were close to at the crossover, 50%. That is, there was no perceiving effect on lexical pitch accent categories. As seen in Figures 7, 8, and 9, there is an increasing pattern toward North Kyungsang listeners from South Cholla listeners building on predicted probability. The ends for North Kyungsang listeners in Figures 7, 8, and 9 were separated for each stimulus point. This point reflects the percentages representing 75%, 50%, and 25%. The intervals for South Cholla listeners were narrower than those for North Kyungsang listeners. The interval for HL-LH was greater toward North Kyungsang listeners than the intervals for HH-HL and HH-LH. In other words, the category goodness was better for the endpoints of HL-LH than for any other types of pitch accent minimal pairs. For the HH-HL pattern, for South Cholla listeners, the interval between percentages for the endpoints was narrower than for the HL-LH pattern, even if the interval was the similar for the other endpoints. The interval of the endpoints for the HH-LH pattern for South Cholla listeners was larger than for the HL-LH and HH-LH. However, the endpoints for South Cholla listeners were not as divergent as the pitch accent minimal pairs for North Kyungsang listeners. In addition, the category goodness was less strict for HH-LH between North Kyungsang and South Cholla listeners. The results confirm that the goodness of category was more condensed for the HL-LH pattern than for any other pitch accent types, especially for North Kyungsang listeners. HH-HL was the intermediate pattern in category goodness. The current study did not conduct a rating task as in Miller (1997), but through the identification task, stimuli 4, 5, and 6, but not stimuli 1, 2, and 3, for one endpoint and stimuli 7, 8, and 9 for the other endpoints, worked for the condition for category goodness. The process of evaluating the goodness of exemplar was the same as that used by Miller (1997). A more interesting result was that the HL-LH pattern showed the more condensed goodness of category compared to the other pitch accent patterns, HH-HL and HH-LH.

4.2 Individual differences in within-category goodness

The variations within categories were not significantly different among individuals between the two dialect groups. However, it is interesting that the HL-LH pattern showed a better goodness of categories than the other patterns. The HL-LH pattern was the best recognition indicator for lexical pitch accent categories, which should be analyzed more compared to other pitch accent pairs. The initial analysis showed that the HL-LH pattern was the best exemplar for perceiving individual variations. Especially, stimulus 4 for the HL-LH pattern was the best one for perceiving among individuals. As an atypical example, stimulus 6 for the HH-LH pattern was also the better exemplar than any other case in this analysis. A better analysis should be conducted to shed further light on issues related to individual variations of within-category goodness.

5. Conclusion

The current study investigated the variations within categories in a typical category perception, focusing on categories of lexical pitch accent for listeners of two Korean dialects. The important result was that the HL-LH pattern had the best category goodness compared to other pitch accent types. The analysis of individual variations also supported this result in that the other pattern did not show any difference among individuals, except one stimulus for HH-LH. The category goodness in lexical pitch accent pattern was the gradient effect within categories as well as within types of lexical pitch accent categories. The property of categorical perception can be interpreted as within-category and between-category differences for the endpoints of stimuli, reflecting the contrastive phonetic categories. The property of category goodness for North Kyungsang listeners needs to be studied in greater detail with various speech materials and experimental techniques.

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