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The production and perception of High-toned [il] by young speakers of Seoul Korean*

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Cho, Sunghye. 2018. The production and perception of High-toned [il] by young speakers of Seoul Korean. *Linguistic Research* 35(3), 533-565. High-toned [il] refers to a sound change in progress, where young speakers of Seoul Korean produce [il] in a high pitch. Previous studies show that [il] meaning 'one' tends to be produced with a high pitch and [il] meaning 'work' to be produced with a low pitch. Using production and perception experiments, this study investigates if the pitch difference between the meaning categories of [il] is categorical or not and if the production and perception of High-toned [il] vary by speakers' age and gender. We find that the production of [il] 'one' is higher than the other meaning categories, but speakers born in the 1990s show less of a pitch difference between [il] 'one' and [il] 'work' than those born in the 1980s. The results of the perception experiment reveal that listeners show a tendency of selecting [il] 'one' when pitch is high, but they do not show a categorical curve in the identification of [il], indicating that the pitch difference among the meaning categories is not categorical. Also, the general identification by listeners born in the 1990s was less categorical than that made by the 1980s group. Considering the speakers born in the 1990s show less pitch difference between [il] 'one' and [il] 'work', as well as a rather flat identification curve in the identification task, and as there is little gender difference in both production and perception of [il], we suggest the High-toned [il] phenomenon is reaching completion. Lastly, we discuss the potential outcome of High-toned [il], along with the tonogenesis-like sound change in Seoul Korean. **(University of Pennsylvania)**

Keywords High-toned [il], Seoul Korean, sound change, tonogenesis, pitch contrast

1. Introduction

Sound change is implemented by successive generations using an innovative

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variant with increasing frequency (Labov 1994, 2001; Bermúdez-Otero 2007). Age is a key criterion that determines if a variation in the pronunciation of a language is a stable variation or a sound change in progress, as in the latter case, younger generations show a higher frequency of using a new feature than older generations (Labov 1994). In contrast, in a stable variation, the frequency of variants does not vary by speakers' age, but rather they are controlled by other factors such as speech style, speakers' socioeconomic class, and/or race (Van Herk 2012). Also, it is found that gender is a key factor in a sound change for females lead a sound change in most cases, regardless of whether the change is above or below the level of speakers' consciousness (Labov 1990). That is, whether speakers are aware of the emergence of a new variant or not, females tend to show a higher frequency of a new variant than their male counterparts. A sound change reaches completion when only the new variant is used by members of the community (i.e., the speakers using the old variant die out) and a gender difference in using the new variant is no longer present (i.e., both males and females use the new variant).

A sound change can affect various sound components of human languages. For example, common types of sound change include the lenition or deletion of consonants and vowel shifts or mergers. Others are more complicated and less common, and tonogenesis is an example of such a sound change. Tonogenesis is a process whereby previously toneless languages develop a tonal contrast and previously tonal languages multiply their tonal inventory (Hombert 1978; Hyman 1978; Kingston 2011; Matisoff 1973; Thurgood 2002). There are several steps involved in tonogenesis: first, a segmental contrast of consonants, such as voicing, gives a rise to a pitch difference. Next, the pitch contrast is exaggerated to such an extent that the pitch difference is no longer considered an effect of the segmental contrast. Later, the pitch contrast develops into a tonal contrast when the segmental contrast ultimately disappears.

Seoul Korean is known to be undergoing a tonogenesis-like sound change, where the Voice Onset Time (hereafter VOT) distinction between aspirated and lenis stop consonants is merged and the categories are distinguished by the pitch value of a following vowel. Previous studies find that aspirated- or tense-initial syllables are produced with a high pitch, whereas lenis-initial or sonorant/vowel-initial syllables are pronounced with a low pitch (Jun 1993, 1996,

1998, 2007, 2011; Kim et al. 2002; Silva 2006; Wright 2007; Oh 2011; Kang 2014; Cho and Lee 2016; Cho 2017). The change shows typical characteristics of a sound change in that a) younger generations show a greater pitch difference than older generations between the high-pitch inducing context (i.e., syllables starting with an aspirated or tense consonant) and the low-pitch inducing one (i.e., syllables starting with a lenis or sonorant consonant), and b) female speakers are leading the change (Oh 2011; Kang 2014; Cho 2017). Furthermore, Cho (2017) shows that the change has nearly reached completion in that younger generations no longer enhance the pitch difference between the high- and low-pitch-inducing contexts, and gender difference is decreasing among younger generations. Also, it is found that the tonogenesis-like change has a direct influence on the intonational melody of Seoul Korean, shown in Figure 1 (Jun 1998, 2006, 2011; Jun and Cha 2015).

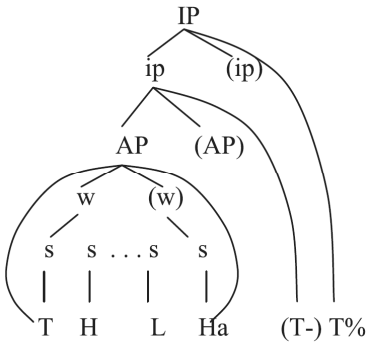

Figure 1. Intonation model of Seoul Korean (Borrowed from Jun and Cha 2015)

According to the K-ToBI model (Jun 2006, 2011; Jun and Cha 2015), the intonation system of Seoul Korean has three prosodic units: Intonation Phrase (IP), Intermediate Phrase (ip), and Accentual Phrase (AP). An IP is marked by an IP-final boundary phrasal tone (%), which varies depending on the sentence type. For example, a declarative sentence is marked by a Low IP boundary tone (L%), whereas an interrogative sentence typically ends with a High IP boundary tone (H%). An ip is a smaller unit than an IP, and represents the domain of pitch reset and prosodic focus. An AP is the smallest prosodic unit in Seoul Korean and is typically realized with a TH-LH intonational tonal pattern (Figure

1), wherein T can be either Low (L) or High (H), depending on the initial consonant of an AP. Previous studies find that aspirated or tense onset consonants induce a considerably high pitch when they are in the first syllable position of an AP and they also affect the pitch values of non-initial syllables (Silva 2006; Kang 2014; Cho and Lee 2016; Cho 2017). Moreover, previous studies on the perception of the stop categories find that the pitch difference between aspirated and lenis stops is categorical in perception, in that speakers of Seoul Korean identify a token with a fixed VOT as 'aspirated' when the pitch of the target syllable is high and as 'lenis' when the pitch is low (Kim 2004).

However, an exception to this rule is reported in previous studies (Jun and Cha 2011, 2015), where [il]-initial words also tend to induce a high pitch in an AP-initial position. This phenomenon is known as High-toned [il], and it is the topic of the present study. There are four meaning categories for [il] in Korean as in (1). Jun and Cha (2011, 2015) examine the production of [il] by speakers of Seoul Korean and find that a) speakers born around 1970 or later more frequently produce [il] with a high pitch, regardless of its meaning, b) [il] is the most frequently produced with a high pitch when it means 'one' and the least frequently when it means 'work', c) High-toned [il] is still lower than aspirated- or tense-initial syllables, d) males generally show less usage of a High-toned [il] than females, yet males in their 20s produce it more frequently than their female counterparts, and e) females use a more tense phonation in producing High-toned [il] than males.

(1) Four meaning categories of [il] in Korean
a. 'One' (一): [il.njʌn] 'one year', [il.tɨŋ] 'first place'
b. 'Day' (日): [il.ki] 'diary', [il.tɕin] 'a day's fortune'
c. 'Work': [il.ha.ta] 'to work', [il.tɕa.ɾi] 'a job'
d. Others: [il.tɕʻik] 'early', [il.kop] 'seven'

Jun and Cha's results indicate that High-toned [il] is an ongoing sound change, wherein younger generations show a higher frequency of using High-toned [il] than older generations and female speakers generally produce more High-toned [il] tokens than males, except the 20s group. The High-toned [il] phenomenon may represent a critical change in Seoul Korean, which has

been considered as a language with no lexical contrast (Jun 1998, 2006), as it is associated with a pitch distinction between the meaning categories. In Jun and Cha (2015), speakers with the High-toned-[il] phenomenon produce [il] 'one' with a high tone about 80% of the time, whereas they produce [il] 'work' with a low tone 80% of the time. Thus, it might be suggested that Seoul Korean is developing a lexical tonal contrast, where [il] 'one' is produced with a high pitch and [il] 'work' is associated with a low pitch. As a pure lexical contrast by pitch is the characteristic of a tonal language, examining whether the difference between these meaning categories is contrastive enough for Seoul Korean to be considered as having a lexical pitch contrast merits consideration.

To further enhance our understanding of the phenomenon, the following questions need to be answered. First of all, do we expect to see the same, categorical difference between the meaning categories of [il] as the pitch contrast between aspirated and lenis consonants? That is, can native speakers of Seoul Korean differentiate [il] 'one' and [il] 'work' only with a pitch cue? Is there a meaningful difference between [il] 'day' and [il] 'work' in speakers' production and/or perception? Furthermore, if [il] 'work' is associated with a low pitch, how is it different from other words starting with an [i] vowel, which are also expected to show a low pitch in the AP-initial syllable? How are the meaning categories perceived by native speakers of Seoul Korean? Also, because it is a sound change in progress, it needs to be investigated if the pitch difference in the production and perception of High-toned [il] varies by speakers' gender and age. For example, Jun and Cha (2015) show that younger speakers produce High-toned [il] more frequently. Do we expect younger generations to show more categorical identifications in the perception of [il]?

Lastly, there are questions related to the process itself. What do we eventually expect when this change reaches completion? That is, do we expect to see a homonym split (Labov 1981), resulting in a lexical tonal contrast between [il] 'one' and [il] 'work' (or between [il] 'one' and the other meaning categories of [il])? Or, do we expect to see a generalization where speakers of Seoul Korean produce all [il]-initial words with a high pitch, as suggested in Jun and Cha (2015)?

In this paper, we conduct both production and perception experiments with native speakers of Seoul Korean to answer the aforementioned questions. We

aim to examine the possibility of a categorical difference between the meaning categories of [il], as well as the difference between [il] and other [i]-initial words and to investigate gender and generational differences in the production and perception of High-toned [il]. Also, along with Jun and Cha (2015), who examine speakers whose age range from 1952 to 1990, we added the comparisons among young generations whose age range from 1981 to 1998, hoping to provide a further detailed picture of the phenomenon.

2. Production

2.1 Participants and materials

Forty native speakers of Seoul Korean (female: 19, male: 21), whose year of birth (YOB) ranged from 1981 to 1998 (M = 1990.8), participated in the production experiment. Speakers born in the 1980s were students studying in the States, but 18 out of the 19 participants reported that their length of residence in the States was less than a year at the time of recording. The other participant was staying in the States for two years at the time of recording, but reported using Korean daily to communicate with his family. The participants born in the 1990s were students living in Korea who reported that they had lived in Seoul (or in the immediate vicinity) since their birth. All participants signed a consent form, and received 10 dollars or 10,000 won as compensation for their participation. None reported any speech or hearing disorder. The following table shows the breakdown of the speakers who participated in this experiment.

Table 1. Age and gender of the participants

	Female	Male	Total
1980s	9	10	19
1990s	10	11	21
Total	19	21	40

Target words were placed in the second AP position in three-AP sentences as in (2), following the methodology used in the previous studies (Jun and Cha 2011, 2015). In (2), the target AP [**il**.tɕoŋ.i.ɾo] ‘with Type 1’, which starts with [il]

meaning 'one', is placed between the first and the third APs.[1] The same template with three APs was used for the other sentences used in the production experiment.

(2) [mjʌn.hʌ-ɾil **il**.tɕoŋ-i.ɾo kæŋ.sin-hæt-ta]
driver's lincense-OBJ Type 1-INSTR renew-PAST-DEC
'(I) renewed my driver license with Type 1.'

There were 59 sentences with target words and 25 filler sentences. All 59 target sentences included one [i]-initial target word (i.e., [il, im, in, iŋ, ip, it, ik, i]) for each, and 31 out of the 59 target words started with [il]. The other 28 target words started with [i] followed by seven different coda consonants ([im, in, iŋ, ip, it, ik] or just [i]) to compare the pitch differences between [il]-starting and [i]-starting words. Hereafter, we refer to an [i] syllable followed by an optional coda consonant other than [l] as /i(C)/, where 'C' stands for any consonant. The number of target words is provided in Table 2.

Table 2. The number of target words by category.

	Category	**Number**		**Category**	**Number**
il	One	8	i(C)	[im]	4
	Day	8		[in]	4
	Work	8		[iŋ]	4
	other meaning	7		[ip]	4
				[it]	4
				[ik]	4
				[i]	4
Total		31			28

The participants were asked to read each sentence twice, so the total number of target syllables intended for collection was 4720 (= 40 participants x 59 target words x 2 times). However, there were cases where a participant made a speech error within the target words or *Praat* (Boersma and Weenink, 2017) fails to track pitch values due to creaky phonation or inordinately short duration. Because

[1] Periods and hyphens in (2) mark syllable and morpheme boundaries, respectively and small capital letters mark grammatical morphemes, where OBJ stands for objective, INSTR for instrumental, PAST for past tense and DEC for declarative ending.

those syllables were excluded from the analyses, the actual number of syllables analyzed in this study was 4571.

2.2 Procedure and measurement

Recordings were conducted in a soundproof recording booth in the phonetics laboratory at the University of Pennsylvania (for the speakers who lived in the States) or in a quiet classroom (for the speakers who lived in Korea), using the same laptop and the same headset microphone (Sennheiser PC151). Recordings were directly saved as 16-bit wave files at the sampling rate of 22,000Hz using *Praat*. The target sentences were shown to the participants in a randomized order. Before reading the target sentences, they had a practice session, where they read three dummy sentences to familiarize themselves with the speech materials. The entire recording procedure took up to 15 minutes per participant.

The boundaries of syllables in the target sentences were annotated with a Korean forced aligner (Yoon and Kang 2012) and were manually checked and corrected later. We also identified AP boundaries for all target sentences, as in Figure 2, to ensure that the target words were read in the second AP position as intended. The median f0 value of the whole duration of each target syllable was measured using a *Praat* script with f0 range set at 75–300Hz for male speakers and 100–500Hz for female speakers (Kang 2014; Cho 2017).

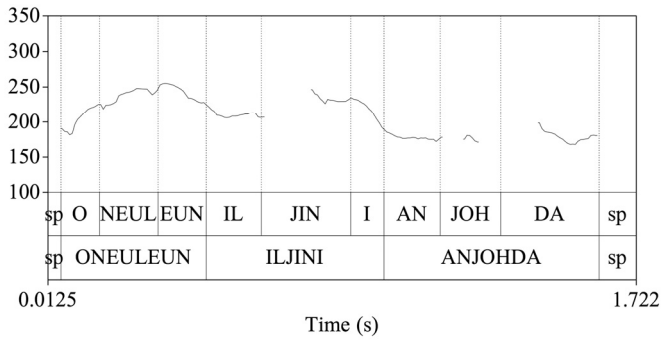

Figure 2. An example of a pitch track produced by a female speaker (S09). The target sentence shown in this figure is [o.nɨl.**ɨl**.tɕin.i an.tɕot.ta] '(I) had a bad luck today', where [il] means 'day'. The first tier shows syllable boundaries and the second tier shows AP boundaries. The y-axis shows pitch values in Hz.

To compare speakers in different ages and genders, it was necessary to normalize the obtained pitch values. Liberman and Pierrehumbert (1984) show that a natural scale for intonation seems to decrease proportionally to a speaker's baseline, which is defined as the bottom of a speaker's pitch range. That is, a scaled intonational value should be evaluated as "baseline units above the baseline", indicating that intonational values change proportionally to a speaker's baseline. Cho (2017) uses each speaker's baseline, which was defined as the 10^{th} percentile of each speaker's pitch range in her study, to normalize pitch values. We adopted this method to normalize inter-speaker differences. We first computed the 10^{th} percentile pitch value within each speaker's pitch range, and used the obtained baseline values to convert f0 values in Hz to Semitone (St) for each speaker, using the following formula: $\log_2(f0/baseline)*12$.

2.3 Results

This section demonstrates the results of the production experiment. First, we compare the meaning categories of [il] to see how the categories are produced and how [il]-initial words are different from other /i(C)/-initial words. Next, we examine a generational difference between the speakers born in the 1980s and those born in the 1990s. Lastly, we investigate a gender difference in the production of [il].

2.3.1 Different meanings of [il]

Figure 3 shows the distribution and the median pitch values of the meaning categories of [il] and /i(C)/, and Table 3 summarizes the output of a linear mixed-effects model, where the pitch values (St) are included as a dependent variable, the meaning categories as a fixed effect, and participants as a random effect. Similar to the results in Jun and Cha (2011, 2015), we find that [il] 'one' has the highest median pitch value (3.71 St), followed by [il] with other meanings (2.1 St = 3.71 − 1.61) and [il] 'day' (1.64 St = 3.71 − 2.07). Compared to [il] 'one', [il] 'day' and [il] with other meanings show a greater pitch distribution, meaning that these categories are produced with a large inter-speaker variation. Also, it is noticeable that [il] 'work' shows the lowest

pitch values among the [il] categories (1.26 St = 3.71 − 2.45) and a narrower pitch variation, indicating that this category is generally produced with a low pitch. The /i(C)/ category, estimated to be lower than all [il] categories (0.5 St = 3.71 − 3.21), shows the least variation in Figure 3. Most importantly, the model finds that [il] 'one' is significantly different from the other categories ($p < 0.001$ for all comparisons).

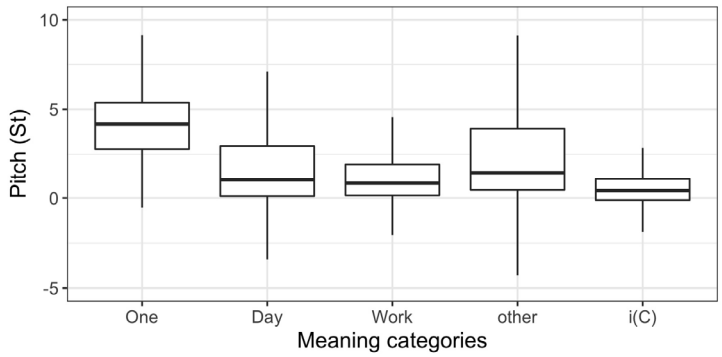

Figure 3. Distributions and median pitch values of [il] and i(C) by meaning categories. The 'other' category indicates [il]-starting words with other meanings than 'one', 'day', or 'work', and i(C) refers to [i]-initial words followed by other coda consonants.

Table 3. Output of a linear mixed-effects model for the effect of the meaning categories. The reference category is [il] 'one'. 'Estimate' refers to estimated coefficients and SE to standard errors.

	Estimate	SE	*t*-value	Pr (> |*t*|)	
(Intercept)	3.71	0.12	31.86	< .001	***
Day	-2.07	0.11	-18.84	< .001	***
Work	-2.45	0.11	-21.47	< .001	***
other	-1.61	0.11	-14.16	< .001	***
i(C)	-3.21	0.09	-36.09	< .001	***

2.3.2 Age and high-toned [il]

This section investigates the effect of participants' age on the High-toned [il] phenomenon. The participants in this experiment were born either in the 1980s or in the 1990s. Figure 4 displays the median pitch values of all participants by

their YOB, and Table 4 summarizes the output of a linear mixed-effects model, where Pitch is a dependent variable and Meaning and YOB (1980s vs. 1990s) are fixed-effect predictors. Participants are added as a random effect.

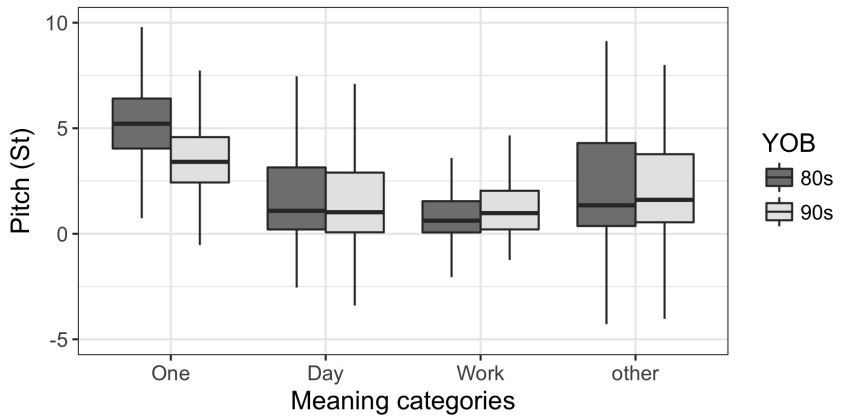

Figure 4. Distribution and median pitch values of the [il] categories by YOB. The 'other' category indicates [il]-starting words with other meanings than 'one', 'day', or 'work'. Speakers born in the 1980s are in dark grey boxes, and those born in the 1990s in light grey ones.

Table 4. Output of a linear mixed-effects model for the effect of age and meaning. The reference meaning category is [il] 'one', and the reference YOB category is 1980s. 'Estimate' refers to estimated coefficients and SE to standard errors.

	Estimate	SE	*t*-value	Pr (> |*t*|)	
(Intercept)	4.92	0.29	16.90	< .001	***
Day	-3.04	0.19	-15.88	< .001	***
Work	-3.81	0.20	-19.23	< .001	***
other	-2.58	0.20	-13.05	< .001	***
YOB (1990s)	-2.03	0.38	-5.40	< .001	***
YOB*Day	1.61	0.25	6.50	< .001	***
YOB*Work	2.27	0.26	8.87	< .001	***
YOB*other	1.62	0.26	6.32	< .001	***

As shown in Figure 4, the model indicates that the estimated pitch value of [il] 'one' produced by speakers born in the 1980s is 2.03 St higher than that of 1990s ($p < 0.001$). Furthermore, it demonstrates that speakers born in the 1980s show a great pitch difference among the meaning categories, when compared to

those born in the 1990s ($p < 0.001$ for all comparisons). In particular, the pitch difference between 'one' and 'work' produced by speakers born in the 1980s (3.81 St) is about twice as great as that produced by those born in the 1990s (1.54 St = 3.81 − 2.27), thereby indicating that the pitch difference between [il] 'one' and [il] 'work' is less likely to be categorical for the 1990s group. Additionally, as the results indicate that speakers born in the 1990s produce a lower 'one' and smaller pitch differences between 'one' and the other categories, compared to those born in the 1980s, it would be expected that the identification rate of the 1990s group would be worse than the 1980s group in a perception experiment.

2.3.3 Gender and High-toned [il]

As previously noted, gender is a key factor in sound changes as females are usually the leaders of sound changes (Labov 1990). In this section, we compare gender differences in the production of [il] in Seoul Korean. Figure 5 shows the median pitch values (left: St, right: Hz) grouped by speaker's gender and the meaning categories of [il], and Table 5 provides the output of a linear mixed-effects model in which normalized pitch values in semitone are included as a dependent variable, Meaning and Gender as fixed-effect predictors, and Participant as a random effect. Although males show a slightly higher median pitch than their female counterparts in [il] 'day', 'work', as well as with other meanings in the left panel of Figure 5, the model estimates that all the other interactions of Gender and Meaning are insignificant, but [il] 'work' ($p = 0.005$). Rather, the model estimates that males produce [il] 'work' with a 0.71 St higher pitch than females, which is contrary to the findings of the literature of sound changes that females usually lead a sound change.

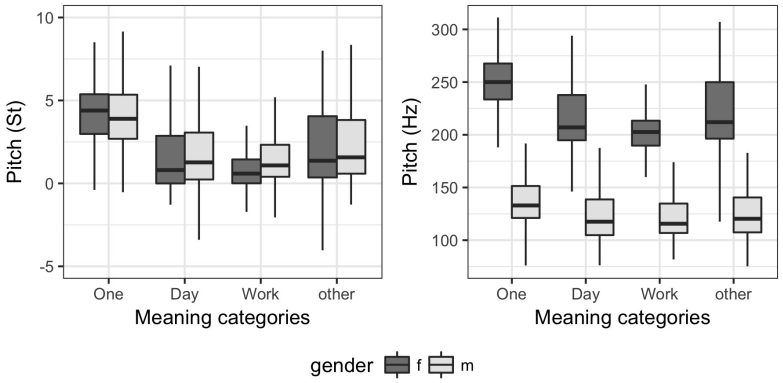

Figure 5. Distribution and median pitch values of the [il] categories by gender. The left shows normalized pitch values in semitone, and the right shows raw pitch values in hertz for reference. Females are in dark grey boxes, and males in light grey ones.

Table 5. Output of a linear mixed-effects model for the effect of Gender and Meaning. The reference meaning category is [il] 'one', and the reference gender category is females. 'Estimate' refers to estimated coefficients and SE to standard errors.

	Estimate	SE	*t*-value	Pr (> |*t*|)	
(Intercept)	3.68	0.27	13.57	< .001	***
Day	-2.13	0.17	-12.21	< .001	***
Work	-2.80	0.18	-15.53	< .001	***
other	-1.67	0.18	-9.28	< .001	***
Gender (males)	0.95	0.38	0.14	.888	
Gender*Day	0.11	0.25	0.43	.666	
Gender*Work	0.71	0.25	2.77	.005	**
Gender*other	0.12	0.25	0.47	.639	

3. Perception

Because the results of the production experiment show that the participants differentiated the meanings of [il] with different pitch values, we hypothesize that the perception of [il] would be also dependent on pitch. In particular, we expect that the participants would perceive [il] with a high pitch as 'one' and [il] with a low pitch as 'work' more frequently. Also, since YOB was a significant factor in the participants' production of [il], we expect the perception of [il] would vary depending on the participants' YOB. We tested these hypotheses

with a perception experiment, in which 37 participants (18 females and 19 males) out of the 40 represented in Table 1 participated.

3.1 Methods

3.1.1 Stimuli

The perception experiment consisted of three identification tasks in which the participants were asked to listen to [il]- or [i]-initial words at five different pitch levels and choose the meaning of the word. All stimuli were recorded in a soundproof booth at 44.1kHz of a sampling rate, by a third-generation female speaker of Seoul Korean (age 28 at the time of recording), whose minimum and maximum pitch values were around 180 Hz and 330 Hz. In all identification tasks, the target syllable (i.e., the first) of the recorded words was synthesized into five equidistant pitch levels with a step size of 30 Hz , within the range established as the lowest 180 Hz, the second lowest 210 Hz, the median 240 Hz, the second highest 270 Hz, and the highest 300 Hz, using the TD-PSOLA (Time Domain Pitch Synchronous Overlap-Add) function in *Praat*.

3.1.2 Experiment design

In the first identification task, the participants only listened to a monosyllabic [il] in five different pitch levels, and selected the meaning of [il] among 'one', 'day', and 'work'. Also, a monosyllabic [to] in the same five pitch levels was employed as fillers to obscure the purpose of the experiment and as controls to compare [il] to syllables starting with stop consonants, which were expected to show a categorical perception depending on pitch (Kim 2004). We also provided three choices for [to]: aspirated-initial [tʰo], tense-initial [t'o], and lenis-initial [to]. The number of stimuli of the first identification task was 20 (= 5 pitch levels x 4 times) for [il] and 10 (= 5 pitch levels x 2 times) for [to].

The second identification task employed six homonyms starting with [il] to examine if pitch affects the identification of the meaning of the words. The listeners listened to two words in the five different pitch levels for each meaning comparison ('one' vs. 'day', 'day' vs. 'work', 'one' vs. 'work') as in Table 6. This

design enabled us to examine the effect of pitch in the meaning identification of homonyms. The number of stimuli participants listened to was 60 (= 6 words x 5 pitch levels x 2 times), and 30 filler words were also included.

Table 6. Target homonyms employed for the second identification task. Periods indicate syllable boundaries.

	Target words	Meaning in English
'one' vs. 'day'	[il.kwa]	'Chapter 1' or 'daily schedule'
	[il.ki]	'first group' or 'diary'
'one' vs. 'work'	[il.tok]	'a single reading' or 'overeagerness to work'
	[il.ca.ris.su]	'ones place' or 'number of jobs'
'day' vs. 'work'[2]	[il.ham]	'Japanese warship' or 'working'
	[il.cuŋ.tok]	'Japan, China, Germany' or 'workaholism'

The third identification task investigated if participants could differentiate [il]-initial and /i(C)/-initial words, using pitch. The stimuli used in this task were listed in Table 7. As the coda consonants of the target syllables were different, the segmental information might provide more information about the target words than pitch, thereby preventing the participants from relying on the pitch cue. To avoid such a case, we recorded all target words without a coda consonant in the first syllable (i.e., we only recorded [i]), cut the second half of the [i] vowel in the first syllable, and inserted a 200 ms of white noise in place of a coda consonant. The purpose of cutting the second half of the [i] vowel was to facilitate the participants' compensation of a coda consonant from the white noise. For example, [i.saŋ] was recorded for the intended near-minimal pair of [il.saŋ] 'daily life' and [in.saŋ] 'impression', and the [i] vowel of [i.saŋ] was cut in half, and a white noise was inserted between [i] and [saŋ]. The number of the target words was 60 (= 6 words x 5 pitch levels x 2 times) and 30 filler words were also included.

[2] The Chinese character for [il] 'day' or 'sun' (日) is used in [**il**.pon] 'Japan' in Korean. In the pairs of 'day' vs. 'work', we inclulded Japan-related words for [il] 'day'.

Table 7. Target words employed in the third identification task.

	Target words	Intended words and their meaning in English
[il] 'one' vs. iC	[i.coŋ]	[il.coŋ] 'Type 1' or [in.coŋ] 'race'
	[i.si]	[il.si] 'date and time' or [im.si] 'temporal'
[il] 'day' vs. iC	[i.saŋ]	[il.saŋ] 'daily life'or [in.saŋ] 'impression'
	[i.cʌŋ]	[il.cʌŋ] 'daily schedule' or [in.cʌŋ] 'admitting'
[il] 'work' vs. iC	[i.kam]	[il.kam] 'something to work' or [in.kam] 'seal'
	[i.pok]	[il.pok] 'destined to work' or [in.pok] 'good fortune to have kind people'

3.1.3 Procedure

The entire perception experiment was built in PsyScope X (Cohen et al. 1993), a free program for psychological experiments. We built three blocks for the three respective identification tasks (one block for each). The perception experiment was conducted after the production experiment, and the participants listened to the stimuli with the same headset used in the production experiment. Because the tasks involved in identifying the meaning of homonyms or near homonyms, we provided examples in the form of sentences in Korean for intended meanings as in (3).

(3) [il] 'one' vs. [il] 'day' in the second identification task[3]

[il.gi] 'first group': 동아리에 **1기**생이 열명이다.
toŋ.a.ɾi-ɛ **il.gi**.sɛŋ-i jʌl.mjʌŋ-i.ta
student club-LOC first group-student-NOM 10-CLA-DEC
'There are ten students in the first cohort of our student club.'

[il.gi] 'diary': 미영이는 **일기**를 쓴다
mi.jʌŋ.i-in **il.gi**-lil s'i-n-ta
Miyeong-TOP diary-OBJ write-PRES-DEC
'Miyeong keeps a diary.'

The stimuli were played in a randomized order in each block. The total

[3] Pronunciation in IPA, their gloss, and translation of the sentences were not present in the experiment, but given for readers. Small capital letters mark grammatical morphemes, where LOC stands for locative, NOM for nominative, CLA for classifier, DEC for declarative ending, TOP for topic, OBJ for objective, and PRES for present tense.

number of stimuli in the experiment was 210 (including fillers): 30 words in the first identification, 90 for the second identification, and 90 for the third identification. The participants read instructions before proceeding to each identification task, and they had two seconds to read example sentences before the target words were played. They were able to move to the next stimuli after selecting an answer.

3.2 Results

3.2.1 Identification task I

Figure 6 shows the identification rate of a monosyllabic [il] by meaning. Even though the identification rates of the three categories were about at the chance level (33.3%) when pitch was the lowest (x = 1 in Figure 6), the result clearly shows that the listeners tend to identify [il] as 'one', as pitch increases. For example, the participants answered that [il] means 'one' about 60% of the time, when the target syllable was produced with the highest pitch (300 Hz; x = 5 in Figure 6). Conversely, the identification rates of 'work' and 'day' decrease as pitch increases. In particular, the listeners identified [il] as 'work' less than 20% of the time, when pitch was the highest.

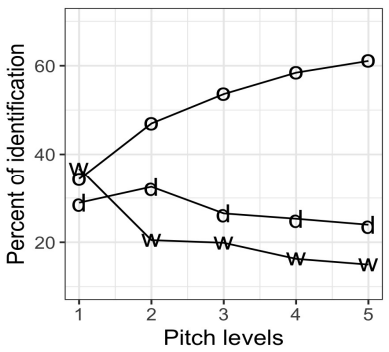

Figure 6. Identification rates of monosyllabic [il]. The x-axis shows the five pitch levels, where '1' is the lowest and '5' is the highest, and the y-axis shows the rate of each response. All three meanings of [il] are shown here, where 'o' stands for 'one', 'd' for 'day', and 'w' for 'work'.

Since both 'day' and 'work' seem to pattern together, we combined the two categories as 'not-one' in Figure 7, where we compare the result of the identification of [il] to that of [to]. We find that the identification curve of [il] is rather linear, compared to that of [to], which shows a typical categorical perception. This indicates that the perception of 'one' and 'not-one' is more a difference in tendency than a categorical difference.

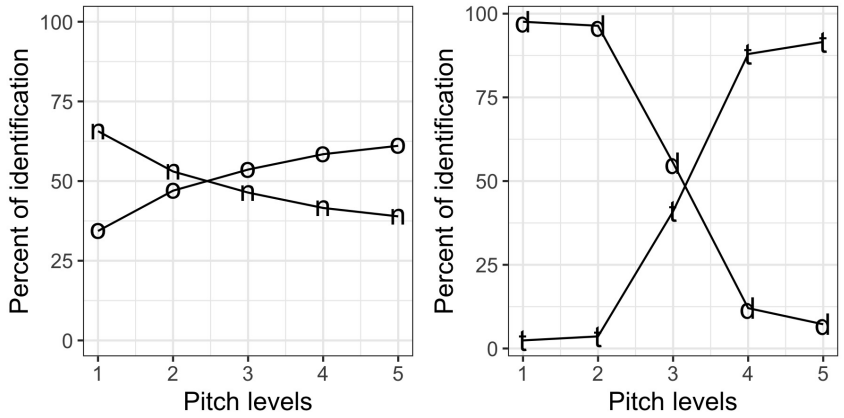

Figure 7. Identification rates of monosyllabic [il] and [to]. Again, the x-axis shows the five pitch levels, and the y-axis shows the rate of each response. The left panel shows the identification rates of [il], where 'o' means 'one' and 'n' means 'not-one' (i.e., 'day' + 'work'). The right panel shows the identification rates of [to], where 'd' means [to] with a lenis onset and 't' means [tʰo] with an aspirated onset. We omit the identification rate of [t'o] with a tense onset, as there were few responses for that category (n = 4).

As for statistical analyses, we build two mixed-effects logistic regression models for [il] and [to], using the *glmer* function in the *lme4* package (Bates et al. 2018) in R (R development core team 2018). In the model for [il], the binary response variable is the meaning of [il], where 'one' is coded as 1 and the other meanings as 0, and in the model for [to], the binary variable is the stop category (lenis '0' vs. aspirated '1'). In both models, pitch levels are included as an independent variable and the participants are treated as a random effect. The results of the mixed-effects logistic regression models show that Pitch is a significant factor ($p < 0.001$ for both [il] and [to]). However, the estimated coefficient of [to] ($\beta = 3.54$) is much higher than that of [il] ($\beta = 0.28$), indicating

that pitch is a factor more crucial in predicting the identification rate of [to] than that of [il].

As the results of the production experiments show that there is a difference in the production of [il] by the participants' YOB, we also examine the effect of YOB in the perception of [il] and [to] in Figure 8. YOB groups (1980s vs. 1990s) do not differ greatly in the perception of [to], showing an abrupt increase of the [tʰo] response from Pitch level 2 to 4. However, the participants show a generational difference in the perception of [il] in that the identification rate of [il] 'one' by the 1990s group is around 50% at all pitch levels, unlike the 1980s group, which shows a moderate increase of [il] 'one' from Pitch level 1 to 5.

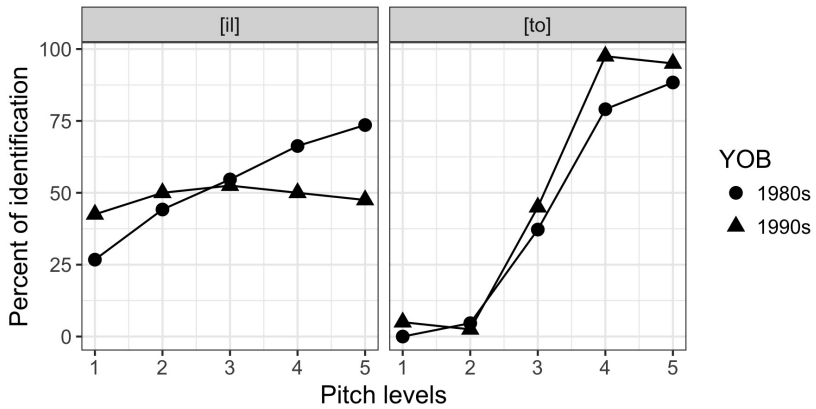

Figure 8. Identification rates of [il] 'one' and [tʰo] by YOB. The left panel shows the identification rate of [il] as 'one', and the right panel illustrates that of [to] as an aspirated-initial syllable. The YOB groups are represented with different shapes.

To test the statistical significance of this difference, we build two mixed-effects logistic regression models for [il] and [to]. We include the identification rates of [il] and [to] as binary response variables ('one' = 1 vs. 'not-one' = 0 in the model for [il]; aspirated = 1 vs. non-aspirated = 0 in the model for [to]). In both models, Pitch and YOB were added as fixed-effect predictors and Participant as a random effect. The model for [il] reveals that the 1990s group is significantly different from the 1980s group (p = 0.001), and Pitch itself is not a significant factor in the 1990s group's identification of [il] (p = 0.561). However, the interaction of Pitch and YOB is estimated to be significant

(p < 0.001), indicating that the two groups' difference in the identification rate is modulated by the pitch levels. The model for [to], on the other hand, reports the opposite result. It is estimated that neither YOB nor its interaction with Pitch is significant in the perception of [to] (p = 0.665 for YOB, p = 0.986 for YOB x Pitch), indicating that the identification rate of [to] is dependent on Pitch only, regardless of the participants' YOB. The output of the logistic regression models is shown in Table 8.

Table 8. Output of mixed-effects logistic regression models for [il] (top) and [to] (bottom). The reference category for Pitch is 1 (the lowest), and the reference YOB group is 1990s.

[il]	Estimate	SE	z-value	Pr (> |z|)	
(Intercept)	-0.18	0.26	-0.71	= .479	
Pitch	0.04	0.07	0.58	= .561	
YOB (1980s)	-1.23	0.38	-3.19	= .001	**
YOB*Pitch	0.48	0.11	4.52	< .001	***
[to]	Estimate	SE	z-value	Pr (> |z|)	
(Intercept)	-10.77	1.82	-5.92	< .001	***
Pitch	3.53	0.56	6.36	< .001	***
YOB (1980s)	-1.04	2.39	0.43	= .665	
YOB*Pitch	0.12	0.68	0.02	= .986	

Additionally, we also built two separate mixed-effects logistic regression models that include both gender and the pitch levels as fixed effect predictors to determine if gender plays a role in the identification of [il]. The same binary response variables and random effects are used. In both models, pitch is still significant (again, p < 0.001 for both [il] and [to]), but gender is not (p = 0.814 for [il] and p = 0.919 for [to]), nor is the interaction of gender and pitch (p = 0.369 for [il] and p = 0.903 for [to]), indicating that the identification of [il] or [to] is not dependent on listeners' gender.

3.2.2 Identification task II

3.2.2.1 'One' vs. 'Day/Work'

Figure 9 displays the results of the second identification task for the comparison of 'one' vs. 'day' (left) and 'one' vs. 'work' (right). In both panels,

the identification rate of 'one' becomes higher as pitch increases, which indicates that 'one' is perceptually associated with a high pitch. However, it is noteworthy that participants tend to identify 'work' more frequently than 'day' even in higher pitch levels. For example, the listeners answered that an [il]-initial word has a 'work'-related meaning more than 25% of the time, when the target word is produced at the highest pitch (the right panel in Figure 9), compared to [il] 'day' being identified about 15% of the time (the left panel). We find that the participants' YOB plays a role in this perceptual difference of [il].

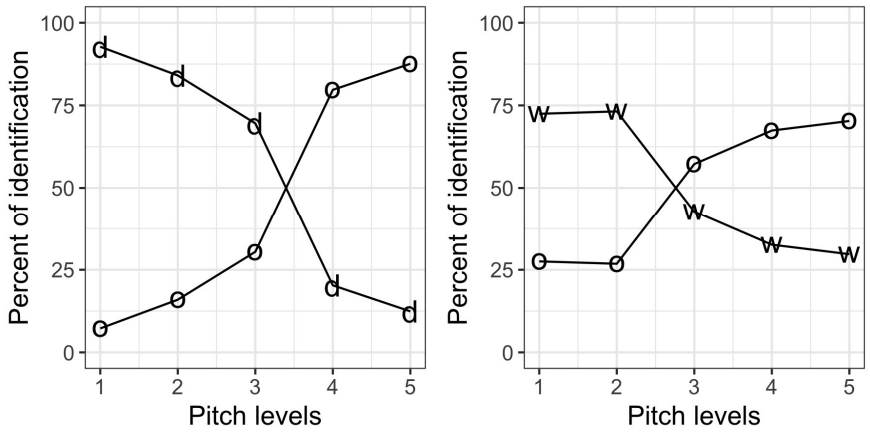

Figure 9. Identification rates of 'one' vs. 'day' and 'one' vs. 'work' in the second identification task. The left panel shows the identification rates of 'one' vs. 'day', and the right shows the identification rates of 'one' and 'work'. Again, 'o' stands for 'one', 'd' for 'day', and 'w' for 'work'.

As shown in Figure 10, the participants born in the 1990s exhibit a large degree of perceptual confusion between 'one' and 'work', answering [il] in the target words means 'one' only about 50% of the time (which is the chance level), when pitch is high (bottom right in Figure 10). On the other hand, the 1980s group shows semi-categorical curves in both comparisons, and their identification curves are steeper than those of the 1990s group in both comparisons.

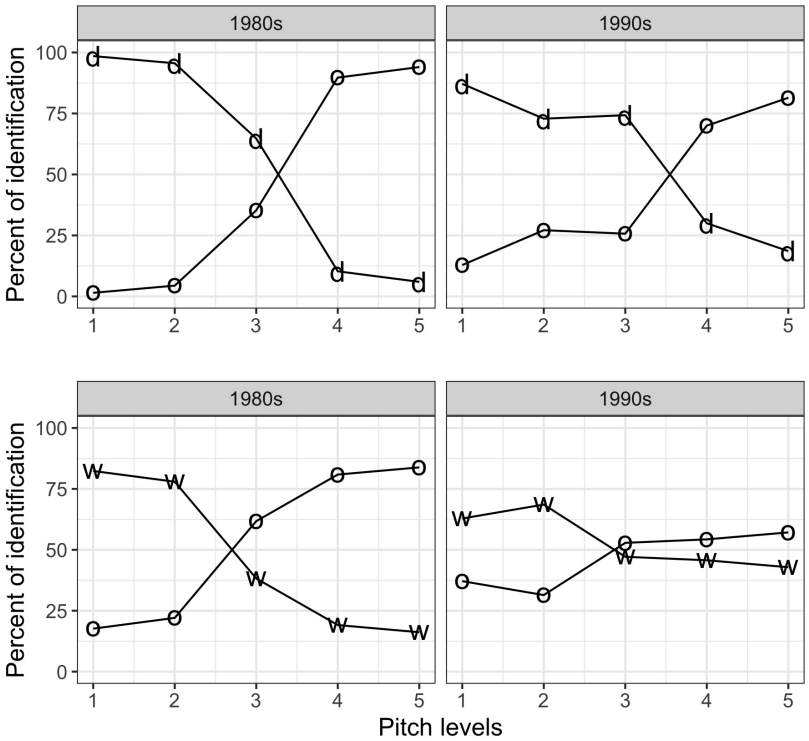

Figure 10. Identification rates of 'one' vs. 'day' and 'one' vs. 'work' by participants' YOB. The left panels show the listeners born in the 1980s and the right panels present the listeners born in the 1990s. The top row displays the comparison between 'one' and 'day' and the bottom row illustrates the comparison between 'one' and 'work'.

We built two mixed-effects logistic regression models (one for each comparison), where the meaning of [il] ('one' vs. 'work/day') is a binary response variable ('one': 1, otherwise: '0'), the pitch levels and the participants' YOB group (80s vs. 90s) are fixed-effect predictors, and participants are a random effect. The outputs of the logistic models are summarized in Table 9. The models clearly show that both the effect of YOB and their interaction with Pitch are significant ($p < .001$ for both comparisons), indicating that the two YOB groups behave differently in the identification of [il]. However, Pitch is still a significant factor in the perception of [il] 'one' for the 1990s group ($p < 0.001$ for both models), thus suggesting that the participants born in the 1990s still rely on

the pitch cue, but to a lesser extent than the 1980s group. The observed difference in the identification of 'one' and 'work' seems to be related to the fact that the 1990s group produces a smaller pitch difference between 'one' and 'work' than the 1980s in the production experiment (Section 2.3.2).

Table 9. Outputs of mixed-effects logistic regression models for the comparisons of 'one' vs. 'day' and 'one' vs. 'work'. The reference category for pitch is '1' (the lowest), and the reference category for YOB is 1990s. 'Estimate' refers to estimated coefficients and SE to standard errors.

'one' vs. 'day'	Estimate	SE	*z*-value	Pr (> |*z*|)	
(Intercept)	-3.02	0.35	-8.63	< .001	***
Pitch	0.89	0.10	8.70	< .001	***
YOB (1980s)	-3.94	0.82	-4.80	< .001	***
YOB*Pitch	1.25	0.25	5.12	< .001	***
'one' vs. 'work'	Estimate	SE	*z*-value	Pr (> |*z*|)	
(Intercept)	-0.92	0.26	-3.47	< .001	***
Pitch	0.26	0.08	3.31	< .001	***
YOB (1980s)	-1.76	0.43	-4.11	< .001	***
YOB*Pitch	0.70	0.13	5.25	< .001	***

3.2.2.2 'Day' vs. 'Work'

Figure 11 shows the comparison of 'day' and 'work' by listeners' YOB and indicates [il] tends to be identified as 'day' rather than 'work' by both YOB groups when the pitch value of the target syllable is high. However, the tendency is weaker in the participants born in the 1990s than those born in the 1980s, showing only a chance level of an identification rate when pitch is the highest. A mixed-effects logistic regression model, wherein the participants' response is a binary variable ('day': 1, 'work':0), YOB and Pitch are fixed-effect predictors, and Participant is a random effect, confirms that the generational difference and its interaction with Pitch are both significant (β = -1.22, p = 0.005 for YOB; β = 0.41, p = 0.001 for YOB x Pitch), indicating that the participants' responses vary by their YOB and the interaction of Pitch and YOB. The output of the model is summarized in Table 10.

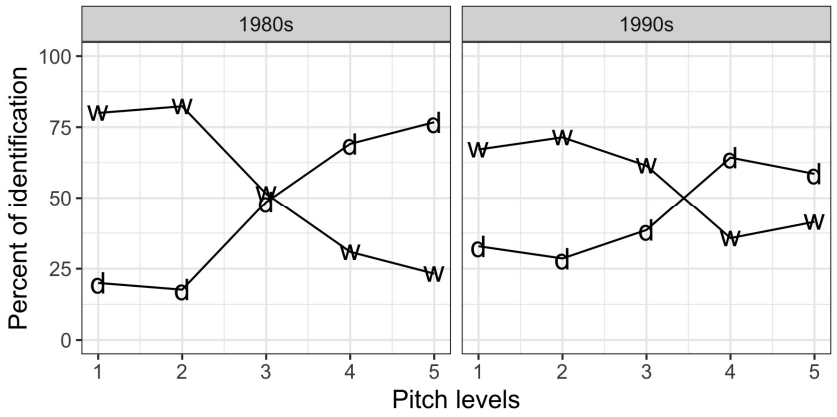

Figure 11. Identification rate of 'day' and 'work' by participants' YOB (left: 1980s, right: 1990s). 'd' stands for 'day' and 'w' stands for 'work'.

Table 10. Outputs of a mixed-effects logistic regression model for the comparison of 'day' (1) and 'work' (0). The reference category for pitch is the lowest level (1), and the reference YOB group is 1990s.

	Estimate	SE	*z*-value	Pr (> |*z*|)	
(Intercept)	-1.33	0.27	-4.88	< .001	***
Pitch	0.37	0.08	4.55	< .001	***
YOB (1980s)	-1.22	0.44	-2.78	= .005	**
YOB*Pitch	0.41	0.13	3.27	= .001	**

3.3 Identification task III

The third identification task involves six target words that contain a white noise in the coda position of the first syllable, and asks if the first syllable is perceived as [il] or /i(C)/. Figure 12 shows the identification rate of [il] over /i(C)/ in the third identification task.

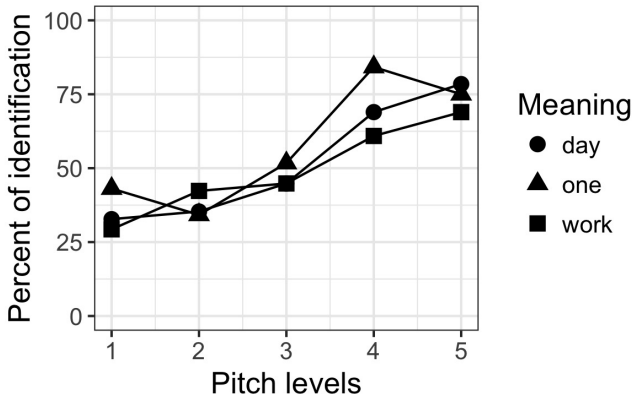

Figure 12. Identification rate of [il] over /i(C)/ by the meaning categories. The meaning categories are marked with different shapes in this figure.

As shown in Figure 12, participants tend to identify the [i] vowel with white noise in the target words as [il]-initial when pitch is high, suggesting that [il] is perceptually associated with a high pitch, regardless of its meaning. We conduct a mixed-effects logistic regression model to investigate the effect of Pitch and YOB on the identification of [il] over /i(C)/. The participants' response is included as a binary variable ([il]: 1, /i(C)/: 0), Pitch and YOB as independent variables, and Participant as a random effect. The model finds that Pitch is an important factor in the participants' response ($p < .001$), but neither YOB nor its interaction with Pitch is significant ($p = 0.535$ for YOB, $p = 0.19$ for YOB*Pitch). The output of the logistic regression model is summarized in Table 11.

Table 11. Output of a mixed-effects logistic regression model for the comparison of [il] and /i(C)/. The reference category for pitch is the lowest level (1), and the reference YOB group is 1990s.

	Estimate	SE	*z*-value	Pr (> |*z*|)	
(Intercept)	-1.52	0.26	-5.85	< .001	***
Pitch	0.46	0.06	7.83	< .001	***
YOB (1980s)	0.22	0.36	-0.62	= .535	
YOB*Pitch	0.11	0.08	1.31	= .190	

We also examined the effect of Gender and Meaning of [il] in two separate mixed-effects logistic regression models, but both factors and their interactions

with Pitch are all insignificant (β_{Gender} = 0.26, p = 0.486; β_{One} = 0.59, p = 0.067; β_{Work} = 0.31, p = 0.315).

4. Discussion

This study examined the production and the perception of High-toned [il] in Seoul Korean, conducting one production experiment and three identification tasks. The results of this study provided interesting findings about the phenomenon. First of all, the results of the production experiment revealed that [il] 'one' was produced with a higher pitch than the other meaning categories and /i(C)/. Also, the results showed that speakers born in the 1990s produced a lower [il] 'one' and less of a pitch difference between [il] 'one' and the other meanings than those born in the 1980s. Moreover, we found a slight gender-based difference in [il] 'work', but males produced [il] 'work' with a higher pitch than their female counterparts.

The results of the perception experiment revealed that the perception of a monosyllabic [il] by speakers born in the 1980s showed an increasing tendency of the identification rate of 'one' in higher pitch levels, yet the identification rate was rather linear, indicating the perceptual difference between 'one' and the other meaning categories is not categorical. The second identification task demonstrated that the perception of [il] showed a (semi-)categorical identification curve when there are only two choices among the three meanings of [il]. The identification curve was more categorical for participants born in the 1980s than for those born in the 1990s. Interestingly, the comparison of 'day' and 'work' also exhibited a tendency that 'day' was more frequently selected than 'work' at higher pitch levels. In the last identification task, the participants selected [il] over /i(C)/ most of the time when the pitch of the target syllable was high, indicating that a high pitch helps participants to compensate the [l] coda consonant from a white noise and [il] was associated with a high pitch, regardless of the meaning. All together, we posit that [il] shows an association with a high pitch, when compared to /i(C)/, and the perceptual hierarchy of a high pitch among the meaning categories is 'one' > 'day' > 'work'. Nonetheless, the distinction in the meaning categories is not categorical, unlike the pitch

distinction between a lenis and an aspirated consonant in Seoul Korean.

The results of the perception experiment look puzzling at first sight; the first identification showed a linear curve between 'one' and 'not-one', and this was quite different from that of [to]. However, the second identification task showed to be rather categorical (or semi-categorical for the 1990s group) among the meanings of [il]. The third identification task also showed a linear curve, but with a better identification rate than the first task. The reason that the participants' response in the first identification task was not as categorical as in the second one or in the case of [to] of the same task seems to be related with the number of choices for [il]. The participants were given three choices, 'one', 'day', and 'work', in the first task, as opposed to two choices in the second test ('one' vs. 'day' or 'one' vs. 'work'). Although we provided three choices for [to] in the first task, the VOT value of the tense-initial syllable [t'o] is much shorter than those of aspirated- or lenis-initial syllables, so the identification of [to] was more like a two choice question between aspirated and lenis, rather than a three choice one. The fact that the total number of [t'o] responses is only about 1% (= 4 responses out of 370) also suggests that the identification of [to] was cognitively different from that of [il]. The three choice questions in the first task would be more difficult for the 1990s group as they produce smaller pitch differences among the [il] categories than the 1980s group. This factor seems to contribute to the poorer identification curve in the first task than in the third one, which involved two choice questions ([il] vs. /i(C)/) and showed no difference by YOB.

One of the key findings of our study is that the speakers showed a generational difference in both production and perception of [il]. The speakers born in the 1980s produced a greater pitch difference between [il] 'one' and the other meanings than the 1990s group, and they showed a more categorical identification in the perception results. Considering that younger speakers tend to enhance a new variant in a sound change in progress (Labov 1989, 2007), the results of the present study seem to suggest that the change of [il] 'one' has nearly reached completion in that younger speakers no longer show a progress with regard to the change. Also, the slight pitch difference between [il] 'one' and [il] 'work' among the 1990s group supports the idea that the phenomenon is spreading to the other words starting with [il], even affecting the pitch values of

[il] ‘work’, which is produced with the lowest pitch in the 1980s group. This trend explains why the 1990s had a difficulty in identifying [il] ‘one’ and ‘work’ in the second identification task. Because they associate a high pitch to [il] ‘work’, as well, only having a pitch cue in the stimuli seems not to help them to differentiate the meaning of the homonyms.

The fact that participants showed little gender difference in both production and perception experiments is interpreted in the same direction. In a sound change in progress, females tend to lead a sound change and males are typically lagging behind (Labov 1990). Jun and Cha’s result (2015) shows that females show a higher frequently of High-toned [il] than their male counterparts, except speakers in their 20s. However, the result of our production experiment with younger generations shows that only [il] ‘work’ is produced with a gender difference, and the direction is the opposite of what we would expect to see from a sound change in progress. Also, there was no gender difference in the three identification tasks. Considering these results all together, it seems that males have caught up to females in terms of this phenomenon to such an extent that participants do not show a gender difference, a further indication that the change has nearly reached completion.

One might wonder why generational difference still exists whereas there is little gender difference in the production of High-toned [il]. When we auditorily examined the productions, we found that speakers in the 1980s group mostly produced [il] ‘one’ with a High tone and [il] ‘work’ with a Low tone, regardelss of gender. In contrast, as for the 1990s group, there were a number of speakers who produced all [il]-initial words with a High tone (i.e., those who already have generalized High-toned [il]). We speculate that this difference in the production pattern of High-toned [il] might contribute to the larger generational difference than the gender one.

Our results support Jun and Cha’s hypothesis (2015) that High-toned [il] started from [il] ‘one’. One of their hypotheses of the possible motivation is that High-toned [il] might have started “to enhance the perceptual difference” between 1 [il] and 2 [i] (p. 103). The two digits were previously distinguished by a vowel length distinction (1 [il] vs. 2 [i:]), yet Seoul Korean lost the vowel length contrast, resulting in a perceptual confusion between 1 and 2. Jun and Cha assume that speakers have started to use a pitch contrast instead of the lost

vowel length contrast to distinguish the two digits. Our results show that [il] 'one' is different from the other meaning categories in that it is produced with a higher pitch and [il] tends to be perceived as 'one' when pitch is high. These results support the idea that [il] 'one' is special and it might be the meaning category where the phenomenon started. Also, we confirm Jun and Cha's finding that High-toned [il] has spread from 'one' to the other meaning categories. The 1990s group showed a higher pitch value for 'work', 'day', and [il] with other meanings than the 1980s group, suggesting that High-toned [il] is more frequently employed among the participants in the 1990s group. The results that the participants born in the 1990s showed poor identification curve for the comparisons of 'one' vs. 'day' and 'one' vs. 'work' in the second identification task also supports that all [il] categories are more or less associated with a high pitch in the participants' cognitive system and High-toned [il] is being generalized among younger speakers.

The results of this study make an interesting comparison to the tonogenesis-like sound change among obstruent onsets in Seoul Korean. Cho (2017) finds that speakers born in the 1990s show a smaller pitch difference by gender between syllables with an aspirated/tense onset consonant and those with a lenis onset than speakers born before 1990, suggesting that the tonogenesis-like change has nearly reached completion as well. It might be a coincidence that both pitch-related sound changes reached completion by the same generation, but the end result of both changes poses an implication to the current status of Seoul Korean. Considering Cho's result (2017) and that of the present study, Seoul Korean produced by speakers born in the 1990s presents both expected and unexpected pitch differences, where the expected pitch difference comes from the laryngeal contrast of obstruents (i.e., aspirated/tense or lenis) and the unexpected pitch difference stems from the lexical distinction between 'one' and 'day/work', although the latter is being generalized. This suggests that Seoul Korean is in a tonally confusing status, providing a potential cause for children to fully understand what to learn. If High-toned [il] continues to be an exception to the intonational melody of Seoul Korean, the systematic distinction between aspirated/tense and lenis might become blurred due to the exception. Also, there are cases where other lexical pitch distinction is reported, for example the comparison between 3 [sam] with a high pitch and 4 [sa] with

a low pitch (Jun and Cha 2015; Cho 2017: Ch. 3), along with the participants' personal report of other vowel-initial words being produced with a high pitch after the experiment, we expect the situation will be tonally dynamic when the future generation learns the language. However, questions of whether Seoul Korean becomes a tonal language or not should be answered with future studies employing further younger generations later. For now, because the results of this study show that the difference between [il] 'one' and [il] 'work' is not categorical, we can only confirm that the pitch difference among the [il] categories is not a lexical tonal contrast.

Although this study attempted a thorough investigation of the phenomenon, it had a few limitations. First of all, we could not include the effect of word frequency in the identification tasks, as there is a dearth of homonyms that could mean both 'one' and 'work', for example. Some words are more likely to occur in natural conversations than the others, as in the example of [il.tɕuŋ.dok], where 'workaholism' is more frequently used than 'Japan, China, Germany.' To cope with the effect of word frequency, we provided example sentences for all target words so that the participants could rely on the context, not the frequency (Section 3.1.3). However, there are previous studies showing that frequent words are more affected by a sound change than those that are less frequent (Bybee 1985, 2002; Pierrehumbert 2001). Thus, the effect of word frequency on High-toned [il] would need to be answered in future works. Also, the pitch steps in the identification tasks were not as fine-grained as those in other studies (e.g., Kim 2004). Identification tasks in a perception experiment usually employed seven to ten steps, although ours had only five. The number of the pitch steps in this study sufficed to show us the general trend in the identification rate of [il], but more steps might provide a deeper understanding of the phenomenon. These limitations should be taken into account in future research.

To summarize, the present study finds that a) the production of [il] 'one' is higher than the other meaning categories; b) however, this pitch difference is being generalized; c) the perceptual association between [il] and a high pitch has the strongest tendency for 'one' and the weakest for 'work'; d) yet, all meaning categories of [il] is linked to a higher pitch, when compared to /i(C)/; e) the pitch difference between the [il] categories is not a lexical pitch contrast.

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