Judgment of L2 phonotactics by Korean listeners at two proficiency levels*

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Sung, Eunkyung. 2014. Judgment of L2 phonotactics by Korean listeners at two proficiency levels. *Studies in Phonetics, Phonology and Morphology* 20.2. 141-159. This study attempts to determine whether native English listeners and native Korean listeners at two different proficiency levels of English show the same judgment patterns when presented with English nonce words composed of three different syllable structures (i.e., legal syllables, illegal syllables with a sonority rise, and illegal syllables with a sonority plateau). Ten native English listeners and twenty native Korean listeners participated in a word-likeness judgment task. The results indicate that both native English listeners and native Korean listeners with higher L2 proficiency reveal the same patterns. Their judgment scores become higher as the sonority distance of onset clusters increases. However, the results for Korean listeners with lower L2 proficiency are not consistent with those of the other two groups. Although listeners with lower proficiency can distinguish between legal and illegal syllables in L2, they do not prefer illegal syllables with a sonority rise to those with a sonority plateau. In addition, the reaction time results show that all the listeners respond faster when they hear nonce words containing illegal syllables than when they listen to those composed of legal syllables. These results suggest that L2 phonotactic knowledge expands as L2 proficiency increases and plays a more important role in the judgment of L2 nonce words than do universal preferences based on the sonority principle. **(Cyber Hankuk University of Foreign Studies)**

Keywords: word-likeness judgment, L2 proficiency, phonotactics, legal syllables, illegal syllables, sonority rise, sonority plateau, reaction time

1. Introduction

The term phonotactics refers to knowledge of possible phoneme combinations in a language. Whereas in English two-consonant onset clusters such as /tr-/ or /fl-/ are allowed, no clusters are allowed in Korean syllable structure. The combination of consonants in onsets and codas is often explained by the sonority hierarchy (Selkirk 1984, Clements 1990, Eckman and Iverson 1993, Berent et al. 2007)[1]. According to the Sonority Sequencing Principle, sonority rises during the onset and falls over the rhyme. For instance, the sequence of obstruent and liquid (e.g., *drive*) is preferred as the onset of a syllable, while the sequence of liquid and

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[1] The sonority hierarchy shown in Clements (1990) is the following: Stops < Fricatives < Nasals < Liquids < Glides < Vowels (from the least to the most sonorous segments). In the present study the distinction between stops and fricatives is not adopted following Berent et al. (2007, 2008).

obstruent (e.g., *bird*) is preferred as the coda. Furthermore, the greater the distance in sonority between two consonants in an onset, the less marked the syllable (Steriade 1982, Broselow and Finer 1991, Parker 2002). Clements (1990) also proposes that all other things being equal, a language prefers a maximal sonority difference in the syllable onset but a minimal one in the coda.

In previous studies (Greenberg 1978, Berent et al. 2007, Berent et al. 2008) a scale of four types of onset clusters was examined to show universal linguistic knowledge. At the top of the scale are clusters with rising sonority (e.g., /bl-/), and at the bottom are clusters with falling sonority (e.g., /lb-/). Clusters with sonority plateaus (e.g., /bd-/) and clusters with small sonority rises (e.g., /bn-/) are in an intermediate position. Across languages the frequency of such clusters consistently decreases as the position of the clusters shifts toward the bottom of the scale. For instance, *bd*-type syllables are more frequent than *lb*-type syllables in onsets. Such preferences have been accounted for by the property of sonority. In the sonority hierarchy stops such as *p, t, k, b, d,* and *g,* and fricatives such as *f* and *v* are least sonorous (s = 1). Next are nasals such as *m* and *n* (s = 2), and then come liquids such as *l* and *r* (s = 3). Finally, glides such as *w* and *y* are the most sonorous consonants (s = 4). Onset clusters manifesting a large rise in sonority (e.g., *blif*) are preferred over those exhibiting a small one (e.g., *bnif*). The order of universal preference is large rises > small rises > plateaus > falls (e.g., *bl* > *bn* > *bd* > *lb*) (Clemets 1990, Smolensky and Legendre 2006).

Accordingly, English permits only onset clusters with a large sonority rise, but not onsets with a small sonority rise, sonority plateau, or sonority fall. Thus, English two-segment onset clusters are most likely to be obstruent + sonorant (e.g., *pl-, br-, tr-, dr-, fl-, gr-, sl-*). If two obstruents occur in an onset, the first one must be /s/ (e.g., *sp-, st-, sk-*)[2]. In addition, only /s/ appears before a nasal consonant (e.g., *sm-, sn-*).

Listeners can rate nonce words based on their syllable structure. Some words like *blick* [blɪk] and *blif* [blɪf] are judged acceptable as English words, whereas other words like *bnick* [bnɪk] and *bdif* [bdɪf] are not (Berent et al. 2007, Hayes and White 2013). Furthermore, it might be the case that *bnick* [bnɪk] and *dnif* [dnɪf] are more acceptable than *bdif* [bdɪf] and *dbif* [dbɪf] even though all of these onset clusters are illegal in English syllable structure.

In the majority of previous studies, judgment of the well-formedness of nonce words has been performed by native speakers (Pitt 1998, Moreton 2002, Wilson 2003, Berent et al. 2007, Berent et al. 2009, Hayes and White 2013). More limited attention has been paid to the phonotactic judgments of

[2] The *s*+stop clusters */sp-, st-, sk-/* violate the Sonority Sequencing Principle because the fricative /s/ is more sonorous than the following stop. It has been suggested that the fricative /s/ can be an adjunct to a simple onset. The term "adjunct" has been used to distinguish between *s*+stop clusters and all other "true clusters". That is, the segment /s/ is not associated with an onset, but rather appended directly at the syllable level (Selkirk 1982, Kenstowicz 1994).

L2 learners (Tench 2003, Altenberg 2005, Trapman 2007, Berent et al. 2008, Mikhaylova 2009, Lee 2011).

In the present study, L2 phonotactic knowledge is examined using a word-likeness judgment experiment. The judgment patterns of onset consonant clusters by adult second language learners at two different proficiency levels are the focus of this study. Two groups of native Korean listeners learning English (higher proficiency and lower proficiency groups) and native English listeners participated in a judgment task. Furthermore, three different syllable types were employed to explore whether the three groups of listeners show universal preferences based on the sonority scale, with preferences decreasing in order from legal onset clusters in English (e.g., /pl-/, /tr-/, /fl-/, etc.) to illegal onset clusters with a sonority rise (e.g., /pn-/, /tm-/, /fn-/, etc.) to illegal onset clusters with a sonority plateau (e.g., /pt-/, /tk-/, /fs-/, etc.). Illegal clusters are defined as consonant clusters that are not attested in L1, and legal ones as consonant clusters that are attested in L1.

More specifically, the central questions to be addressed in this study are the following: (1) Are there any differences between the three groups (i.e., native English speakers, native Korean speakers with higher English proficiency, native Korean speakers with lower English proficiency) in their word-likeness judgments of nonce monosyllabic words including two consonants in their onsets? (2) Are there any differences in judgment scores between the three types of syllable structure (i.e., legal consonant sequences, illegal consonant sequences with a sonority rise, and illegal consonant sequences with a sonority plateau)? (3) Are there any differences in reaction times between the three groups and/or between the three syllable types?

In order to answer these questions, a word-likeness judgment experiment was conducted. In this experiment, one group of native English speakers and two groups of native Korean speakers rated the acceptability of nonce words with different onset clusters as new words of English. Of interest is whether the two groups of Korean listeners show the same judgment patterns. If the universal preference for greater sonority distance in onset clusters is active in the listeners' linguistic knowledge, then not only native English listeners but also both groups of Korean listeners should rate illegal syllables with a sonority rise as more plausible candidates for English words than illegal syllables with a sonority plateau. According to universal preferences shown in previous studies (Greenberg 1978, Berent et al. 2007, Berent et al. 2008), across languages onset clusters with a large sonority rise are most common. Further, onset clusters with a small sonority rise are more frequent than those with a sonority plateau.

In addition, legal syllables are expected to require a longer reaction time than illegal syllables, since legal syllables may involve the access of lexical knowledge. This prediction is based on the results of Kager and Shatzman (2007) and Trapman (2007). In a lexical decision task the native English speakers needed significantly more time to reject nonce words with legal onset clusters than to reject those with illegal onset clusters. They argued that

nonce words of high probability or legal syllables impeded processing when lexical activation was needed, and those nonce words had longer reaction times than nonce words of low probability or illegal syllables.

2. Literature review

Previous studies tested the acceptability of syllable structure in nonce words to native speakers (Pitt 1998, Moreton 2002, Wilson 2003, Berent et al. 2007, Berent et al. 2009, Hayes and White 2013). Pitt (1998) drew attention to the important role of phonotactic constraints in the perception of onset consonant clusters. When native English speakers listened to legal or illegal stop-liquid onsets, their responses were strongly biased toward legal sequences (e.g., /dr-/, /tr-/ or /sl-/) in comparison with illegal sequences (e.g., /dl-/, /tl-/ or /sr-/). Moreton (2002) investigated whether various stop-sonorant onset clusters were equally difficult for native English speakers to perceive. The results revealed that there was a bias against the onset /dl-/, but not against /bw-/ even though both onset clusters are illegal in English. He attributed this asymmetry to the difference between accidental gaps and phonotactically illegal onsets.

Berent et al. (2007) examined the sensitivity of English speakers to the sonority of onset clusters by using three types of L1-illegal onset consonant clusters, either sonority rises (obstruent-nasal or obstruent-liquid combinations), plateaus (obstruent-obstruent combinations), or falls (nasal-obstruent or liquid-obstruent combinations). The native English participants indicated whether they heard a nonce word composed of one syllable or of two syllables. The results showed that they distinguished these three types of illegal consonant clusters by perceiving onsets with rising sonority correctly, and perceiving onsets with a sonority plateau more correctly than those with falling sonority. The participants tended to misperceive ill-formed sequences like /lb-/ as separated by a short schwa-like vowel most often. In other words, universally more marked structures posed more perceptual problems than less marked ones although none of the test items were attested in the L1. Berent et al. (2007) argue that native English speakers actively deploy knowledge of sonority sequencing universals, rather than knowledge of the English lexicon. Furthermore, Berent et al. (2009) reported a universal preference regarding unattested nasal-initial onset clusters in participants' native language. The native English speakers were more likely to misperceive nasal-initial onsets with falling sonority as disyllabic compared to those with rising sonority. This misperception was not due to L1 or to a failure of processing the acoustic cues. They suggest that English speakers possess phonological knowledge of the relative markedness of onset clusters based on universal grammar.

Hayes and White (2013) tested the status of phonotactic constraints in nonce words: 10 violating unnatural constraints (e.g., *[+cont, -strident] [-son], *hethker*), 10 violating natural constraints (e.g., *[-son] [+son] in coda,

kipl) and 20 violation-free forms (e.g., *hethler, kilp*). In the familiarization phase, the native English listeners were presented with *bzarshk* as an example of a strange-sounding word, *kip* as an example of a normal-sounding one, and *poik* as an intermediate example. They found that violations of natural constraints had a stronger effect on native listener judgment than violations of unnatural constraints. That is, native listeners are biased to favor natural generalizations.

Previous research on L1 phonotactic knowledge has focused on the effects of native phonotactics and universal preferences. In general, the results of previous experimental studies investigating native speakers' responses to legal and illegal nonce words support a bias effect of syllable structure. Natural unmarked patterns are preferred and learned more easily than unnatural marked forms. In the following section the previous literature on the role of phonotactics in L2 perception is presented.

Dupoux et al. (1999) and, Kabak and Idsardi (2007) demonstrated the way listeners perceived L2 sound strings which were illegal in the L1. Dupoux et al. (1999) conducted a series of perceptual studies and indicated that Japanese listeners, in contrast to French listeners, tended to perceive illusory epenthetic vowels within consonant clusters due to native phonotactics. Moreover, Kabak and Idsardi (2007) investigated the causes of perceptual epenthesis and showed that Korean listeners heard epenthetic vowels more often when a presented cluster had a syllable structure violation (e.g., *[c] or *[j]) than when a cluster had a consonantal contact violation (e.g., *[k.m] or *[l.n])[3].

Tench (2003) asked Korean learners of English to listen to English words and write down the words they heard. He found that there was variability when Korean listeners heard the English words including initial consonant clusters. For example, /sp-/, /st-/ and /str-/ were perceived correctly 100% of the time, /fr-/ 80% of the time, and /sf-/ 25% of the time. Altenberg (2005) investigated the acquisition of English onset consonant clusters by adult native speakers of Spanish. The results of the judgment task indicated that beginning, intermediate and advanced L2 learners had accurate knowledge of English onset clusters although L2 learners were not able to use that information as effectively as native English speakers. She pointed out that L2 listeners' misperception was not due to transfer from L1 as there was no difference in perception accuracy between the onset clusters which were grammatical in L1 and those which were not. Altenberg (2005) suggests that L2 perception is constrained by universal factors such as markedness and sonority principles.

[3] Korean bans certain consonants in coda position (e.g., *[p^h], *[c.], *[s.]). Stop sounds are neutralized as a homorganic lenis stop, and a fricative or an affricate becomes a coronal lenis stop [t]. Also, Korean has a nasalization rule that turns stop sounds into nasal sounds before a nasal sound (e.g., /k.m/ → [ŋ.m]: /hak.mun/→ [haŋ.mun] 'learning'). Furthermore, a lateralization rule changes nasal sounds into lateral sounds before or after a lateral sound (e.g., /n.l/ → [l.l]: /han.la.san/ →[hal.la.san] 'Mt. Halla').

Trapman (2007) conducted a word-likeness judgment task and a lexical decision task focusing on different consonant clusters. Phonotactically legal and illegal clusters of Dutch were presented in nonce words to native Spanish and Russian speakers learning Dutch. The results illustrated that L2 learners distinguished between Dutch legal and illegal clusters. The level of the L2 learners' exposure to Dutch was found to have a significant bearing on the selection of legal or illegal clusters. Namely, the responses of advanced learners were closer to native speakers' responses than those of less advanced learners. That is, the advanced learners, not early learners, discriminated between different levels of ill-formedness.

Cardoso (2008) examined the effects of two hypotheses (markedness on sonority sequencing and input frequency) for the development of English sC onset clusters in L2 interlanguage. The markedness hypothesis predicted that acquisition would progress from the least marked to more marked clusters (i.e., /sl-/ > /sn-/ > /st-/) whereas the frequency hypothesis predicted the reverse order of development (i.e., /st-/ > /sl-/ > /sn-/). The results from the analyses of a corpus and interviews for eliciting spontaneous speech indicated that sC clusters developed as a function of increased proficiency, and that the development of sC clusters supported the markedness hypothesis rather than the frequency hypothesis.

Berent et al. (2008) investigated L2 listeners' misperception of ill-formed clusters, and found that Korean learners of English misperceived universally dispreferred onset clusters (e.g., /lb-/) more frequently than universally preferred ones (e.g. /bl-/). Berent et al. (2008) argued that the misperception of universally dispreferred onset clusters by Korean speakers could not be readily explained by English proficiency or other phonetic and phonological properties of the L1.

Mikhaylova (2009) tested the salience of the L2 phonological filter in fluent Russian-English bilinguals using monosyllabic nonce words with CCVCC structure that violated or conformed to the phonotactic constraints of English (e.g., *dvind, flind*). The results showed that L2 English speakers did not differ in their intuition patterns from native speakers, although they did differ from monolingual native speakers of English regarding overall accuracy and response time. The results also revealed that illegal nonce words were rejected faster than legal items. Mikhaylova (2009) claims that L2 materials which are not accessible in the L1 can be internalized by fluent L2 speakers.

Lee (2011) explored the perception interaction between schwa deletion and English phonotactic constraints by conducting a syllable-count experiment on three different groups of L1 listeners (i.e., native English, Korean and Japanese speakers). The results of both mean accuracy and reaction times showed that among the three groups only English speakers were able to differentiate legal onsets from illegal ones resulting from schwa deletion. She also argued that native English listeners' perception of illegal onsets with a sonority rise, a sonority plateau or a sonority fall complied with

prediction based on sonority-driven onset markedness.

Previous research on L2 phonotactic knowledge is generally suggestive of a strong effect of L1 phonotactics in L2 perception. However, previous results regarding distinctions between legal and illegal syllables in L2 are not consistent. Altenberg (2005) and Berent et al. (2008) claim that L2 listeners are able to differentiate legal syllables from illegal syllables even though both syllable types are absent in their L1, and that these perceptual patterns can be explained by universal onset markedness. Lee (2011), on the contrary, concludes that only native listeners, not L2 listeners, are sensitive to the distinction between legal and illegal syllables resulting from schwa deletion.

Furthermore, the effect of proficiency levels in L2 phonotactics is also still controversial. For example, Trapman (2007) suggests that relative inexperience with an L2 leads to failure to distinguish between illegal onset clusters. Mikhaylova (2009) also indicates that the overall patterns of recognizing nonce words with consonant clusters are the same between L1 and fluent L2 speakers. In contrast, Altenberg (2005) purports that L2 speakers, irrespective of their L2 proficiency, have accurate knowledge of English onset clusters. Berent et al. (2008) also argue that universally preferred clusters are correctly perceived more often than universally dispreferred ones, and that L2 proficiency cannot sufficiently explain L2 learners' misperception.

The current study examines the effects of universal phonotactic knowledge and L2 proficiency levels on the perception of onset consonant clusters. One group of native English listeners and two groups of native Korean listeners at different L2 proficiency levels participated in a word-likeness judgment experiment, and rated nonce words composed of three syllable types (i.e., legal syllables, illegal syllables with a sonority rise, and illegal syllables with a sonority plateau). Judgment scores and reaction times were measured.

3. Methods

3.1 Participants

One group of native English listeners and two groups of native Korean listeners at different English proficiency levels participated in this experiment. Ten native English listeners (EL), five male and five female, served as a control group. All of them were English professors or instructors at a university in Seoul.

The ten native Korean listeners with higher English proficiency (KLH), four male and six female, were graduate students at the same university. They were all in their 20s, and their major was English Education. They received partial course credit in return for their participation in this experiment. All of them had taken the TOEIC exam (Test of English International Communication), and their average TOEIC score was 924,

ranging from 895 to 980. They were considered advanced level learners of English based on their self-reported scores of the English proficiency test and the researcher's observations in class.

The ten native Korean listeners with lower English proficiency (KLL), five male and five female, were graduate or undergraduate students at the same university. They were all in their 20s and were not majoring in English. Only three of them had taken the TOEIC exam, and their average TOEIC score was 745. None of them had lived in an English-speaking country for more than six months. Their English proficiency was considered low based on their self-reported English proficiency level and on the researcher's evaluation during a short interview before the experiment. None of the participants reported any speech or hearing problems.

3.2 Materials

The test items were nonce words of three syllable types: those including an initial consonant cluster which is legal in English (e.g., obstruent + liquid, /plig/, /grʊf/), those including an initial consonant cluster with a sonority rise which is illegal in English (e.g., obstruent + nasal, /pnig/, /fmʊk/), and those including an initial consonant cluster with a sonority plateau which is also illegal in English (e.g., two stops or two fricatives, /pkig/, /fzʊk/)[4].

There were a total of 162 nonce words (42 test items x 3 repetitions, 12 filler items x 3 repetitions). The test items were constructed such that each onset was followed by a single vowel (/i/, /ʊ/ or /ɛ/), and was followed by a single consonant (/k/, /g/, /p/, /b/, /f/ or /v/). All the items were monosyllabic words. Thus, the total of 126 test items include 14 nonce words with legal onset clusters, 14 nonce words containing illegal onset clusters with rising sonority, and 14 nonce words beginning with illegal onset clusters with a sonority plateau. Additional items containing initial consonant clusters such as /ʃr-/, /sl-/, /sm-/, or /ʃr-/ were used as fillers. All of the test stimuli are listed in the appendix.

All of the items were produced naturally by a phonetically trained native speaker of English using *GOM* recorder with a Plantronics DSP-500 headset in a quiet room at a sampling rate of 44,100Hz. The speaker was asked to produce three repetitions at a natural speech rate of each nonce word written in both standard English orthography and phonetic symbols. Among each set of three repetitions of the same word, the second or last item was taken as the stimuli. The waveforms and spectrograms of all the items were checked using *Praat* 5.3.55 (Boersma and Weenink 2013) to make sure that there was

[4] One reviewer wondered why another set of stimuli including onset clusters with sonority fall (e.g., *lb-*) was not used in this experiment. In much previous research (Berent et al. 2008, Lee 2011) four types of onset sequences were used in syllable count experiments, including sequences with a sonority fall. In the present study a word-likeness judgment experiment was conducted, and it was supposed that it would have been difficult for the subjects to judge the acceptability of nonce words with falling sonority onset clusters, since those clusters could have been perceived as two syllables.

no vowel inserted between the two onset consonants. In sum, 162 nonce words were presented to each participant, and with the filler words excluded, a total of 1780 responses (126 tokens x 30 participants) were obtained and submitted for statistical analyses.

3.3 Procedure

The word-likeness judgment task was conducted in a quiet room on campus. The subjects were told how they should respond to each auditory stimulus, and a trial session consisting of 12 items was provided. They sat in front of a computer with a Plantronics DSP-500 headset, and the score choices were visually presented simultaneously on the computer screen. Five-point scales were utilized in order to judge how acceptable a nonce word was as an English word. A score of one (the worst) indicated that the stimulus was completely unacceptable as an English word, and a score of five (the best) implied that it was completely acceptable. The participants were asked to click on the number shown on the computer screen. They were also instructed to focus on onset clusters in the word-likeness judgment task.

The auditory stimulus items were automatically randomized for each listener using *Praat*. Before the test, the native Korean participants filled in a language background questionnaire and were briefly interviewed about their English proficiency. In order to familiarize all the participants with the test, a trial session was administered before the main session started. The main experiment lasted approximately 20 minutes for each participant. The judgment scores and reaction times were recorded with *Praat*. Reaction times were measured from the offset of stimulus to the onset of response. The following figure shows the computer screen used during the judgment experiment.

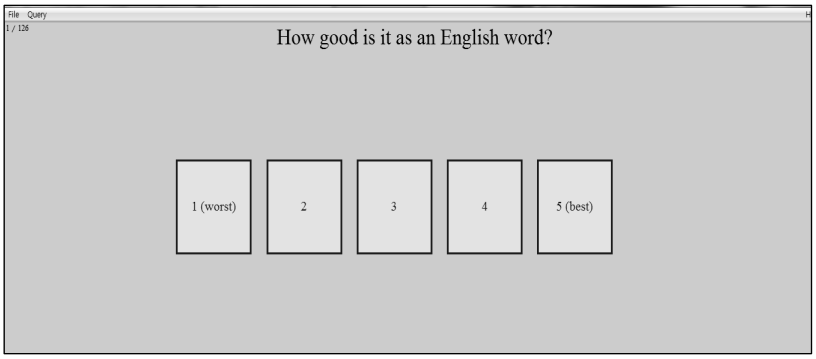

Figure 1. Computer screen prompted by the *Praat* software

4. Results and discussion

4.1 Judgment scores

The average judgment scores obtained from all participants were 3.32 for the first syllable type (legal syllables in English), 1.93 for the second syllable type (illegal syllables with a sonority rise), and 1.74 for the third syllable type (illegal syllables with a sonority plateau). Figure 2 displays the judgment patterns of the three listener groups.

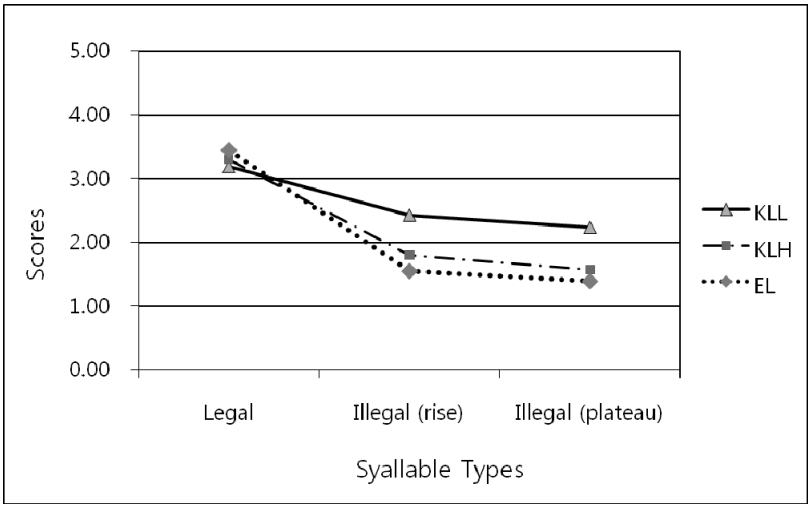

Figure 2. Mean judgment scores by three listener groups

The judgment score data was submitted to an ANOVA (analysis of variance) with listener group and syllable type as factors and judgment score as the dependent variable. All the analyses were performed using SPSS Statistics 18. The results of the analyses are described as significant if $p<.05$ and highly significant if $p<.01$. The average scores on the three syllable types for each group, and pairwise comparisons between the three syllable types and between the three listener groups, are shown in Table 1.

Table 1. Pairwise comparisons of mean judgment scores

Groups	Syllable types	Mean	S.D.	Comparisons (syllables)	Comparisons (groups)
EL	(1) Legal	3.45	0.74	(1) vs. (2) p=.000**	EL vs. KLH p=.546 EL vs. KLL p=.003** KLH vs. KLL p=.018*
	(2) Illegal (rise)	1.55	0.47	(1) vs. (3) p=.000**	
	(3) Illegal (plateau)	1.39	0.45	(2) vs. (3) p=.009**	
KLH	(1) Legal	3.31	0.94	(1) vs. (2) p=.001**	
	(2) Illegal (rise)	1.81	0.76	(1) vs. (3) p=.000**	
	(3) Illegal (plateau)	1.58	0.50	(2) vs. (3) p=.044*	
KLL	(1) Legal	3.19	0.45	(1) vs. (2) p=.001**	
	(2) Illegal (rise)	2.43	0.55	(1) vs. (3) p=.001**	
	(3) Illegal (plateau)	2.24	0.60	(2) vs. (3) p=.067	

*p<.05, **p<.01

There were significant main effects of listener groups [$F(2, 27) = 5.126$, $p<.01$] and syllable types [$F(2, 27)=56.267$, $p<.01$]. There was also a significant effect of their interaction [$F(4, 27)=2.781$, $p<.05$]. Post-hoc pairwise comparisons (LSD test) of listener groups indicated that the judgment scores of native English listeners (EL) were significantly different from those of native Korean listeners with lower proficiency (KLL) ($p<.01$). However, the scores of native English listeners were not significantly different from those of Korean listeners with higher proficiency (KLH) ($p=.546$). When the scores of the two groups of Korean listeners were compared with each other, the Korean listeners with higher proficiency showed significantly lower scores than the Korean listeners with lower proficiency ($p<.05$). This suggests that the native English listeners did not perform differently from the Korean listeners with higher proficiency. Conversely, the performance of Korean listeners with lower proficiency was markedly different from both that of English listeners and Korean listeners with higher proficiency. This implies that L2 proficiency plays an important role in judging L2 syllable types.

Another post-hoc pairwise comparisons (LSD test) of syllable types illustrate that legal syllables in English are more acceptable than the two illegal syllable types (all $p<.01$). However, the two types of illegal syllables are not significantly different from each other. ($p=.237$). It is suggested that

nonce words with legal syllables are generally more acceptable than those containing illegal syllables.

Furthermore, a repeated measures ANOVA was conducted for the three listener groups separately in order to determine the effect of syllable types. For native English listeners, there was a highly significant effect of syllable types [$F(2, 7)=39.089$, $p<.01$]. A post hoc pairwise comparison indicated that native English listeners distinguished between the three types of syllable structure (all $p<.01$). In other words, it is clear that for native English listeners legal syllables are more acceptable than illegal syllables, and illegal syllables with a sonority rise are more acceptable than those with a sonority plateau. Also, a significant effect of syllable types was shown for the Korean listeners with higher proficiency [$F(2, 7)=22.871$, $p<.01$]. A post hoc pairwise comparison showed that Korean listeners with higher proficiency also discriminated between the three types of syllable structure ($p<.01$ between the legal and illegal syllables, and $p<.05$ between the two illegal syllable types).

Moreover, there was a significant effect of syllable type for the Korean listeners with lower proficiency [$F(2, 7)=10.773$, $p<.01$]. A post hoc pairwise comparison showed that the Korean listeners with lower proficiency distinguished between the legal and illegal syllables ($p<.01$), but they did not distinguish between the two illegal syllable types ($p>.05$).

It appears that the native English listeners and Korean listeners with higher proficiency showed the same judgment pattern. Both listener groups were sensitive to sonority distance in onset clusters, and distinguished between the three syllable types. However, the results of the Korean listeners with lower proficiency were not consistent with those of either the native English listeners or the Korean listeners with higher proficiency. The Korean listeners with lower proficiency were not aware of the differences between the two illegal syllable types. In other words, although phonetic naturalness (illegal syllables with a sonority rise vs. illegal syllables with a sonority plateau) affected the judgment of the native English listeners and native Korean listeners with higher L2 proficiency, it did not affect the judgment of native Korean listeners with lower L2 proficiency.

These findings were consistent with the results of Trapman (2007) and Mikhaylova (2009). Trapman revealed that only advanced L2 learners demonstrated a significant difference between the legal and illegal onset clusters. He suggests that experience with the target language plays a role in L2 development. Mikhaylova (2009) also contended that the overall judgment patterns of fluent L2 speakers were very similar to those of native speakers

However, the current findings do not fully conform to some existing research (Altenberg 2005, Berent et al. 2008, Lee 2011). Altenberg (2005) indicated that all L2 learners, regardless of proficiency level, were able to use their knowledge of L2 onset clusters correctly most of the time in perceptual experiments. He argued that L2 learners' perception accuracy for onset

clusters supported the role of universal factors such as segment well-formedness, universal CV syllable type and sonority. Furthermore, Berent et al. (2008) contended that Korean listeners' more frequent misperception of ill-formed clusters could not be explained by either speakers' L2 proficiency or L1 phonology. In Lee's study (2011) Korean listeners with upper-intermediate or advanced level of English did not show a sensitivity to English phonotactic restriction on legal vs. illegal onset clusters derived by schwa deletion.

The results of the present study cannot be explained only by universal preferences. According to Clements (1990), onset clusters with greater sonority differences are universally preferred to onset clusters with smaller sonority differences. If sonority-based universal markedness prevailed over L2 proficiency, even Korean listeners with lower proficiency could differentiate illegal onset clusters with a sonority rise from illegal onset clusters with a sonority plateau. However, the Korean listeners with lower proficiency were not able to discriminate between those two illegal onset cluster types. In other words, the native Korean listeners with lower proficiency did not demonstrate that universally less-preferred clusters were considered worse examples of a language than universally more-preferred ones when both kinds of clusters were unattested in L2.

The present study does not exploit the misperception of ill-formed or well-formed L2 syllables, and its findings cannot be directly compared with those of some previous studies (Berent et al. 2008, Lee 2011). However, it is clear that L2 phonotactic knowledge based on L2 proficiency has a strong effect on the acceptability of onset clusters in nonce words.

4.2 Reaction time

The average reaction times were 2.28 seconds for the first syllable type (legal syllables in English), 2.03 for the second syllable type (illegal syllables with a sonority rise), and 1.98 for the third syllable type (illegal syllables with a sonority plateau). The following figure displays the reaction times for the three different syllable types for the three groups[5].

[5] One reviewer raised the question of why the reaction times were longer in general in the present study relative to those shown in the previous studies (Berent et al. 2008, Lee 2011). The differences in reaction times could be derived from the differences in the tasks. Whereas in the previous studies a syllable count task was used, in the present study a word-likeness judgment task was employed, a task which might have needed more time to complete.

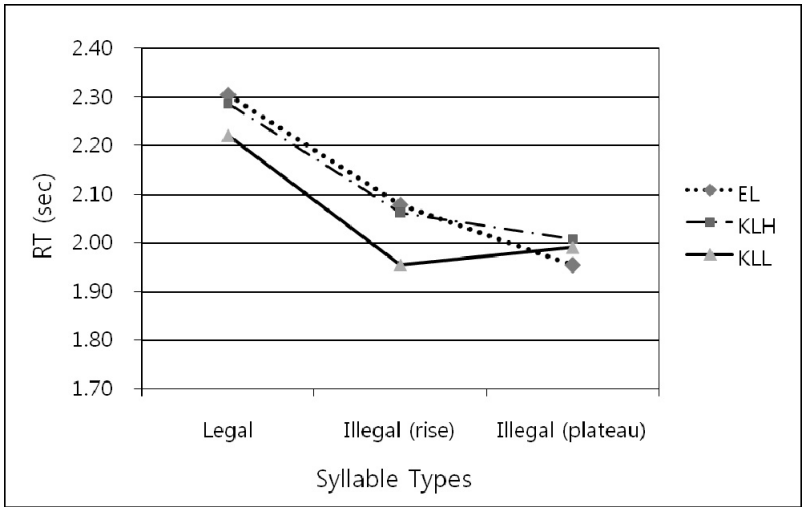

Figure 3. Reaction times (RT) by three listener groups

As shown in Figure 3, the results of the native English listeners and those of the native Korean listeners with higher proficiency revealed the same pattern. The reaction time (RT) data was submitted to a ANOVA with listener groups and syllable types as factors and judgment scores as a dependent variable. There was no significant main effect of listener groups [$F(2, 27)=0.172$, $p=.842$]. However, there was a marginally significant effect of syllable types [$F(2, 27)=3.282$, $p<.05$]. Further, there was no significant effect of their interaction [$F(4, 27)=0.086$, $p=.986$]. Although the Korean listeners with lower proficiency responded slightly faster than the other listener groups, there was no significant difference between the three groups in terms of RT.

Post-hoc pairwise comparisons (LSD test) of syllable type illustrated that the processing of legal syllables took more time than that of the two illegal syllable types (both $p<.05$). However, the two types of illegal syllables were not different from each other. ($p=.698$). It seems that the listeners generally responded more slowly for nonce words with legal clusters than for those containing illegal ones. This is to say that the listeners denied the acceptability of illegal syllables quickly, whereas they responded more slowly when they had to judge the acceptability of legal syllables. Although both the native English listeners and native Korean listeners with higher proficiency distinguished between the two illegal syllable types in terms of judgment scores, this distinction was not reflected in their reaction times.

In addition, a repeated measures ANOVA was conducted for the three listener groups separately in order to determine where there was a syllable type effect. There was no significant syllable type effect for any of the three groups (all $p>.05$).

The results of reaction times in the current study revealed a tendency for

participants' response times to decrease along with a decrease in sonority distance. In other words, they quickly identified and rated illegal syllables with a small sonority rise or sonority plateau as bad candidates for English words. In contrast, when presented with legal syllables with a large sonority rise, their responses were slower.

These results are consistent with those of Kager and Shatzman (2007) and Trapman (2007). The results of their experiments indicated that native listeners assigned higher scores to nonce words with legal onsets and needed more time to reject these phonotactically well-formed nonce words than nonce words containing illegal onsets. The present findings also support the results of Mikhaylova (2009), where both native English speakers and fluent Russian-English bilinguals rejected words containing illegal clusters much faster than those containing legal clusters.

However, the present results are not consistent with those of some previous research. Berent et al. (2008) found that participants were more accurate and significantly faster when they responded to onsets with large sonority rises compared with relatively less well-formed onsets with plateaus. Lee (2011) pointed out that native English listeners responded to legal onset clusters more accurately and much faster than to illegal onsets, while Korean listeners were insensitive to the distinction between legal and illegal onset clusters, and showed the opposite tendency.

The disparity in results between the present study and previous research may be attributed to a difference in the experimental tasks. The participants in Berent et al. (2008) were asked to indicate whether the stimuli included one syllable or two (a syllable count task), and whether two paired stimuli were identical or not (a discrimination task). Lee (2011) also used a syllable count task. However, in the present study the participants were asked to judge the acceptability of stimuli items as English words (a word-likeness judgment task). The participants' responses to nonce words with legal syllables were slower than to those with illegal syllables because the former are only slightly different from existing English words, but the latter are clearly different from them. Thus, it may naturally take more time for the participants to judge items based on subtle differences than ones based on large differences. Lexical activation may impede the judgment process when legal items are presented (Kager and Shatzman 2007, Trapman 2007).

The general patterns shown in the judgment scores of three different syllable types are different from those shown in the reaction times. In the judgment scores a gradual difference is revealed between three different onset clusters for at least native English listeners and native Korean listeners with higher proficiency: legal syllables > illegal syllables with a sonority rise > illegal syllables with a sonority plateau (from the highest to the lowest scores). However, in the reaction times, only a categorical difference between two types of syllables (legal vs. illegal syllables) is shown. The sonority-based difference in illegal onset clusters does not affect the listeners' reaction times.

5. Conclusion

The current study was designed in order to gain a greater insight into L2 phonotactics. Word-likeness judgments of onset clusters by Korean listeners at two different levels of L2 proficiency were examined. Native English listeners also participated in this study as a control group. The participants judged the acceptability of nonce words composed of three onset clusters as new English words – legal onsets (e.g., /prɒk/, /blɪf/), illegal onsets with a sonority rise (e.g., /pnɪg/, /fmɔk/), and illegal onsets with a sonority plateau (e.g., /pkɪg/, /fzɔk/).

The results obtained from the judgment scores revealed significant effects in terms of listener group and syllable type. All three listeners groups were able to distinguish between legal and illegal syllable structures. However, the judgment patterns of both native English listeners and native Korean listeners with higher proficiency were significantly different from those of native Korean listeners with lower proficiency. The native English listeners and native Korean listeners with higher proficiency preferred illegal syllables with a sonority rise to illegal syllables with a sonority plateau, even though English has neither type of onsets. Conversely, the native Korean listeners with lower proficiency did not reveal a preference between the two illegal syllable types, although they were able to discriminate between legal and illegal syllables.

The results for reaction times indicated a significant effect of syllable type. As sonority distance in onset clusters decreased, the listeners' responses tended to be faster. The listeners quickly rated illegal syllables with a small sonority rise or sonority plateau as bad candidates for English words. In contrast, when they were presented with legal syllables with a large sonority rise, their responses were slower. Furthermore, only a distinction between legal and illegal syllables was shown, as no distinction was found between illegal syllable types in terms of reaction times. It would seem that in the present study the results of the judgment scores were more fined-grained than those of the reaction times because the latter did not reveal any differences between the two illegal syllable types.

The present results cannot be explained only by the universal preference for greater sonority distance in onset clusters. Universal preferences related to the sonority principle and L2 proficiency interacted with each other in L2 judgments. If universal preferences had a strong effect on the listeners' judgments, all the listeners in the three groups would have differentiated the illegal syllables with a sonority rise from the illegal syllables with a sonority plateau. However, in the present study the Korean listeners with lower English proficiency were not able to discriminate between the illegal syllables with a sonority rise and the ones with a sonority plateau. Thus, the results suggest that L2 phonotactic knowledge expands as L2 proficiency increases and plays a more important role in the judgment of L2 nonce words than universal preferences related to the sonority principle.

Appendix. Stimuli used for the word-likeness judgment task

Legal syllables in English	Illegal syllables in English	
Large sonority rise	Small sonority rise	Sonority plateau
(pl/pr) plig [plɪg] prook [prʊk]	(pn/pm) pnig [pnɪg] pmook [pmʊk]	(pk/pt) pkig [pkɪg] ptook [ptʊk]
(tr) treg [trɛg] trook [trʊk]	(tn/tm) tnig [tnɪg] tmook [tmʊk]	(tk/tp) tkig [tkɪg] tpook [tpʊk]
(kl/kr) klib [klɪb] kloop [klʊp]	(kn/km) knib [knɪb] kmoop [kmʊp]	(kp/kt) kpib [kpɪb] ktoop [ktʊp]
(bl/br) blif [blɪf] broof [brʊf]	(bn/bm) bnif [bnɪf] bmoof [bmʊf]	(bd/bg) bdif [bdɪf] bgoof [bgʊf]
(dr) drif [drɪf] droof [drʊf]	(dn/dm) dnif [dnɪf] dmoof [dmʊf]	(db/dg) dbef [dbɛf] dgoof [dgʊf]
(gl/gr) glef [glɛf] groof [grʊf]	(gn/gm) gnif [gnɪf] gmoof [gmʊf]	(gb/gd) gbef [gbɛf] bdoof [bdʊf]
(fl/fr) flig [flɪg] frook [frʊk]	(fn/fm) fnig [fnɪg] fmook [fmʊk]	(fs/fz) fsig [fsɪg] fzook [fzʊk]

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