Gender Effect on /l/-darkening in American English

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ABSTRACT

American English lateral /l/ often become dark depending on their phonological conditions (Catford, 1977, 1992). When they appear in a word-final position, for instance, the lateral approximant /l/ are realized as being darker than the ones in the word-initial. The degree of darkness depends on various factors amongst which the regional (Ladefoged and Maddieson, 1996) and syntactic (Bermúdez-Otero, 2007) factors have been previously suggested. Sociophonetic factors of the variants that are possibly relevant to the degree of darkness, however, has been less explored. The current study is designed to examine the phonetic properties of /l/ with respect to one of the sociolinguistic factors in terms of gender effects. In order to investigate the gradient and dynamic properties of laterals in male and female speeches, both male and female speakers were requested to produce various types of English /l/. Laterals were placed in the form of CV₁(C)CV₂L words and both male and female speakers were asked to read the words. The experiment result showed that female speakers’ /l/ were significantly darker than those of males’, which suggests that the allophonic realization of female speakers is more likely to be close to the so-called ‘standard’ of the language group. (Hankyong National University)

Keywords: /l/-darkening, gender, F₂, Δ F₂-F₁, production

1. Introduction

Languages that have alveolar lateral /l/ as a phoneme in their sound inventories often have its velarized variant as an allophone (Jones, 1966; Moosüller et al. 2015). English is one of the languages in which lateral elements occur in allophonic distribution. Depending on its phonological environments, English lateral is either velarized or unvelarized and these two allophones are to be dark or clear, respectively (Catford, 1977, 1992; Huffman, 1997). The terminology referring the darkness of lateral sounds is based on the perspective of perceptual aspects. In other words, whether the two allophones are clear or dark depends on their auditory quality in the point of listeners; whereas, velarization implies considering...
phonological aspects in terms of speakers. Thus, /l/-darkening and velarization basically refer to the same phenomenon. This refers to the auditory percept of laterals while that captures the phonological realization. Articulatorily, laterals become velarized when the tongue dorsum is raised toward the velum. Acoustically, it involves low value of F2 or $\Delta F2-F1$ (i.e., the difference between the first and the second formants). And auditorily, the two low values lead to the perception of dark /l/.

Across languages, various laterals were acoustically examined in the previous literature. Some of Romance languages, Catalan (Recasens et al. 1995) and Italian (Marotta and Nocchi, 2003) and Arabic languages (Davis, 2008), for instance, were discussed and it was found that laterals vary in the degree of darkness. The studies have shown that the degree of darkness of laterals is heavily influenced by various phonological factors, which involve positions within a syllable and their neighboring vowels. Recasens and Farentani (1990) suggested the neighboring sound of the laterals severely influence on the realization of the target, lateral sounds, by showing that the lateral is darker after back vowel [u] but clearer after the front vowel [i]. The phonetic properties and the degree of darkness of English lateral also depends on other factors and morpho-syntactic environment has been considered as one of the typical ones. According to Bermúdez-Otero (2007), laterals in some dialects of English often velarized at the end of the word. These laterals, however, are not velarized when they are followed by vowel initial word. Bermúdez-Otero showed that, in Leeds, the lateral in the isolated word heal is acoustically dark [hil], while the same lateral is clear when the word is followed by vowel-initial word as in heal it [hil ɪt]. Both of these experimental findings show that the phonetic properties of being dark or clear deeply has to do with the phonological, morpho-syntactic environment in which where the laterals are placed.

While these two types of factors toward the degree of the darkness of laterals have been previously discussed, sociolinguistic factors on velarization have been largely ignored (Davis, 2008). To what extent velarization varies according to sociolinguistic factors such as gender and speech style has been unexplored. Notably, Royal (1985) showed that in Cairo Arabic heavy velarization is patterned for male speakers, which suggests that the darkness of laterals may have to do with gender. On the other hand, Mackenzie et al. (2015) explored the two sociolinguistic factors, gender and age, in another English dialect, Newfoundland English. They argued that the darkness of the lateral was associated with female speakers and no age difference was found. The reason why the gender difference in laterals rises among speakers has been unexplained.

In fact, study of gender-based varieties in language use is not new. The relationship between the linguistic realization and gender differences has been studied for a long time from sociolinguistic perspectives. Many of the research have examined the general linguistic features of female speakers and how theirs differ from males. Some of those features included female speakers’ frequent use of lexical hedges and tag questions (Lakoff, 1973). These linguistic features suggest that female speakers favor using expressions of uncertainty instead of strong expression of feeling. In addition, different phonetic and phonological realizations are found between male and female speakers. For instance, female speakers in Jordan are known to be more linguistically conservative than males in that they use less linguistic variables and in their pronunciation (Al-Harahsheh, 2014). They do not follow so-called the non-standard ways of pronunciation and the usage of vernacular forms are limited. Similar examples are found in French. Sankoff and Cedergren (1972) compared the percentage of /l/-deletion in Montreal French for male and female speakers. Regardless of where /l/ appears within a word, i.e., whether it is in word-initial, -medial or -final /l/, male speakers tend to delete the sound more
than female speakers. This tendency may be understood as the linguistic forms of female speakers are associated with
the standard ways of pronouncing words.

The present progressive marker -ing is another good example from English. Pronunciation of -ing was examined in a
New England Village and it was found that the marker was often pronounced as [-in] instead of [-ɪŋ] more in male
speakers’ speech than females’ while female speakers used [-ɪŋ] more frequently than male speakers (Finegan, 2015).
That is, preference for [-ɪŋ] pronunciation was higher in female than male speakers. This explains female speakers’
attitude to comply with the standard prestigious pronunciation (Trudgill, 1972). Similar phenomenon is found in
English intrusive /r/. Intrusive /r/ is known to be stigmatized in some non-rhotic varieties of English (Crystal, 1984;
Wells, 1982). Mompeán-Gonzalez and Mompeán-Guillamón (2009), for instance, examined the pronunciation of RP
speakers, and they found that female speakers use fewer intrusive /r/ than males. This difference between male and
female speakers in pronunciation suggests that female speakers tend to avoid using linguistic forms that are considered
as being less prestigious or non-standard.

The current study is in line with these previous ones. We examine how gender plays a role in determining specific
linguistic forms. Particularly, we investigate how male and female speakers differently plan their speech in terms of
phonetic/phonological realization. Focusing on a single variety of English, American English, we explore the role of
gender with specific reference to /l/-darkening. In this dialect, word-final /l/ typically becomes dark, known as
/l/-darkening, while word-initial /l/ remains clear (Yuan and Liberman, 2011). This phonetic property characterizes the
pronunciation of /l/ in American English, which, arguably, is accepted to be the standard way of pronouncing word-final
/l/. Thus, the following may be hypothesized: if female speakers are more likely to adopt a standard and/or prestige
way of linguistic representation and the dark /l/ is considered to be the standard from of lateral realizations in American
English, it may be that female speakers’ laterals would be darker than male speakers’. In terms of the realization of
laterals in American English, general linguistic conditions such as phonological and/or morphological environments
have been largely studied. Sociolinguistic aspects such as the gender difference, however, have been largely ignored. In
this production-based study, we examine the sociolinguistic factor in /l/-darkening in detail and present how the
linguistic property of /l/-darkening is connected to gender difference and understand how the degree of darkness is
determined in male and female speakers’ speech.

2. Design and Methodology

2.1 Participants

For the purpose of this study, we conducted a production experiment in which six native speakers of American
English were recruited for pay. The participants were recruited around the Seoul National University campus and the
number of speakers in each gender was evenly distributed (i.e., three males and three females). No one had a difficulty

1) Yuan and Liberman (2011) analyzed a large corpus data called ‘SCOTUS’ which “includes more than 50 years of oral arguments from
the Supreme Court of the United State” (Yuan and Liberman, 2011: 39) and showed that word-initial laterals are clear and word-final
ones are dark. Ladefoged & Johnson (2011: 69) also argues that most of word-final laterals are velarized in American English.
Word-final dark lateral seems to prevail among American English speakers. Along with being widely accepted as a general form, the
idea whether the word-final dark /l/ should be considered as ‘standard’ or not may need further study.
in speaking or listening.

2.2 Reading Materials

The reading materials included 40 words provided in Table 1. The words were either English real-words or non-words. Both types of words were considered due to the effect of lexicality toward the degree of /l/-darkening (Ahn, 2015). All the words were bisyllabic with the CV(C).CVL syllable structure. The coda of the first syllable was optional and that of the second syllable contained the lateral /l/. The syllable structure of the second syllable was always closed and heavy while that of the first one was mostly open and light, which naturally led the speakers to place the stress on the second syllable in their production. The vowels that precede each lateral were varied depending on the backness. Each word was placed in a carrier sentence, “Say ____ clearly”, so that natural speech was possibly collected. The order of the sentences was randomized and no information regarding the status or the condition of words was provided to the participants.

Table 1. The speech material of /l/ embedded words based on the backness of the preceding vowels

<table>
<thead>
<tr>
<th>Front</th>
<th>dofill</th>
<th>haseal</th>
<th>kasheal</th>
<th>poseal</th>
<th>sanill</th>
<th>appeal</th>
<th>reheel</th>
<th>repeat</th>
<th>resael</th>
<th>reveal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bogell</td>
<td>chasell</td>
<td>homell</td>
<td>marel</td>
<td>pidell</td>
<td>gazelle</td>
<td>hotel</td>
<td>impel</td>
<td>lapel</td>
<td>retell</td>
</tr>
<tr>
<td>Back</td>
<td>finule</td>
<td>kinool</td>
<td>masool</td>
<td>regoole</td>
<td>shedool</td>
<td>retool</td>
<td>befool</td>
<td>recool</td>
<td>cesspool</td>
<td>carpool</td>
</tr>
<tr>
<td></td>
<td>mirole</td>
<td>hemoul</td>
<td>boosole</td>
<td>marole</td>
<td>pagole</td>
<td>cajole</td>
<td>Nicole</td>
<td>dipole</td>
<td>charcoal</td>
<td>parole</td>
</tr>
</tbody>
</table>

2.3 Procedure

The participants were invited to the Phonetics Lab at the Seoul National University. They were asked to read the material and their reading was recorded. The data were collected using the software program Praat (Boersma and Weenink, 2017) and the cardioid microphone (ATR3035) at the sampling rate of 44,100 Hz. The participants read the whole reading material five times and all the procedure was conducted in the same manner.

After all the recording was completed, speech sounds were analyzed as follows. To begin with, using Praat, each target word containing the lateral was excerpted from the sentences. Then, segmentation was processed marking word-initial, word-final boundaries and individual speech sounds. After labeling each boundary, the section labelled as a lateral was sent to spectral analysis in which the three formants, F1, F2 and F3, were measured. In addition to the measurements of each formant, the difference between F2 and F1, Δ F2-F1, was calculated.

A long-established idea with regard to the understanding the value of Δ F2-F1 has been focused on at least the two following attributes: firstly, the three formant frequencies were considered as critical in determining the quality of vowels, which is because the frequencies correspond the height (or openness) and backness of vowels (Ladefoged, 2001). It is well known that (i) the oral constriction of the vocal tract lowers F1 and the pharyngeal constriction raises F1, and that (ii) the front constriction of the vocal tract raises F2 and back constriction lowers F2 (Johnson, 1997; Ladefoged and Johnson, 2011). Thus, high vowels are linked to low F1 and low ones to high F1. Similarly, front vowels are marked by high F2 and back ones by low F2. According to Seong (2004, 2005), however, the value of F2 is
associated not only to backness of the vowels but also to the roundness, and this association does not allow us to examine the exclusive correlation between F2 and backness. As an alternative strategy to inspect the degree of backness, the value of $\Delta F2-F1$ was adopted (Seong, 2004; Ladefoged and Johnson, 2011; Yun and Seong, 2013). Yun and Seong (2013) explained that the value of $\Delta F2-F1$ and backness is inversely correlated in the way that as the value increases the vowels become less back (i.e., more front). Seong (2004) showed the correlation between the value of $\Delta F2-F1$ and backness in a Korean vowel production study wherein the value of $\Delta F2-F1$ of /u/ was found to be lower than that of /o/, which suggests that Korean /u/ is produced in more front position than /o/ in some Korean speakers. Considering this finding, one attribute of $\Delta F2-F1$ is interpreted as an indicator for backness in describing the properties of vowels.

The other attribute of the value of $\Delta F2-F1$ has to do with the darkness of laterals. As described above, since the value of F1 is associated with openness of vocal tract while that of F2 is related to backness of articulators, the spectral properties of laterals, F1 and F2, become affected by the changes of the constricted area of the articulators. Articulatorily, clear /l/ requires the tongue tip raised towards the alveolar ridge while dark /l/ involves the front of the tongue pushed down (Narayanan and Alwan, 1997; Gick et al. 2006). When dark laterals are articulated, on the other hand, the tongue dorsum is raised toward velum which affects the size and the constricted area of vocal tract. In other words, as laterals become dark, the articulator – tongue – moves from front to back, which leads to the decrease of F2. Because of this reason, traditionally, the degree of darkness of laterals was explained by the values of F2. However, Browman and Goldstein (1995) found out that, in the articulation of laterals, the direction of tongue dorsum may not always be toward the velum. The tongue gesture often involves pharyngeal constriction approaching the upper pharynx, which may influence frontness of articulators. Considering the fact that pharyngeal constriction raises F1, the finding in Browman and Goldstein (1995) suggests that the articulation of dark /l/ involves not only F2 but also F1 value changes. Due to this reason, the two spectral measures, the distance between the two formants $\Delta F2-F1$, and F2 are often discussed when understanding the degree of darkness of laterals. In this study, we examine both values so that we understand how the two values possibly differ from each other and what each spectral measure implies with reference to the darkness of laterals.

In addition to comparing the two values of spectral analysis, it is important where these formant values are measured. The average formant values of the whole lateral duration are often suggested. In this method, the entire portion of the laterals is selected and the mean formant values from the lateral selection is obtained. Alternatively, Huffman (1997) measured F1 and F2 at the midpoint of laterals where the darkness may be best observed. Examining the lateral at various points is important to explore the detailed spectral properties of the lateral. We adopt the normalizing method in analyzing the formant values. By examining time-normalized trajectory of the entire length of the laterals, we present time-wise changes in the degree of darkness and examine the darkest point through the whole gesture of laterals, which enables us to compare the darkest points between male and female speakers.

Gender difference was applied to all the collected data before the statistical analysis. That is, male and female speakers have biologically different vocal tract length, which possibly influence the three formant values in that the longer the vocal tract is, the lower the formant frequencies are. In removing this unwanted gender effect, the method of gender normalization was adopted following Pickett (1980). According to Pickett, male speakers have about 15% longer vocal tract than females and this gender difference causes the increase of female speakers’ formant value. Due to
3. Results and Discussion

The results for the formant frequency values of American English speakers are summarized in Table 2, which lists the mean of the first two formant frequencies, F1 and F2, and ΔF2-F1 values produced by the six speakers according to the gender (male vs. female) and the preceding vowel contexts (lateral after front vs. back vowels).

As described in the table, the F1 values of male speakers’ laterals were generally higher than those of female speakers. Since the F1 values are associated to oral and pharyngeal constriction, it can be said that male speakers less constrict their oral cavity compared to female speakers and their pharyngeal area is more severely constricted than female speakers in their lateral production. Also, it was found that the F2 values were high in males’ than females’ speech. Concerning that front constriction are marked by high F2, female speakers’ speech is characterized back constriction of the vocal tract, which means that female speakers constrict their vocal tract by lifting up tongue body toward velum more severely than male speakers do. The two values of F1 and F2 formant frequencies suggest that female speakers’ speech is more intense and extreme than those of male speakers in that females generate more effort in causing oral constriction.

Table 2. Mean values of F1, F2 and ΔF2-F1 for American English lateral approximant /l/ by gender and the pre-lateral contexts (Data represent mean ±sd, n = 300)

<table>
<thead>
<tr>
<th>Gender (pre-lateral)</th>
<th>F1 (±sd)</th>
<th>F2 (±sd)</th>
<th>ΔF2-F1 (±sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (front)</td>
<td>455 (±82)</td>
<td>1151 (±246)</td>
<td>696 (±243)</td>
</tr>
<tr>
<td>Male (back)</td>
<td>396 (±47)</td>
<td>825 (±159)</td>
<td>429 (±150)</td>
</tr>
<tr>
<td>Female (front)</td>
<td>424 (±45)</td>
<td>1013 (±115)</td>
<td>590 (±115)</td>
</tr>
<tr>
<td>Female (back)</td>
<td>365 (±43)</td>
<td>788 (±85)</td>
<td>424 (±80)</td>
</tr>
</tbody>
</table>

In terms of backness of the preceding vowels, both F1 and F2 values were lower after back vowels than after front and this trend was found in both male and female speakers. Concerning that back vowels are marked with low F2, low F2 of laterals after back vowels may not be surprising. It should be noted, however, that not only F2 but also F1 are marked as low after back vowels. This finding coincides with previous studies arguing F2 alone may not be the indicator for /l/-darkening. The two values, F2 and ΔF2-F1 respectively, in Table 2 also compare how F2 alone could be different from ΔF2-F1 by providing the pooled F2 and ΔF2-F1 values in both gender. It represents that the F2 difference between male and female speakers is larger than ΔF2-F1, which implies that the gender difference decreases when F1 is incorporated. Because of this reason, it may be arguably said that although both F2 and ΔF2-F1 indicate the darkness of laterals, ΔF2-F1 could be a more strict indicator than F2 alone in terms of oral constriction in laterals.

In order to examine whether or not the values were significantly different, a statistical analysis was conducted. Incorporating the gender effect [Male vs. Female] and the possible influence of the preceding vowel contexts (i.e., backness [Front vs. Back]), two mixed Repeated Measures analyses of variance (RM ANOVA) were conducted for
each formant value of $F_2$ and $\Delta F_2-F_1$. As in Figure 1, both gender and backness were found to be significant main effect regarding $F_2$ values (Figure 1a) and $\Delta F_2-F_1$ values (Figure 1b). Figure 1a represents that $F_2$ values in back vowels were significantly lower than those after front vowels ($F[1, 4] = 151.083, p < .001$) and $F_2$ values of female speakers were significantly lower than those of male speakers ($F[1, 4] = 10.845, p < .001$). The similar statistical results were found in $\Delta F_2-F_1$ values. The difference between $F_2-F_1$ was significantly low after back vowels ($F[1, 4] = 271.696, p < .001$) and in female speakers’ speech ($F[1, 4] = 27.577, p < .001$).

As the two figures represent, the difference between male and female speakers were found in both $F_2$ and $\Delta F_2-F_1$. Compared to female speakers, male speakers’ $F_2$ and $\Delta F_2-F_1$ were higher, which implies that male speakers make less constriction on their vocal tract while articulating word-final laterals. Hence, female speakers’ word-final laterals are more constricted so that they are darker than male speakers’. This trend were found in both $F_2$ and $\Delta F_2-F_1$ values.

The constricted areas for back vowels and for dark /l/ do not differ much in that both require constriction on the back of the oral cavity. In both genders’ speech, dark /l/ is typically marked after back vowels, which already constrict the back of the oral cavity. This is not surprising since after back vowels articulators need to travel less compared to they do after front vowels due to coarticulation. After back vowels, males and females’ speech do not make significant difference. The difference is mostly found after front vowels.

Figure 2 visually represents time-wise trajectories of laterals, which tells us what $F_2$ and $\Delta F_2-F_1$ values imply regarding /l/-darkening. In the following figure, we plot the trajectories of /l/-darkening in which Figure (1a) shows the trajectories of $F_2$ values while Figure (1b) shows those of $\Delta F_2-F_1$. The X-axis shows time changes, which correspond to the onset to the offset of the lateral articulation, and the Y-axis represents the frequency of $F_2$ (Figure 2a) or the frequency difference of $F_2-F_1$ (Figure 2b). In Figure (2a), male and female speakers do not show difference in their lateral articulation after back vowels. The figure represents that mostly the difference between male and female speakers’ can be found in laterals after the front vowels. From the onset to the offset of the lateral articulation, male speakers’ $F_2$ values were consistently higher than those of females and the same frequency difference keeps throughout the whole lateral articulation. The gender difference is larger in Figure (2b). Regardless of the backness of the preceding vowels, male speakers’ $\Delta F_2-F_1$ values were larger than those of female speakers. Due to coarticulation, after back vowels, laterals were more velarized, thus, darker, which is found in both gender.
In both of the figures, the onset of laterals in female speakers’ speech is generally much lower than male speakers, and the difference continues to decrease as the lateral articulation proceeds. Male speakers fast reach to the dark point and continues the degree to the offset of the laterals while female speakers gradually approach to the point and ends laterals with less velarized. The darkest point in male speakers’ speech is placed between midpoint to the offset after front vowels and at the midpoint after back vowels. On the other hand, according to Figure (2a), the darkest point of female lies toward the offset after both front and back vowels and it is around the midpoint in Figure (2b). In addition to the degree of darkness, the slope became steep after front vowels while it gradually changes after back vowels, which indicates that the articulators for laterals were already set and so travel less right after those of back vowels are completed.

Based on the production experiment results of the current study, the gender difference between male and female speakers’ speech could be examined. It was found that generally female speakers’ laterals are darker than those of male speakers’. In the previous section, the two points were discussed: first, female speakers tend to be close to so-called ‘standard’ pronunciation, and second, word-final /l/-darkening prevails in American dialects including General American. In this sense, the experimental results can be understood in the way that females’ word-final laterals are darker than males since they believe /l/-darkening word-finally is closer to be standard.

4. Conclusion

Various sociolinguistic factors have been known to influence on speech production. The factors ranges from linguistic factors such as morpho-syntactic structure and lexicality to socioeconomic ones such as speaker groups (Labov, 1966), social class (Trudgill, 1974) and speech style (Sankoff and Cedergren, 1972) among many others. These previous works have noted that some of allophonic variations are considered more prestigious than others. Less sound deletions, for instance, are found in those prestigious variations and the allophonic variation is more frequent in casual male speech.

Among previously suggested various sociolinguistic factors, in the current work, we examined the gender effect on the lateral darkening and compared how male speakers’ laterals are acoustically different from those of female
speakers’. Through the production experiment, it was found that female speakers’ F2 and $\Delta$ F2-F1 were significantly lower than those of males and the difference was consistently found in all contexts regardless of the backness of the preceding vowels. The low values of F2 and $\Delta$ F2-F1 were interpreted as indicating dark lateral approximants and, thus, it was suggested that female speakers make their word-final laterals darker than males do. The small number of participants obviously one of limitations of the current study and a larger scale study needs to follow for the study to be more persuasive.

In the line of several previous studies in which one of the main characteristics of female speakers’ speech lies on their ‘standard’ pronunciation, the experimental results can be understood as follows: female speakers produce their word-final laterals darker so that their pronunciation sounds more standard. Concerning that dark laterals involve the gesture of additional tongue dorsum retraction toward velum, female speakers more severely constrict their oral cavity. This severe constriction requires female speakers to make more efforts in arranging their articulators, which allows their speech more distinctive (Kent and Read, 1992). Whether or not speech style is associated with /l/-darkening has been unclear and more research needs to be done on this topic. However, female speakers’ deliberate speech style allows us to conjecture that clear speech is associated with dark laterals.

References


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