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The effect of word frequency on the reduction of English CVCC syllables in spontaneous speech

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ABSTRACT

The current study investigated CVCC syllables in spontaneous American English speech to find out whether such syllables are produced as phonological units with a string of segments, showing a hierarchical structure. Transcribed data from the Buckeye Speech Corpus was used for the analysis in this study. The result of the current study showed that the constituents within a CVCC syllable as a phonological unit may have phonetic variations (namely, the final coda may undergo deletion). First, voiceless alveolar stops were the most frequently deleted when they occurred as the second final coda consonants of a CVCC syllable; this deletion may be an intermediate process on the way from the abstract form CVCC (with the rime VCC) to the actual pronunciation CVC (with the rime VC), a production strategy employed by some individual speakers. Second, in the internal structure of the rime, the proportion of deletion of the final coda consonant depended on the frequency of the word rather than on the position of postvocalic consonants on the sonority hierarchy. Finally, the segment following the consonant cluster proved to have an effect on the reduction of that cluster; more precisely, the following contrast was observed between obstruents and non-obstruents, reflecting the effect of sonority: when the segment following the consonant cluster was an obstruent, the proportion of deletion of the final coda consonant was increased. Among these results, the effect of word frequency played a critical role for promoting the deletion of the second coda consonant for clusters in CVCC syllables in spontaneous speech. The current study implies that the structure of syllables as phonological units can vary depending on individual speakers' lexical representation.

Keywords: English CVCC syllables, reduction, word frequency, consonant clusters, spontaneous speech

1. Introduction

The purpose of the current study was to establish whether the reduction of coda consonant clusters in the CVCC structure occurs in spontaneous American English speech. More specifically, I investigated the reduction on the internal structure of the rime in the CVCC structure. Previous research (Fudge, 1969, 1987; Goldsmith 1990; Selkirk, 1982), has argued that the possibility for a structural division within an English syllable is higher for between the onset and the nucleus than between the nucleus and the coda. Moreover, initial consonant clusters exhibit a stronger tendency in English to be treated as units than final consonant clusters (Treiman, 1983). With respect to the structure of the typical CVC English syllable, while some researchers have argued for a division between CV and C, most of the phonological literature reports that the division is between C and VC (Fudge, 1969, 1987; Goldsmith, 1990; Selkirk, 1982). As psycholinguistic research, Treiman and Danis (1988) have shown that there are statistical reasons for combinations of segments such as the combination of the vowel and final consonant for a CVC, the initial consonant clusters of a CCV, and within a VCC, the combination of a vowel and liquid. These previous studies are consistent with the view that English syllables are divided into an onset and a rime.

Given the division into the onset and rime argued for in the previous literature, the current study focused on the English

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CVCC syllable to examine whether the internal structure of its rime affects the reduction of coda consonant clusters. While the rime (i.e., VC) in a CVC syllable has been treated as being more cohesive than the body (i.e., CV), it is not clear for a CVCC syllable whether the rime (i.e., VCC) is a cohesive psychological unit. Halle and Vergnaud (1980) postulated that the nucleus (i.e., peak) is obligatory in the rime, but the coda (e.g., a final consonant or consonant cluster) is optional. Treiman (1983) reported that English speakers did not tend to treat the coda of a CVCC syllable as a cohesive unit. Nevertheless, results of Treiman’s (1983) study were inconclusive regarding the psychological unit of the coda, suggesting that the division between the VC and C was no more difficult than the division between the V and CC. The internal structure of the rime is less clear than the division between the onset and rime (Treiman, 1983).

It is a possibility that the internal structure of the rime relies on the makeup of its segments (MacKay, 1978; Stemberger, 1983; Treiman, 1986). MacKay (1978) and Stemberger (1983) argued, based on an examination of speech error patterns, that post-vocalic /r/ and /l/, unlike other consonants, are not the syllable coda, but part of the syllable nucleus. Treiman (1984) also found, using a word game task that requires that subjects make a division between postvocalic liquid and the final consonant or a division between the vowel and the liquid, that English speakers preferred to make a division between the postvocalic liquid and the final consonant. With respect to postvocalic nasals, Treiman (1984) suggested that there was no difference for the division between the V and CC and division between the VC and C. However, Treiman (1984) showed that postvocalic obstruents were combined less closely with the vowel nucleus than with the second final consonant. In other words, Treiman’s (1984) study conducted the word games that subjects were asked to create one new syllable from two syllables when the part of the first syllable is followed by part of the second syllable (e.g.,/arz/+/ʌld/ → /arld/). From these word games, English speakers tended to have more natural divisions between the V and CC than between the VC and C when postvocalic obstruents were employed. Based on the result of Treiman’s (1984) study, the conclusion suggests itself that obstruents may less often behave as a unit with the vowel nucleus than liquids do. Therefore, Treiman (1984) proposed that nasals may be an intermediate status based on the actual pronunciation for the hierarchical internal structure of the rime, reflecting the difference among postvocalic consonants. This proposal for the effect of postvocalic consonants is related to evidence for a sonority hierarchy (Hooper, 1976; Kiparsky, 1979; Vennemann, 1972).

Regarding the effect of the sonority hierarchy for the reduction of coda consonant clusters in the CVCC syllable structure, the previous literature has investigated the preceding context effect as the internal condition of the rime and the following context effect as an external condition. Interestingly, the reduction in coda consonant clusters appeared to be a pattern associated with coronal stops. According to Guy’s (1991, 1994) studies, the rate of coronal stop deletion was 39.2% when the preceding segment was an obstruent, 35.1% when it was a nasal, and 18.2% when it was a liquid. Regarding the effect of the following context, the rate of coronal stop deletion was 48.6% when the following context consisted of consonants, 15% when it consisted of vowels, and 27.8% when the stop was in the phrase-final position. Furthermore, Labov (1989) provided a hierarchy that showed which consonant classes trigger deletion of a following coronal stop, and the hierarchy is as follows: /s/ > stops > nasals > other fricatives > liquids. Similarly, with respect to the preceding consonant, the deletion rate was higher when more features were shared between the consonants in the coda cluster (Coetzee & Pater, 2011; Guy & Boberg, 1997).

In addition, morphological conditioning is regarded as a factor accounting for the deletion rate among monomorphemic words, irregular past tense forms, and regular past tense forms. Guy (1991, 1994) showed that the rate of coronal stop deletion is 38.1% in monomorphemic words (e.g., *mist, pact, west*), 33.9% in irregular past tense forms (e.g., *left, told, lost*), and 16% in regular past tense forms (e.g., *missed, packed, tolled*). From this point of view, coronal stop deletion was predominant in the pattern of reduction of coda consonant clusters. This deletion pattern has been found to be quite general, occurring in many different English dialects (Cetzee & Pater, 2011). That is, the deletion rate for monomorphemic words is higher than that for irregular past tense forms, and that for irregular past tense forms is higher than that for regular past tense forms (Coetzee & Pater, 2011; Guy, 1994; Labov, 2004).

Another factor to induce the deletion of word-final coronal stops in some words is their very high frequency (Bybee, 2000; Coetzee & Pater, 2011; Patrick, 1992). Coetzee and Pater (2011) showed that, based on the data in the Buckeye Corpus, the deletion rate for the coronal stop in the word *friend* was 81% in the pre-consonantal context, but the deletion rate in the word, *list*, was 56%. Within a CVCC syllable, there may be a positive relation between the reduction rate in the internal structure of the rime and lexical frequency, although there are some words that do not follow of general tendency.

So far, I have discussed several factors that induce reduction patterns in word-final coda consonant clusters, such as phonological context, morphological conditioning, and lexical frequency. I will now turn to the question whether extralinguistic variables such as age and gender influence the reduction of syllabic constituents. Raymond et al. (2006) reported that in onset positions, younger speakers deleted word-internal alveolar stops more often than older speakers did; however, there was no such difference in coda positions. Previous studies also observed gender differences (Neu, 1980; Wolfram, 1969), showing that word-final deletion occurred more for men than for women. Based on these results, the current study, additionally, needed to examine whether there are extralinguistic differences promoting reduction patterns in CVCC syllables.

The goal of the current study was to investigate the reduction of coda consonant clusters within the CVCC syllable structure in spontaneous American English speech. It addressed three research questions. First, what factors affect the deletion rates of different consonant types? Second, are there any phonological or lexical constraints on inducing the reduction of coda clusters in the internal structure of the rime? Finally, what is the effect of the following context on the reduction of coda clusters? The goal of these research questions was to investigate the reduction pattern of the coda of the English CVCC syllable in more detail; the data used to answer them came from the Buckeye Speech Corpus.

2. Experimental Method

2.1 Participants

For this research, twelve speakers were chosen from the Buckeye Speech Corpus (Pitt et al., 2007). The participants, who are natives of Columbus, Ohio, were stratified as young and old for age (i.e., under or over forty) (for more details, see Kiesling et al., 2006). Six of the chosen speakers were female (three under forty and three older than forty), and six were male (three under forty and three older than forty).

2.2 Speech Materials

The data used in the current study consisted of a transcribed subset selected from the Buckeye Speech Corpus (Pitt et al., 2007). The Buckeye Speech Corpus consists of the spontaneous speech of forty individual speaker interviews in terms of a sociolinguistic-style method. The Buckeye Speech Corpus provides two types of transcription: an orthographic transcription (i.e., the canonical, citation-form pronunciation) and time-aligned phonetic transcription for both the word and phone level. For the current study, I extracted all consonant - vowel - consonant - consonant (CVCC) content words from the speech of the twelve subjects; of these content words, 771 were transcribed as containing final consonant deletion. For example, Figure 1 is cited from the corpus to show the word-final consonant deletion in the target word with the CVCC structure, *just*. The tiers of words and phones were shown using Praat (Boersma & Weenink, 2012). The second tier, the phones, was transcribed to represent the actual pronunciation corresponding to the words. The reader can see that in the phone tier, the voiceless alveolar stop (i.e., [t]) was deleted in the target word, *just*, as shown in Figure 1. The reason for this deletion is clearly seen from the waveform and the spectrogram displayed: neither the waveform nor the spectrogram contain any evidence of the word-final coda consonant (i.e., [t]).

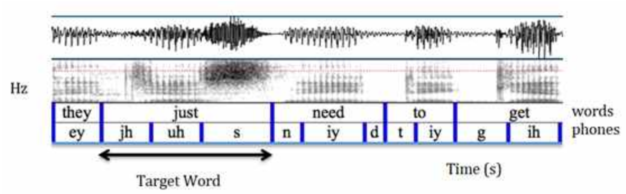

Figure 1. Consonant cluster reduction (i.e., final consonant deletion) in the word *just*, extracted from the Buckeye Speech Corpus. In the target word, *just*, the voiceless alveolar stop (i.e., [t]) was deleted.

Before proceeding to the analysis, it is worth noting that labeling consistency in the Buckeye Speech Corpus (Pitt et al., 2007) is high: the overall percentage of transcriber agreements is 80.3%. The percentage of transcriber agreements was the highest in the labeling of stops and fricatives. That is, stops were labeled consistently 92.9% of the time, and fricatives were labeled consistently 91.2% of the time. Transcriber agreements when labeling nasals and liquids were decreased slightly. Nasals were labeled consistently 87.5% of the time, and liquids were labeled consistently 86.5% of the time. Vowels showed less transcribing agreement, labeled consistently only 69% of the time. The labeling convention relative to deletion in the Buckeye Speech Corpus states that a segment is deleted when it cannot be heard or seen in the spectrogram. For the purpose of the current study, it means that the transcriber agreements were appropriate to investigate whether reduction of the internal structure of the rime occurs in CVCC syllables.

2.3 Data Analysis

For the analysis of the rate of deletion of the final consonant in CVCC syllables, linear regression models were employed. First, a mixed-effects linear regression analysis was conducted. The fixed-effects predictors were consonant types that underwent deletion, age and gender of the speaker, and manner of articulation of the preceding and following phones; the random-effects predictor was participants. Second, as the extension of linear regression models, multiple regression was run in order to observe the details of the consonant types deleted relative to the relation between the internal structure of the rime and the effect of word frequency, and the following phone. Multiple regression is computed as in (1). Y is the outcome variable, and b_1 and b_2 are the coefficients of predictors (X_1 and X_2). That is, the nth predictor (X_{ni}) has the coefficient b_n. b_0 is the intercept that tells us about the location in geometric space. The difference between the predicted and the observed value of the outcome variable (Y) is i. εi is the error term that captures all other factors influencing the dependent variable.

(1) $Y_i = (b_0 + b_1X_{1i} + b_2X_{2i} + \cdots + b_nX_{ni}) + \varepsilon_i$

3. Results

3.1 Consonant Types Deleted

In the current study, when it comes to the proportion of deletion in consonant clusters in the CVCC structure, the second coda deletion within the rime was much more frequent than the coda cluster deletion. As shown in Figure 2, the proportion of the second coda deletion within the rime is 0.97 and the deletion of the coda cluster is 0.025. Participants in the current study did not have any difficulty separating a VCC into a VC and C, compared to the division between a V and CC.

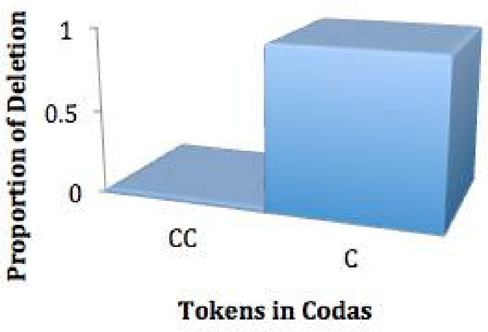

Figure 2. Proportion of coda deletion in VC/C and V/CC blends

On the basis of the proportion of the second coda deletion within the rime, deletion of three consonant types was observed: voiced and voiceless alveolar stops and voiceless velar stops. The proportion of deletion for voiceless alveolar stops is 0.063, for voiced alveolar stops, it is 0.016, and for voiceless velar stops, it is 0.002, as shown in Figure 3. The deletion of voiceless alveolar stops was more frequent (β = 0.047, t = 4.654, $p < 0.001$) than that of voiced alveolar stops. However, the difference in the proportion of deletion between voiced alveolar stops and voiceless velar stops was not significant (β = -0.013, t = -1.380, p = 0.1768). The R-squared for the three variables relative to consonant types deleted is 54%. The variance of 54% can be explained in terms of the proportion of the second coda deletion for the rime, VCC.

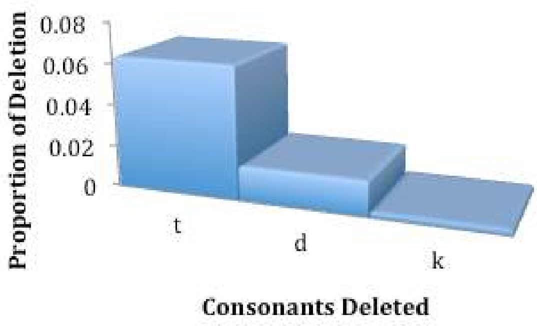

Figure 3. Coda consonant types underwent the second coda deletion within the rime

3.1.1 Morphological structure

In the current study, the CVCC structure is represented by monomorphemic words such as *just, kind* and irregular past tense forms like *went, told*. The regular past tense forms were excepted because previous literature (e.g., Guy, 1994) has established that the deletion rate in these forms is the lowest. To find out whether morphological constraints play a role for promoting deletion, monomorphemic words and irregular past tense forms were analyzed, but there was no significant difference between them (β = -0.012, t = -0.380, p = 0.706). R-squared for the monomorphemic words and irregular past tense forms is 0.33%. For the data collected in the current study, there was little variance related to morphological structure.

3.1.2 Extra-linguistic variables: age and gender

In the current study, age and gender did not predict deletion for the word-final consonant within the rime of the CVCC structure. The female speakers did not show a significant difference from the male speakers (β = 0.007, t = 0.593, p = 0.556). Furthermore, unlike the previous studies, the difference between the young and old speakers was not statistically significant (β = 0.011, t = 986, p = 0.331). R-squared for the gender difference is 1%, and it is 2% for the age difference. The variance for age and gender confirmed that there was no difference between the female and male speakers and between the young and old speakers.

3.1.3 Individual speaker differences

Individual speakers were different when promoting deletion for the word-final consonant in the CVCC structure. According to the mixed-effects linear regression model, random effects for participants showed different intercept values. The highest intercept is 0.013596773 and the lowest one is -0.005573612. Table 1 shows the intercept values for random effects relative to individual speaker differences.

Table 1. The values of intercept for random effects

Participants	Intercept
1	0.005928619
2	-0.005573612
3	-0.004011581
4	-0.003159563
5	0.002662554
6	0.013596773
7	0.001952539
8	0.001242525
9	-0.001455529
10	-0.004011581
11	-0.004437589
12	-0.002733555

3.2 The Internal Structure of the Rime

3.2.1 Preceding context: vowels

When predicting the reduction of word-final consonant clusters, the classification of preceding vowels can be considered. In the current study, the preceding vowels were classified into monophthong vowels and diphthong vowels. The mean proportion of deletion when the preceding vowels were monophthongs is 0.42, and the one when the preceding vowels are diphthongs is 0.57. Statistically, however, the effect of these vowel types did not contribute to promoting deletion in CVCC syllables (β = -0.020, t = -0.884, p = 0.382).

3.2.2 Preceding context: consonants

In this section, I discuss the results concerning the effect of preceding consonants on the proportion of deletion. That is, I analyze the manner of articulation of postvocalic consonants. Figure 4 shows the proportion of deletion for different preceding phones where the second coda consonant within the rime was deleted. When the preceding phone was a fricative, the proportion of deletion increased to 0.055. The proportion of deletion for nasals is 0.023; for liquids, it is 0.002; and for stops, it is 0.001. The proportion of deletion for fricatives and nasals significantly differed (β = -0.032, t = -3.789, p < 0.001). The difference between the proportion of deletion for fricatives and liquids was also significant (β = -0.053, t = -6.279, p < 0.001); fricatives and stops also showed a significant difference (β = -0.054, t = -6.388, p < 0.001). R-squared for the proportion of deletion related to the preceding phone is 55%. Fricatives as preceding phones were a lot more frequent when it comes to the deletion of the second coda consonant in the division of the rime. Considering the predominance of fricatives, it is not clear whether these deletion patterns for preceding phones are related to the sonority effect reflecting the internal structure of the rime, as discussed in the previous literature.

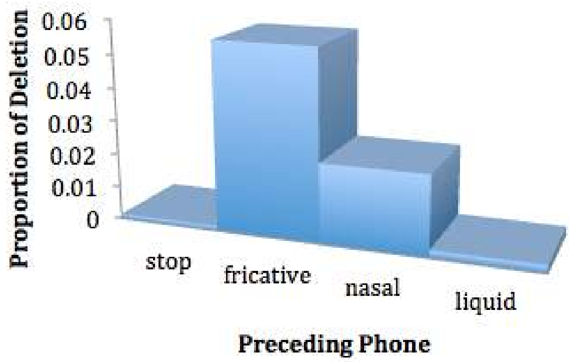

Figure 4. Preceding phone in the VC/C blends

3.2.3 The effect of word frequency

The proportion of deletion corresponding to the frequency of word tokens was analyzed as a critical factor. The frequency of each word made a significant difference for the proportion of deletion (β = -0.010, t = -14.61, p < 0.001). More specifically, given the frequency of words as shown in Table 2, the proportion of deletion for the word *just*, which occurred the most frequently among the words collected, is 0.509. The second most frequent one is the word *kind*, and the proportion of deletion for it is 0.119. In the word *just*, the phone preceding the final deleted consonant [t] is the fricative [s]; in the word *kind*, the phone preceding the final deleted consonant [d] is the nasal [n]. Given the proportion of deletion for each word shown in Table 2, it was not clear, for the CVCC structure, that the proportion of deletion relative to the preceding phone was due to a sonority effect. In other words, the proportion of the second coda consonant deletion associated with the internal structure of the rime may be influenced by the frequency of the word, rather than by the effect of sonority of the preceding segment.

Table 2. Proportion of deletion for word-final consonants

Words	Proportion	Words	Proportion
just	**0.5091**	felt	0.0039
kind	**0.1191**	list	0.0039
want	0.0575	lost	0.0039
went	0.0431	past	0.0039
most	0.0366	rest	0.0039
think	0.0301	beast	0.0026
last	0.0209	child	0.0026
best	0.0196	hard	0.0026
find	0.0157	sound	0.0026
test	0.0117	build	0.0013
told	0.0104	desk	0.0013
found	0.0091	dusk	0.0013
point	0.0091	heart	0.0013
send	0.0091	hind	0.0013
fact	0.0078	hold	0.0013
hand	0.0065	hunt	0.0013
kept	0.0065	part	0.0013
left	0.0065	pent	0.0013
mind	0.0065	pound	0.0013
land	0.0052	round	0.0013
least	0.0052	shift	0.0013
tend	0.0052	sort	0.0013

3.3 The Effect of the Following Context

In this subsection, I discuss the effect of following context that was observed in the study and conclude that there is a possibility that the sonority of this context has some effect on the deletion of the final coda consonant. The segment following the target word can be either a consonant or a vowel. In addition, the Buckeye Speech Corpus labeled non-speech sounds such as <LAUGH>, <NOISE>, <VOCNOISE>, and <SIL>. As indicated in Figure 5, when the following phone is a consonant, it was labeled C, and when the following phone is a vowel, it was labeled V. Next, when a non-speech sound followed, the # symbol was used as the label. The proportion of deletion when the following context was C is 0.048; when the following context was V, it is 0.023; and when the following context was #, it is 0.011. The proportion of deletion was thus higher when the following context was C than when it was V or #, although this difference among the following contexts was not statistically significant.

However, in itself, the result that the difference in proportions of deletion between C, V, and # contexts was not statistically significant is not enough to conclude that the following phone has no role in promoting the deletion of the second coda consonant, or that there is no effect of sonority. In Figure 6, the proportion of deletion is 0.034 for stops, 0.027 for fricatives, 0.0009 for affricates, 0.009 for nasals, 0.006 for liquids, and 0.004 for glides. Given these proportions of deletion for each manner of articulation, the reader can see that they are more or less consistent with the effect of the sonority hierarchy, though the proportion for affricates is left out. Moreover, multiple regression showed that the proportion of deletion for stops and affricates (β = 0.033, t = 7.228, p < 0.001) and for fricatives and affricates (β = 0.026, t = 5.734, p < 0.001) showed a significant difference. On the other hand, the proportions of deletion for nasals (β = 0.008, t = 1.898, p = 0.0621), liquids (β = 0.005, t = 1.292, p = 0.2008), and glides (β = 0.003, t = 0.727, p = 0.4699) were not statistically different.

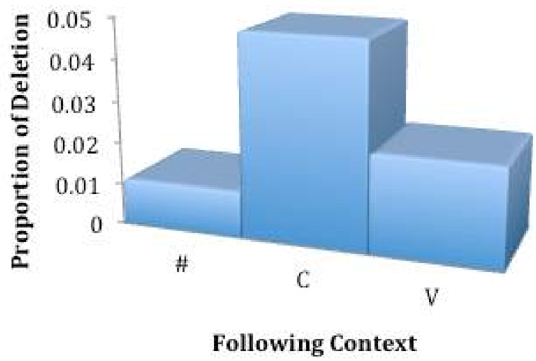

Figure 5. The proportion of deletion relative to the following context

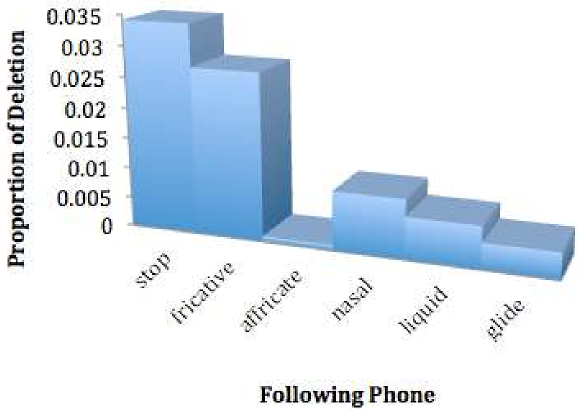

Figure 6. The proportion of deletion relative to the following phone

4. Discussion

The current study investigated the reduction of coda consonant clusters in English CVCC syllables. The transcribed data the current study analyzed was taken from the Buckeye Speech Corpus. The findings of the current study are as follows. First, in the CVCC structure, coda consonant clusters underwent deletion of the second coda consonant. With respect to the consonant types deleted, voiceless alveolar stops were predominant in promoting deletion compared to other consonants, with some speakers using final consonant deletion more than others. Second, the current study have found a factor internal to the structure of the rime that does not influence deletion and a factor that is external to the structure of the rime that influences deletion. That is, word frequency influenced deletion but the sonority effect of postvocalic consonants did not. Finally, for the following contexts, there was a possibility that the less sonorous the following phone, the more the proportion of deletion increased, as also mentioned in the previous literature. These findings have the implication that, in CVCC syllables, the reduction of coda consonant clusters is affected by lexical properties such as word frequency. I discuss this possibility in some more detail in the following sections.

4.1 Proportion of Deletion Relative to Consonant Types

Regarding CVCC syllables in spontaneous American English speech, the current study showed that, within the rime, the division between VC and C is more typical than that between V and CC, showing that the proportion of the second coda deletion is 0.97. The phonetic forms of word-final coda consonants that underwent deletion were voiceless and voiced alveolar stops and voiceless velar stops. The factors that promote the deletion of the second coda consonant were shown to not be associated statistically with morphological structure, age, and gender. However, the proportion of deletion for the second coda consonant was different among the individual speakers who participated in the current study. Syllables have hierarchical structures (with onsets and rimes, which have nuclei and coda) and predict pronunciation for CVCC syllables (i.e., what pronunciations would be well-formed). The current study explains how this prediction comes about. For instance, the second coda deletion as a voiceless alveolar stop in a CVCC syllable may exist as one of reduction types derived from actual phonetic forms for consisting of a syllable. Some phoneticians have mentioned that the syllable does not exist as a phonological unit but is rather a result of timing processes. (Browman & Goldstein, 1990; MacKay, 1972). Moreover, Bybee (2001) argued for a gradual reducing process between articulatory gestures leading to the deletion of alveolar stops. To sum up, the deletion of the second coda consonant in CVCC syllables can be one phonetic form in the process of reduction for consisting of the part of a syllable, which is referred as the rime. The various phonetic forms in the reduction process for producing CVCC syllables may be an intermediate process to accounting for the pronunciation, which would be well-formed. The current study focused on the deletion of the second coda consonant in CVCC syllables, but the other phonetic forms that can be produced for consisting of CVCC syllables needs to be investigated in the future research.

4.2 The Internal Structure of the Rime

The rime of a CVCC syllable is composed of a vowel that is the peak and two consonants that play the role of coda. The effect of vowel type (i.e., monophthong vs. diphthong vowels) was not significant in the current study. However, postvocalic consonants, most notably fricatives, seem to influence the deletion of the second coda: voiceless alveolar fricatives induced a high proportion of deletion, especially where the rime-final consonant was a voiceless alveolar stop. It is important to note, however, that this high rate of deletion was also associated with word frequency, making the role of the postvocalic consonant in promoting deletion less clear. For example, the word *just* was the most frequent in this study and had the highest proportion of deletion, 0.5091. Nasals were the second most influential postvocalic consonants in promoting the deletion of the rime-final consonant. The deletion rate for nasals was also associated with the frequency of words. The proportion of deletion for the word *kind* was 0.1191, though the consonant deleted was a voiced alveolar stop. On the other hand, liquids and stops had much lower proportions of deletion than fricatives and nasals; the proportion of deletion for fricatives significantly differed from those of nasals, liquids, and stops. Previous literature (Coetzee & Pater, 2011; Guy, 1991, 1994; Guy & Boberg, 1997) suggested a sort of hierarchy relative to the sonority effect for the deletion of word-final consonants such as coronal stops, but the current study did not find clear evidence of the effect of sonority for postvocalic consonants influencing the deletion of rime-final consonants. Rather, word frequency in spontaneous speech was a critical factor for promoting deletion in CVCC syllables. The current study is consistent with the previous literature (Bybee, 2000; Coetzee & Pater, 2011; Patrick, 1992) in that words with very high frequency, such as *just*, induced the deletion of word-final voiceless alveolar stops. I thus conclude that the rate of deletion of the second coda consonant in CVCC syllables in spontaneous speech is higher in more frequent words than in not so frequent words.

4.3 The Effect of the Following Context

The previous literature (Guy, 1991, 1994; Labov, 1989) proposed that the context following the CVCC syllable also plays a role in the deletion of the rime-final consonant. Nevertheless, in the current study, the following context did not play a role in including a high proportion of deletion. That is, although the proportion of deletion was the highest when the following context consisted of consonants, the results of the current study did not show a statistical difference among various following contexts, such as consonants, vowels, and non-speech sounds.

However, there was a difference in terms of the manner of articulation of the following phones for promoting the proportion of deletion. When the following phones were stops, the proportion of deletion for the second coda consonant in the rime, VCC, was more increased than when the following phones were fricatives. When the following phones were fricatives, the deletion of the second coda showed higher proportions compared to affricates, nasals, liquids, and glides. When the following consonants were obstruents (except for affricates), the second coda in a CVCC syllable showed a tendency to be deleted. On the other hand, when the following context consisted of sonorant consonants, such as nasals, liquids, and glides, the proportions of deletion were much lower than with obstruents. In this respect, one can argue that sonority is a factor inducing the deletion of the second coda consonant in a CVCC syllable. In the current study, obstruents including stops and fricatives showed a different distribution for the proportion of deletion compared to non-obstruents, which are closer to vowels. However, according to Guy's (1994) study, when the final consonant is a voiceless alveolar stop, which is often deleted, a following liquid like /l/ can induce the deletion because /tl/ as onsets are prohibited in English, although the sequence of /tr/ in English is possible (e.g., *just like* vs. *just right*). Hence, the result of the current study lends some support to the generalization that the sonority of the following phones plays a role in promoting the deletion of the rime-final consonant; however, it remains to be determined in future studies whether phonotactic constraints associated with resyllabification of the rime-final consonants in CVCC syllables with the following consonants are involved, not just the sonority hierarchy.

5. Conclusion

A major finding of this study is that the highest proportion of deletion of the rime-final consonant in the English CVCC syllable is associated with the word *just*, which has the highest frequency in the data. This fact makes the hypothesis that such deletion is promoted by word frequency more compelling than the proposals involving the effect of sonority, which was argued for in the previous literature. In addition, with respect to the reduction of coda consonant clusters, the current study is involved with the existence of substantial phonetic forms for consisting of a phonological unit as a CVCC syllable. That is, the most frequent deletion of voiceless alveolar stops in the second coda consonant in CVCC syllables may be part of the articulatory process of forming syllabic constituents in spontaneous speech. As the paper stands currently, intermediate stages and lexicalized CVC versions of CVCC syllables are not discussed sufficiently in the body of the current paper. Hence, I remain questions and discussions of limitations of the current study for further research.

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