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L2 Production of English Onset sC and CC Clusters

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Abstract

This study examines the production of onset sC clusters and CC clusters by L2 English learners whose L1s do not have onset clusters. Specifically, the study researches the role that sonority distance plays in L2 learners' modification strategies. Results show that L2 English learners treat sC clusters differently from CC clusters. Sonority distance does not correlate with correct production of CC clusters; however, sonority distance is negatively correlated with correct production of sC clusters. Following a proposal by Kaye (1992), the study assumes that the /s/ in an sC sequence is outside the onset. Consequently, sequences such as [st] are more harmonic than sequences such as [sw], in terms of syllable contact. The results of this study show the same pattern – [st] is likely to be produced correctly, while [sw] is likely to be modified using internal vowel epenthesis.

Accounting for the errant behavior of onset sC clusters is a common phonological problem (Barlow, 2001; Gierut, 1999 *inter alia*). Studying L2 production of sC and CC clusters can give insight into how adult speakers acquire the two differently. Several studies in L2 phonology indicate that onset clusters with a large sonority distance are less marked and acquired earlier than onset clusters with a small (or negative) sonority distance (Broselow & Finer, 1991; Eckman & Iverson, 1993). Among sC clusters, this means that [st] is more marked than [sn], which is more marked than [sl] (Carlisle, 2006; Cardoso & Liakin, 2009). Many of the previous L2 studies that examine the treatment of sC clusters study speakers of languages such as Spanish and Brazilian Portuguese, which have onset clusters, but not sC clusters (Cardoso & Liakin, 2009; Carlisle, 2006; Yavaş & Someillan, 2005). This paper examines L2 English learners whose L1s do not have any onset clusters, to determine the effect of markedness in terms of sonority distance on production of sC clusters and CC clusters.

The current study compares the effect of sonority distance on onset sC clusters and CC clusters. Participants are 8 L2 English learners (L1 Mandarin Chinese, Cantonese, Japanese). Results show that for sC clusters, sonority distance is negatively correlated with correct production. For example, [st] is likely to be produced correctly, while [sw] is likely to be modified using internal epenthesis. For CC clusters, sonority distance is not correlated with correct production, meaning that CC clusters of all sonority distances result in approximately the same production.

Participants who do not have onset clusters in their L1 treat sC clusters differently from CC clusters. sC cluster results show the opposite pattern of that predicted by sonority distance. To account for the data, I consider /s/ to be the coda of a previous syllable (Kaye, 1994; Goad, 2012; Pan & Snyder, 2004) and appeal to the Syllable Contact Law (Murray & Venneman, 1983). The SCL states that the greater the sonority drop between coda and following onset, the more harmonic the relationship. The data from this study exhibit a pattern that follows the predictions of the Syllable Contact Law. The most harmonic relationships (Gouskova, 2004), such as s-stop, are likely to be produced correctly; less harmonic relationships, such as [sw], are likely to be modified using internal epenthesis. The Syllable Contact Law is not relevant for the production of CC clusters, because CC clusters are treated as true branching onsets, whereas sC clusters are treated as coda-onset sequences (Goad, 2012).

LITERATURE REVIEW

Sonority Distance in L2 Production

Because some sC clusters, such as s-stop, violate the Sonority Sequencing Principle (Clements 1992), research into the L2 production of sC clusters often focuses on sonority. Broselow and Finer (1991) studied the production of onset clusters by Korean, Japanese, and Hindi speakers of

L2 English. Their data suggest that L2 speakers attend to the Minimal Sonority Distance (MSD) parameter; specifically, that speakers abide by a MSD that is somewhere between that of the L1 and the target language. Eckman and Iverson (1993) re-examine Broselow and Finer's data, suggesting instead that the results are due to sonority distance alone, or what they term "typological markedness" (p.240), rather than MSD. In both studies, sonority distance informs L2 cluster production.

Both Carlisle (2006) and Cardoso and Liakin (2009) applied the study of sonority distance specifically to sC clusters. Carlisle (2006) examined the relative markedness of st >> sn >> sl in the production of 17 native Spanish speakers learning English. He found that clusters with a large sonority distance, like [sl], are produced correctly more often than clusters that are more marked in terms of sonority distance, like [st]. Cardoso and Liakin (2009) examined the relative impacts of markedness and frequency on the accuracy rates of onset sC cluster production. Specifically, they examined markedness in terms of sonority distance. Their data, which come from Brazilian Portuguese L2 English learners, indicate that markedness is a much stronger predictor than frequency. These data corroborate Carlisle's findings, and suggest that onset clusters with a larger sonority distance between C1 and C2 are acquired earlier than onset clusters with a small (or negative) sonority distance.

Yavaş & Someillan (2005) studied Spanish-English bilingual children, specifically looking for a way to group sC clusters. Based on their production data, they conclude that [st] and [sn] are more marked than [sl] and [sw]. They appeal to the continuance of C2 in their discussion of the results, rather than sonority, but the results do suggest that sonority distance informs production of sC clusters.

Before moving forward, it is necessary to say a few words about the sonority scale used in this study. Although definitions of sonority vary, the function of sonority within a syllable is widely acknowledged. Versions of the sonority scale vary as well. Following Yavaş and Someillan (2005), this study references the ten-point sonority scale proposed by Hogg and McCully (1987). The sonority scale, with sonority indexes, is produced in Table 1.

Table 1. Hogg and McCully Sonority Scale

Sounds	Sonority Index
Low vowels	10
Mid vowels	9
High vowels	8
Flaps	7
Laterals	6
Nasals	5
Voiced fricatives	4
Voiceless fricatives	3
Voiced stops	2
Voiceless stops	1

Another commonly referenced sonority scale is the five-point sonority scale proposed by Clements (1990). This scale ranks the sounds as follows: obstruent < nasal < liquid < glide < vowel. Because this scale combines stops and fricatives into the category 'obstruent', this scale results in s-stop clusters being classified as sonority plateaus rather than sonority reversals. The ten-point sonority scale allows for a more precise examination of the role that sonority plays in the production of onset sC clusters.

Structural Representations of sC Clusters

Researchers have suggested a variety of explanations as to how sC clusters differ in structure from other clusters. Some consider sC clusters to be complex segments, like affricates (Broselow, 1992; Yildiz, 2005). Some view sC clusters as structurally similar to any other clusters, and look to phonotactics to explain the errant behavior of sC clusters (Gouskova, 2001). Still others view the initial /s/ as an adjunct or appendix or coda, rather than as part of a true branching onset (Barlow, 2001; Goad & Rose 2004; Goad, 2011; Goad, 2012; Kaye, 1994; Pan & Snyder, 2004).

Broselow (1992) studied Iraqi Arabic and Egyptian Arabic learners of English, looking at production data. Her data indicate that speakers are more likely to modify a cluster by inserting a vowel before the cluster, termed prothesis, when the cluster exhibits a drop in sonority, like s-stop clusters. For example, when producing the loan word 'school', speakers insert a vowel before the cluster, resulting in [ɪskul]. By contrast, internal epenthesis is the preferred modification strategy for clusters exhibiting a rise in sonority. When producing the loan word 'fruit', speakers insert a vowel between the two segments of the onset, resulting in [fɪrut].

Broselow suggests that this is an indication that s-stop clusters are complex segments that can't be broken up by epenthesis.

Yildiz (2005) studied sC cluster production by both L1 and L2 learners. Her L1 data suggests that children view sC clusters as special. Some children repair onset sC clusters by deleting the entire cluster, resulting in a marked structure that has no onset. Deletion of the entire onset is rare in child production, and only found with sC clusters in her data. Yildiz also examined L2 data in the form of Turkish loan word production. Like Broselow's findings, her data also show that sC clusters are likely to be modified using prothesis. However, she also found evidence of rising sonority onset clusters, such as [sl], being modified by prothesis. Based on this, Yildiz suggests that sC clusters are complex segments.

Gouskova (2001) studied the production of Russian loan words with onset sC clusters by Kirgiz speakers. Like Broselow, she found that onset clusters that rise in sonority are modified using epenthesis, whereas onset clusters that fall in sonority, namely s-stop clusters, are modified using prothesis. She suggests that this is not, as Broselow and Yildiz propose, due to the fact that s-stop clusters are complex segments, but rather that this tendency is a result of the Syllable Contact Law. The Syllable Contact Law (Murray & Vennemann, 1983) indicates that syllables prefer a fall in sonority across syllable boundaries. Gouskova found evidence of clusters other than s-stop clusters that fall in sonority in the onset, and considers this to be an indication that s-stop clusters do not have a different structure than other clusters.

Some researchers propose a more distant relationship between /s/ and C than in a binary branching onset. Barlow (2001) suggests that that /s/ is an adjunct that is a direct dependent of the syllable. Goad and Rose (2004) argue that /s/ connects not at the syllable node, but at the higher prosodic word level. Most relevant to the current study is the line of research (Kaye, 1994; Pan and Snyder, 2004; Goad, 2012) that suggests yet a more distant relationship between /s/ and C, arguing that /s/ is in fact the coda of a previous syllable, and C is the onset. Kaye (1994) proposes a model in which the coda /s/ is governed by an empty nucleus of a previous syllable. Goad (2012) identifies some phonotactic predictions that this model makes regarding relative harmony of sC sequences. She suggests that if /s/ is part of the onset, then sonority predicts that clusters with a larger sonority distance are more harmonic than clusters with a smaller sonority distance. If /s/ is represented as an adjunct or appendix, then the role of sonority does not make any predictions about the cluster. However, if /s/ is the coda of a previous syllable, then syllable contact makes the opposite prediction of sonority: sC sequences that exhibit a drop in sonority, such as s-stop sequences, are more harmonic than those that exhibit a rise in sonority, such as s-liquid sequences. A branching onset is depicted in Figure 1, and a representation of /s/ as the coda of a previous syllable is depicted in Figure 2.

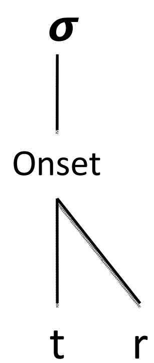

Figure 1. Branching Onset

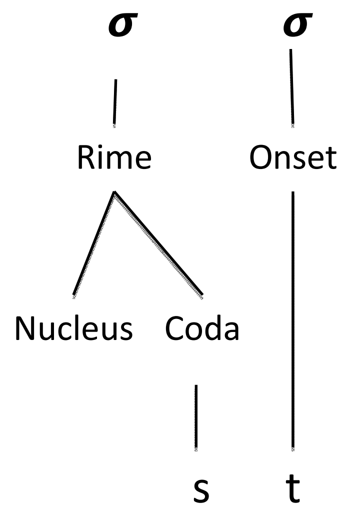

Figure 2. Coda-Onset Pair

Structural accounts of sC clusters vary because data come from a variety of sources – L1 acquisition, L2 acquisition of various L1 backgrounds, and loan word production. However, they are generally (although not exclusively) understood to be structurally different from CC clusters. This distinction will be probed further in the current study.

THE CURRENT STUDY

Previous studies examining sC clusters (Carlisle, 2006; Cardoso & Liakin, 2009; Yavaş & Someillan, 2005) look at L1s that have onset clusters, but do not have sC in onset position, such as Spanish and Brazilian Portuguese. The current study examines L2 English learners who are native speakers of Mandarin Chinese, Japanese, and Cantonese – all of which are languages that do not have any onset clusters – to determine the effect of sonority distance on the production of onset sC and CC clusters.

Procedure

Participants read from a word list that included 83 test items, all CCVC, and 37 filler items, all CVCC. The sonority distance between C1 and C2 of the onset clusters ranged from -2 to 7. The word list contained between 3 and 9 tokens of each sonority distance, and included items such as “twin” (SD 7), “star” (SD -2), and “fresh” (SD 3). Words were read individually, not in a carrier phrase. Test items and filler items were arranged so that no two tokens of the same cluster type occurred back to back. Each word was displayed as a slide in a self-paced PowerPoint presentation. Participants were recorded using a Marantz PMD670 recorder and microphone in a quiet room.

Participants

8 participants (5 male) were recruited through the English Language Institute at the researcher’s university. All participants are L2 English speakers and enrolled in an intermediate level ESL program at the University. 6 are native speakers of Mandarin Chinese, 1 is a native speaker of Japanese, and 1 is a native speaker of Cantonese. All of these are languages that do not have onset clusters. The age of English onset ranges from 10-16, with a mean of 12. All participants began learning English academically overseas. Length of residence in the United States ranges from 6 months to 13 years, with a mean of 3.2 years. The three participants who have lived in the United States for more than a year all report speaking their native language along with English at work and with friends.

Coding

All test items were analyzed in Audacity (http://audacity.sourceforge.net). The onset cluster productions were coded as correct or incorrect. Incorrect productions were categorized as vowel epenthesis or “other”, with notes indicating the type of error classified as “other”. The focus of the study is the production of onset clusters; therefore, the correct or incorrect production of the vowel and coda were not considered in coding the data.

RESULTS

The study elicited 664 tokens of onset clusters, 466 of which were produced correctly (70%). The most common modification strategy is internal vowel epenthesis. There are 131 occurrences of vowel epenthesis, accounting for 66% of errors and 20% of all productions. For example, one participant produced "swim" as s[ə]wim. Deletion of C2 is rare; there are only 2 occurrences in the data. There are no instances of C1 deletion. Unlike some other sC cluster studies, these participants produced no tokens of prothesis. For example, the word "swim" was never produced as [ə]swim in these data. The remaining nontarget-like productions are substitutions (51 instances). For example, one participant produced the word "swim" as "slim". Results indicate no difference in production between L1 groups.

CC Clusters

Proportions were normalized by arcsine transformation for the statistical analyses. Correct production values are reported as untransformed proportions for descriptive purposes. A correlation returns a Pearson R which indicates that among CC clusters, there is no correlation between sonority distance and correct production ($r(40) = -.176$, $p = .278$). Mean production by sonority distance is illustrated in Figure 3. 77% of sonority distance 7 tokens are correctly produced, 25% of SD 6 tokens are correctly produced, 77% of SD 5 tokens are correctly produced, 80% of SD 4 tokens are correctly produced, and 68% of SD 3 tokens are correctly produced. Sonority distance 7 includes clusters such as [tw] as in "twin", SD 6 includes clusters such as [dw] as in "dwell", SD 5 includes clusters such as [pl] as in "please", SD 4 includes clusters such as [bl] as in "black", and SD 3 includes clusters such as [fɹ] as in "freeze".

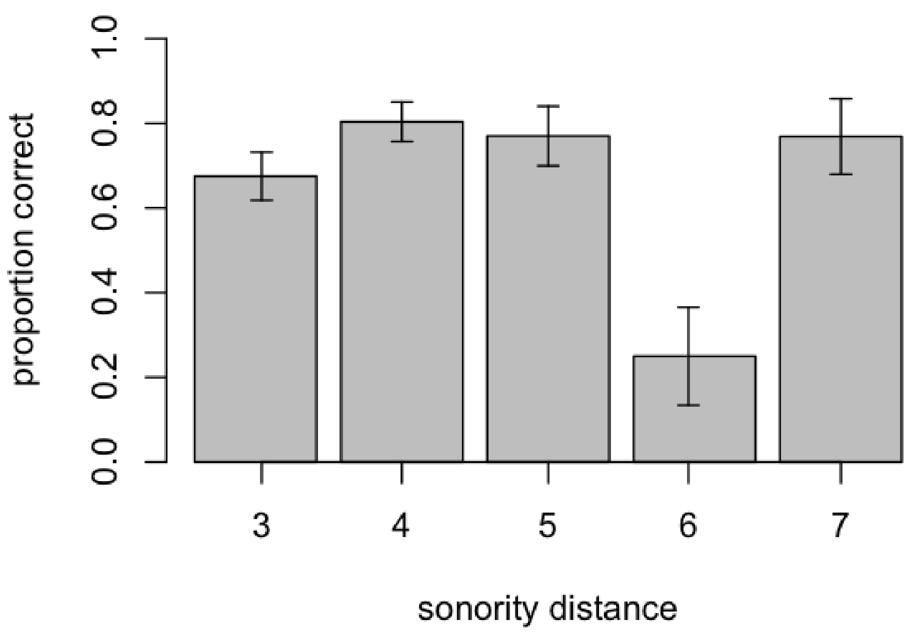

Figure 3. Accuracy of CC production by sonority distance. Error bars represent standard error.

With the exception of SD 6, which I will address in more detail in the Discussion section, the production of onset CC clusters is consistent across sonority distances.

sC clusters

Results indicate that participants treat sC clusters differently from CC clusters. Results show the opposite pattern from that predicted by sonority distance. Sonority distance predicts that st >> sn >> sl >> sw. The results here show the opposite: sw >> sl >> sn >> st. Descriptive results indicate that sC clusters with a smaller sonority distance are produced correctly more often than sC clusters with a larger sonority distance. 86% of s-stop tokens are produced correctly, 79% of s-nasal tokens are produced correctly, 60% of [sl] tokens are produced correctly, and 43% of [sw] tokens are produced correctly. This means, for example, that participants are more likely to correctly produce "star" than "swim".

Among sC clusters, sonority distance is negatively correlated with correct production at alpha level $p < .05$, ($r(32) = -.511$, $p = .003$). As sonority distance increases, correct production decreases. Figure 4 shows mean correct production by sonority distance.

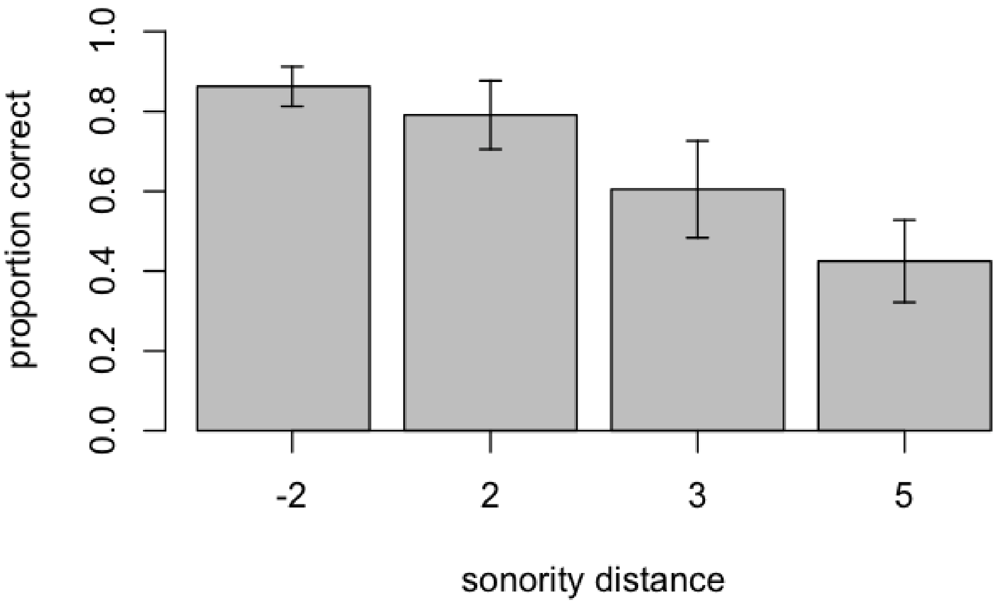

Figure 4. Accuracy of sC production by sonority distance. Error bars represent standard error.

DISCUSSION

The object of the study is to identify the influence of sonority distance on the L2 production of onset sC clusters and CC clusters. Results indicate that sonority distance negatively correlates with correct production in sC clusters, meaning that clusters with a larger sonority distance are produced correctly *less* often than clusters with a smaller (or negative) sonority distance. This is the opposite of what is expected based on sonority distance alone. Sonority distance does not correlate with correct production in CC clusters.

Syllable Contact Law

As Goad (2012) argues, if the /s/ in an initial sC sequence is not part of the onset, then syllable contact rather than sonority distance will determine relative harmony. Under the analysis in which /s/ is outside the onset, we can appeal to the Syllable Contact Law to account for the results. The Syllable Contact Law states that the greater the sonority drop between coda and following onset, the more harmonic the relationship (Murray & Venneman, 1983). If we consider sC to be a coda-onset pair, then among these participants, the most harmonic relationships are likely to be produced correctly, while less harmonic relationships are likely to be modified using internal epenthesis. For example, [st] exhibits a sonority drop, and participants produce [st] correctly 86% of the time. By contrast, [sw] exhibits a steep sonority rise, and is correctly produced only 43% of the time.

Gouskova (2004) proposes a harmonic alignment scale that combines the sonority scale with the Syllable Contact Law's preference for a sonority drop between coda and onset. While I have modified this a bit to reflect the sonority scale used in this study, the relationships between the sounds remain the same.

DIST+5 (sw) >> DIST+3 (sl) >> DIST+2 (s-nasal) >> DIST-2(s-stop)

The results of onset sC production among participants in the current study mirror this harmonic alignment scale. The fact that a large positive sonority distance seems to be more marked than a negative sonority distance indicates that it is an effect of syllable contact and not an effect of sonority distance. This suggests that sC sequences are coda-onset pairs rather than binary branching clusters.

Syllable Contact in the L1 Grammars

The experimental design used in the current study controls for onset clusters in the L1, but not for syllable contact parameters in the L1. It is important then to consider whether L1 syllable contact information can account for the results. In Mandarin Chinese (Duanmu, 2000; Duanmu, 2006), [n] and [ŋ] can occur in coda position. Among other things, [l] and [r] can occur in onset position. Duanmu (2000) argues that the Chinese [r] is most accurately described as an approximant (p.26). Given these possibilities, the least harmonic coda-onset pair that is possible in Mandarin Chinese is sonority distance 3. In Japanese (Vance, 1987), nasals can occur in coda position. In onset position, among other things, [j] and [w] can occur. Like Mandarin Chinese, this means that the least harmonic coda-onset relationship possible is SD 3. Cantonese (Matthews and Yip 2011) allows stops (among other things) to occur in coda position, and the approximants [w] and [j] (among other things) to occur in onset position. This results in the least harmonic pair possible being SD 7.

Based solely on syllable contact in the L1, one would predict that speakers of Chinese and Japanese would treat s-stop and s-nasal sequences the same way, and [sl] and [sw] the same way. By contrast, one would predict that Cantonese speakers would treat all sC sequences the same way. However, neither of these predictions plays out in the data. The data show a steady decrease in correct production as the relationship between the two sounds in an sC sequence becomes less harmonic. This suggests that the production pattern is not simply a result of L1 transfer. Instead, participants seem to show linguistic knowledge of the phonotactics explicated by the Syllable Contact Law. Syllable contact does not impact production of CC clusters, because they are treated as true branching onsets.

Variability in Production

The production of [sl] is highly variable, with two participants producing all tokens of [sl] correctly, and two participants producing only 17% of tokens correctly. Participants largely modified [sl] using internal vowel epenthesis, using the same modification strategy that occurs with other sequences. It is possible that participants' difficulty with [sl] is because of [l]; however, participants do not show particular difficulty with [l] in other sequences. The high percentage of epenthesis that occurs with [sl] is not apparent in other clusters involving [l], such as [pl] and [kl]. Additionally, only 4 occurrences of substitution involve changing [l], and there is only 1 occurrence in the data of deleting [l]. A possible account for this variability is the fact that [sl] violates the OCP for place of articulation. Generally, homorganic segments are disallowed in English onset cluster; [sl] is the exception. This may result in the variable production exhibited by these L2 speakers.

Apart from SD 6, participants produce CC clusters of all sonority distances correctly to approximately the same degree. Production of SD 6 is quite variable, with three participants producing no correct tokens, and one participant producing all tokens correctly. In English, the onset clusters with a sonority distance of 6 are [dw] and [gw]. These onset clusters are rare in English, and consequently likely to be rare in the input. There are few tokens in the data, and the tokens that are included are infrequent (Google Ngram)[1]. To see if the low production of SD 6 is influencing the results, the statistics were run again without these tokens. Even without the tokens of SD 6, though, sonority results ($r(32) = 0.126$, $p = .49$) are not significant.

There are, of course, some limitations to the study. The current experiment does not control for input frequency. Cardoso and Liakin (2009) found that [st] occurs in L2 English learner input far more

[1] The frequency of each word in the task was checked, post hoc, using Google Ngram. Frequency was assessed over the last 50 years. When there was a large change in frequency across that time, the most recent frequency was recorded.

frequently than [sn] or [sl]. The current study includes these clusters, but also many other clusters. While input frequency can potentially account for L2 production patterns, further research is necessary to determine whether frequency alone can account for the current results. It is also important to note that the number of participants in this study, N = 8, is small, and that participants come from three different L1 backgrounds. While all the L1s used in this study are languages that do not have onsets, there are potentially other indirect behaviors that could impact acquisition.

CONCLUSION

The purpose of the current study was to examine the role that sonority plays in the production of initial CC and sC sequences among L2 English learners. Results suggest that L2 learners from L1s that do not have onset clusters treat initial CC sequences like branching onsets, and initial sC sequences like coda-onset pairs. The correct production of sC sequences decreases as sonority distance increases, contrary to the prediction that sonority distance makes for onset cluster production. This suggests that the production is informed by syllable contact, rather than sonority distance. Assuming that sC sequences are coda initial, then the Syllable Contact Law accounts for the negative correlation between sonority distance and correct production that is demonstrated by the data.

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