The role of input frequency, universals, and L1 transfer in the acquisition of English L2 onsets by native speakers of Cantonese, Mandarin Chinese, and Vietnamese

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Introduction:

This chapter focuses on universal and language-specific patterns in the acquisition of English second language (L2) onsets by native speakers of three Asian languages: Mandarin Chinese, Cantonese, and Vietnamese. In specific, the purpose of this chapter is to examine whether the acquisition orders found for the English onsets /sl sn st/ for native speakers of these three languages as well as the modifications found in the production of the onsets can be best explained by input frequency of the onsets, universal constraints, or L1 transfer. In terms of the former, the chapter examines whether the frequency of a particular form in the input affects acquisition orders. The chapter also examines whether linguistic universals, which are innate and devoid of influence from the input, provide a better explanation for the acquisition orders found in the data. As the L2 research to date that has examined input frequency vs. markedness, has not examined the role of L1 transfer, although it has been found to have a prominent role in the acquisition of L2 phonology, the current study will also examine the role of the participants' native language in comparison with the role of input frequency and markedness in the acquisition and production of these onsets.

Background to the study:

The primary objective of this chapter is to examine whether language-universal constraints, input frequency, or L1 transfer provides a better explanation for the acquisition sequences found for English onsets produced by native speakers of Cantonese, Mandarin Chinese, and Vietnamese. The role of L1 transfer and markedness on the L2 acquisition of all domains of phonology has been supported by a significant number of studies (cf. Eckman, 2008; Major, 2008), with a consensus among researchers that both of these factors, particularly L1 transfer in the early stages and markedness in later stages of acquisition, are major constraints on the development of an L2 sound system. In contrast, very little is known about the role of input frequency on L2 phonological acquisition although it has been found to play a significant role in acquisition orders for child L1 phonology (cf. Zamuner, Gerken, & Hammond, 2004, 2005; Zamuner, this volume) as well as an important constraint in the acquisition of other domains of SLA (cf. Ellis & Ferreira-Junior, 2009). In specific, in the area of child L1 acquisition, research on input frequency typically examines the role of the Universal Grammar Hypothesis (UGH), versus the Language-Specific Grammar Hypothesis (LSGH) on the acquisition sequences of L1 sounds. As Zamuner, Gerken, and Hammond (2005) note:

> In the domain of phonology, the UGH predicts that children should initially produce those sound patterns that are unmarked or frequent across languages before those patterns that are marked or infrequent. The SLGH predicts that children should initially produce the most frequently occurring sound patterns in their ambient language before producing the less frequent ones … . (p. 1406)

Research (cf. Zamuner, Gerken, Hammond, 2004, 2005, and Zamuner, this volume) has provided substantive evidence that input frequency of sound structures can override universal

constraints in the acquisition of L1 sound structures. It is therefore important to investigate the role of input frequency in the acquisition of L2 sound structures.

To date, only a few studies have examined the effect of input frequency on L2 phonological acquisition, in particular in contrast to universal constraints such as markedness. L2 researchers who examine input frequency:

> ...hold that language users are sensitive to the frequency of lexical items in linguistic input and that language acquisition involves the learning of phonological, morphological, semantic, and other regularities from input. With respect to L2 phonology, the logic here is that certain aspects of speech (e.g., speech sounds, stress patterns, intonation contours) are easier to learn when they occur within and across a variety of recurrent familiar lexical items. The more frequently L2 learners experience a given phonological pattern in the input, especially across a range of lexical items, the more accurately they will perceive and produce this pattern. (Trofimovich, Collins, Cardoso, White, and Horst, 2012, p. 176-177)

The findings on the role of input frequency on L2 phonological acquisition are limited for a number of reasons: One, there have only been a few studies on the effect of input frequency on L2 phonological acquisition to date; second, the findings from these studies have been mixed. An study by Flege, Takagi, and Mann (1996) which did not specifically focus on input frequency nevertheless found that frequency may have an impact as the L2 learners in their study had a higher accuracy in identifying sounds in more frequently used words than sounds in less frequently used words. In research on the acquisition of voiceless versus voiced obstruent codas, Broselow and Xu (2004) found that frequency itself of the L2 structure did not have an impact on acquisition but that the L2 structures that were 'perceived' to be more frequent by the learners

were produced with more accuracy. This study implies that learners themselves are active agents in perceiving which structures are more frequent, and possibly more important for acquisition, and that this perception can override actual input frequency rankings. Finally, a study by Cardoso (2008) that examined the effects of input frequency versus markedness on the acquisition of /sl sn st/ onsets found that markedness, which would predict a /sl/ > /sn/ > /st/ accuracy order, provided a better explanation for his findings. Therefore, it appears that the findings for the effect of input frequency in L2 phonology are not as clear-cut as those for child L1 phonology, which may not be surprising given that more factors, extraneous and internal, impact L2 than L1 acquisition.

Previous research on /sC/ onsets:

As the focus of the current study is the acquisition of /sC/ onsets, the findings from previous studies that have focused on those onsets will be reviewed briefly. There has been a great deal of research on the acquisition of /sC/ onsets and in particular the acquisition orders of onsets such as /sl sn st/. One reason for interest in these onsets is that they can be studied in a markedness relationship based on sonority. The sonority sequencing principle (SSP) (Selkirk, 1984) states that optimal, and thus less marked, onsets are those that increase in sonority from the margin into the nucleus (usually a vowel) of the syllable. Both /l/ and /n/ are considered to be sonorous while /t/ is not; in addition, /l/ is considered to be more sonorous than /n/. Therefore, on a sonority scale, the onset preference would be for /sl/ > /sn/ > /st/, with the /st/ onset violating the SSP as stops are less sonorous than fricatives and therefore there is a decrease rather than increase in sonority for this onset. Researchers have been interested in examining to

what extent sonority plays a role in acquisition orders for these onsets, as the SSP would predict the follow acquisition order based on sonority rankings: /sl/ > /sn/ > /st/.

The majority of the L2 research on these onsets has focused on learners of L2 English whose L1 is Spanish or Brazilian Portuguese as neither Spanish nor Portuguese permit /sC(C)/ sequences though they do have some complex onsets. Additionally, both these languages have the initial sequence *esC(C)* (Abrahamsson, 1999), which provides researchers with a good opportunity to examine not only the effect of markedness on the acquisition of these structures in terms of length (e.g., /sC/ is shorter and thus less marked than /sCC/ and would be hypothesized to be acquired earlier) but also the effect of linguistic environment in promoting vowel epenthesis, which is likely to occur as a transfer from the L1. In particular, for Brazilian Portuguese L1 speakers of English, it could be predicted that epenthesis would be more likely to occur in /st/ over /sl sn/ clusters as it only occurs in a voiceless obstruent cluster and in Portuguese, /sl sn/ are voiced clusters (Rebello & Baptista, 2006).

A series of studies on Spanish L1 speakers production of English L2 /sC/ and /sCC/ onsets by Carlisle (1988, 1991, 1992, 1997, 2006; see also Carlisle & Cutillas Espinosa, this volume) found that the /sC/ onsets had higher accuracy ratings than the longer, and more marked /sCC/ onsets, and that epenthesis occurred significantly more often after a consonant (before the onset) than after a vowel (and before the onset). Carlisle also found that the more sonorous, and thus less marked, /sl/ was more accurate than /st/, and that the more sonorous /sl/ was produced more accurately than either /sn/ or /sm/. Markedness in terms of sonority thus provided the best explanation for the patterns found in Carlisle's studies. Abrahamsson (1999) examined the production of /sC(C)/ onsets by L1 speakers of Spanish who were learning Swedish as an L2. Like English, Swedish also allows /sC(C)/ onsets. Abrahamsson found the following sequence

of modification, and therefore level of accuracy, was from least modified, and thus most accurate: /s/ plus nasal > /s/ stop > /s/ plus /l/. In other words, /sl/ was modified the most, followed by /s/ plus stop sequences, while /sn/ and /sm/ were modified the least. This accuracy hierarchy could only partially be explained by sonority. Rebello and Baptista (2006) examined the acquisition of English /sC(C)/ clusters by native speakers of Brazilian Portuguese and found that error rates were higher for /sn/ > /sl/ > /st/ onsets, resulting in the accuracy hierarchy, from most to least, of /st/ > /sl/ > /sn/, which only provides partial support for the SSP but could be explained by markedness in terms of voicing, as /st/ as a voiceless cluster could be argued to be less marked than either the heterogeneously voiced /sl/ or /sn/ cluster. Rauber (2006) examined the production of these English onsets by both L1 speakers of Argentine Spanish and Brazilian Portuguese. Rauber found that both groups modified the /st/ onset more often than either the /sl/ or /sn/ onset although this was only significant for the Argentine Spanish speakers. Both groups also had more modification for the /sn/ over the /sl/ cluster, although this was not significant for either group.

A series of studies by Cardoso and colleagues (Cardoso, 2008; Cardoso, John, & French, 2008; Cardoso & Liakin, 2009), focusing on production and perception of these clusters also with Brazilian Portuguese L1 learners of English L2, examined the role of input frequency versus sonority in the production of these onsets. In both production studies (Cardoso, 2008; Cardoso & Liakin, 2009), the researchers found that accuracy orders followed a sonority pattern of /sl/ > /sn/ > /st/, rather than input frequency, which would have predicted an accuracy order of /st/ > /sn/ > /sl/. This is similar to the majority of the findings from the previous studies discussed above. Interestingly, however, in the perception study (Cardoso, John, & French, 2008), the researchers found that input frequency best explained the accuracy orders, as the most

accurately identified onset was /st/, followed by /sn/, with /sl/ the least accurately identified onset. This finding provides evidence that the constraints governing perception and production may differ, and that even though participants may be able to correctly perceive /st/ onsets, sonority constraints may override frequency effects when it comes to production. Finally, Enochson (2013) focused on the acquisition of the English L2 onsets /sl sn st/ by L1 Japanese, Cantonese, and Mandarin Chinese speakers, and also found that sonority did not explain her participants' accuracy orders of /st/ > /sn/ > /sl/, which did not vary across the three L1 groups. Enochson's findings indicate that the L1 of the participants may be an important factor and to some extent, that language-specific constraints such as L1 transfer may override language-universal constraints such as sonority. This deserves more investigation.

In summary, the majority of the L2 studies to date have found that sonority provides the best explanation for the acquisition orders found in their studies, typically /sl/ > /sn/ > /st/. However, these findings may only be relevant to the domain of production as Cardoso, John, and French (2008) found that input frequency, and not sonority, may be a more powerful constraint on learners' abilities to perceive the three onsets. Finally, the findings on /sC/ onsets in L2 research also comes from a relatively homogenous population of learners as the L1 of the participants has been either Brazilian Portuguese or Spanish, and the L2 typically English, and in one case Swedish. Conflicting findings comes from Enochson (2013), which examines the acquisition of English L2 onsets by speakers of three different Asian languages: Japanese, Cantonese, and Mandarin Chinese. Enochson's findings demonstrate the need to examine the acquisition of these onsets by learners from various L1s as the role of sonority in the acquisition of these onsets may not be a universal constraint but may be governed by the L1, to some extent. This needs further exploration.

The Current Study:

The study examines the acquisition of English /sl sn st/ onsets by native speakers of Mandarin Chinese, Vietnamese, and Cantonese, and the role of input frequency, markedness, and L1 transfer in the acquisition of these onsets. Similar previous research (cf. Cardoso, 2008), this study adopts the following markedness hierarchy, from least to most marked, based on sonority as nasals are less sonorous than liquids and stops are less sonorous than either liquids or nasals: /sl > /sn/ > /st/. In terms of input frequency, a number of previous investigations, including Cardoso's (2008) analysis of teacher talk, an L2 textbook analysis, and a corpus analysis, has found that /st/ onsets occur more frequently than either /sl/ or /sn/ onsets, and that /sl/ onsets are more frequent than /sn/ onsets, with the following frequency hierarchy found, from most to least frequent: /st/ > /sl/ > /sn/. As this ordering was consistent across the teacher talk analysis, an L2 textbook analysis, as well as a analysis of both a spoken (ALERT Corpus) and a written corpus (the Brown Corpus) (see Cardoso, 2008), the current study will adopt this input frequency hierarchy.

As this study also examines the role of the L1 in onset acquisition, it is important to examine the onset structures in the three languages in the current study. An overview of the phonotactic constraints for English, as well as Vietnamese, Cantonese, and Mandarin Chinese onsets are given in Table 1, below. As Table 1 indicates, all three speaker L1 languages are similar to each other and to English in that they allow a single consonant in onset position. These singleton onset consonants include the voiceless alveolar fricative /s/, the voiceless stop /t/, the liquid /l/, and the nasal /n/. In short, all the three L1s in the study allow the constituents of the onsets of the study, /sl sn st/, in singleton form. Unlike English, however, none of the three L1s allow complex onsets and therefore, on the basis of L1 transfer, all

Insert Table 1 here

speakers from all three L1 groups would be similar in the predicted effect of L1 transfer, in that all three onsets would be equally difficult for all three speaker groups.

To summarize, markedness would predict that the participant in the study would acquire the onsets in question in the following order: /sl/ > /sn/ > /st/, while input frequency based on the order found in Cardoso (2008) would predict the acquisition order as /st/ > /sl/ > /sn/. As none of the three languages in the study allow complex onsets, L1 transfer would predict that speakers of all three languages would find the three onset clusters to be equally difficult.

Three different speech samples comprise the data. As the three data sets are drawn a larger research study, there is disparity in the number of participants and therefore the number of tokens, across the three L1s. However, since the frequency of /sl sn st/ onsets in speech is not very high, and the language samples within each L1 group are homogenous both in terms of accuracy rates and modifications, all the available data were employed for this study in order to increase the robustness of the findings. The first data sample is taken from 33 native speakers of Cantonese who were all first year English majors at a tertiary institution in Hong Kong. All the participants were required to take the Hong Kong Advanced Level Examination (HKALE) for university admission and based on these scores, were considered to be have an advanced proficiency level in English speaking skills. They were also all living in a context where English is one of three official languages and the language of their university study. The second data sample is taken from three native speakers of Mandarin Chinese, all of who were postgraduate students at a large tertiary institution in the US. The participants were required to take a Test of Spoken English (TSE) upon admission to their postgraduate programme; based on this test, the participants were rated as being high intermediate speakers of English. The third data sample is taken from two native speakers of Vietnamese residing in the US at the time of the study. These

two L2 speakers of English had a low intermediate proficiency in English based on a proficiency test given at the community college where they were studying at the time of the research.

Although the three data sets differ in both the number of speakers and the spoken English proficiency level of the participants, there are a number of commonalties in the data sets that are beneficial for a comparative study such as this. Firstly, all three data sets are exclusively based on naturalistic, spoken conversational data drawn from one-on-one interviews between the participants and the researcher; this is different from the previous research, which has primarily relied on word lists or sentence readings tasks. The conversational data of the current study allows for the analysis of naturalistic production of the onsets in question, which may yield greater insights into the acquisition of these onsets than more structured and controlled speech tasks. Secondly, the participants are all speakers of Asian languages. These languages both differ and have similarities in terms of both phonemic/phonetic inventories as well as phonotactic constraints, which will allow the examination of both the role of universals as well as L1 transfer in the acquisition of the onsets in question.

All data were based on one-on-one interviews between the researcher and each participant. The interviews between the researcher and the Mandarin Chinese and Cantonese speaking participants lasted approximately 30 minutes per participant, while the interviews between the researcher and the Vietnamese participants lasted approximately 1.5 hours each. The interviews did not attempt to specifically elicit /sC/ forms; rather, the focus was on the participants' English language use, motivation to study English, opportunities to study English, favorite books, favorite movies, travel, and hobbies. Therefore, frequency of use of each /sC/ onsets was not controlled for; rather, their frequency is as naturalistic as possible. The caveat of employing a conversational task rather than a word list and/or reading passage is that the

participants may only use a small range of words with which they are familiar, which may create an inaccurate picture of their ability to produce a given type of sound structure. To minimize this occurrence, the researcher focused the interviews on a broad range of topics (see above) in order to promote the use of a wide range of vocabulary.

The interview data were transcribed first by the researcher and then by research assistant trained in English phonetic transcription in order to increase the accuracy of the phonemic and phonetic transcriptions. Inter-rater reliability was calculated with an agreement percentage of 93.10%. Where there was a disagreement between the two raters, another research assistant transcribed the token/words. If there was disagreement among all three raters, the word(s) in question were eliminated from the data set. All in all, 145 tokens from the Mandarin Chinese data set, 511 tokens from the Cantonese L1 data set, and 280 tokens from the Vietnamese data set were analyzed, for a total of 936 tokens.

Findings:

Table 2, below, outlines the production of each onset type by speaker L1 group and by type of production: accurate, deletion (of either the entire onset or one member of the onset), epenthesis, or modification of one or more of the members of the onset. As Table 2 indicates, aside from Cantonese speakers' production of /sl/ and /sn/ onsets, the onsets are overall produced with a high accuracy of over 80% and for some onsets, 100%. Interestingly, however, none of the participants in the three speaker groups produced all of the onsets with 100% accuracy. The

Insert Table 2 here

accuracy hierarchy for each speaker group is as follows:

Cantonese L1: /st/ (100%) > /sn/ (53%) > /sl/ (43%)

Mandarin Chinese L1: /st/ (89%) > /sl/ (86%) > /sn/ (82%)

Vietnamese L1: /sl/, /sn/ (100%) > /st/ (84%)

As these hierarchies indicate, the three speaker groups varied in their hierarchies, although for both the Mandarin Chinese speakers and the Cantonese speakers, /st/ was the most accurate onset of the three, indicating that input frequency may be a stronger constraint than markedness (and L1 transfer) in the acquisition of these onset structures by this group of learners. In contrast, for the Vietnamese speakers in the study, the less marked structures /sl/ and /sn/ were both produced with 100% accuracy, while the more marked structure /st/ was produced with a slightly lower accuracy. For the Vietnamese speakers then, markedness may have more of an impact on acquisition than input frequency; it is possible that the role of input frequency vs. markedness is related to the language proficiency of the learner. Just as L1 transfer is hypothesized to be a more powerful constraint in the early stages of L2 acquisition, it may be that input frequency becomes a more powerful constraint on L2 acquisition in later stages, with markedness possibly a more dominant factor in the middle stages of acquisition. This supports Major's (2001) Ontogeny Phylogeny Model, which predicts that L1 transfer is initially the most powerful constraint on L2 phonological acquisition; across time, however, L1 transfer effects decrease and universal constraints, such as sonority, become more powerful constraints on acquisition. In their research on the acquisition of /sl sn st/ onsets, Carlisle and Cutillas Espinosa (this volume) also found that markedness, and the OPM, provided the best explanation for the acquisition orders of /sl/ > /sn/ > /st/ for their Spanish L1 English L2 participants, and

particularly for the intermediate learners in their study as these learners were appeared to be affected more by markedness than L1 transfer effects, in contrast to beginning learners, who were affected more by L1 transfer. Carlisle and Cutillas Espinosa state that their findings confirm the OPM; the current study also partially confirms the OPM, with the extension that it may be that input frequency effects become dominant in later stages of acquisition, as universal constraints lessen.

Another interesting finding is that the modifications employed by the participants differed by L1 and was consistent within each L1 group. As Table 2 illustrates, the most difficult onsets for Cantonese speakers were /sl/ and /sn/ and for both of these clusters, there was feature change, /sl/ changed to /sn/ and /sn/ to /sl/. There were no cases of deletion or epenthesis in this data set, even though it comprised 511 tokens. For the Mandarin Chinese speakers, deletion was employed for both /sn/ (to /n/) and /st/ (to /t/) onsets, and epenthesis for /sl/ and /st/ (there was slightly more epenthesis than deletion for /st/ onsets for this speaker group). Finally, the only onset Vietnamese speakers had difficulty with was the /st/ onset, which they deleted to /s/. As these patterns were different for each speaker group, and since they were remarkable consistent for all members of each L1 group, these group patterns will be discussed in turn below.

As noted previously, the Cantonese L1 speakers of English do not appear to have difficulty with complex onsets, in particularly the /sC/ onset. Nor do they have difficulty with sonorants as they can produce both an /sl/ and an /sn/ onset. In other words, if we disregard the actual modifications of /l/ to /n/ and vice versa, the Cantonese speakers do not have any difference in their production of a /s/ plus sonorant vs. /s/ plus obstruent onset. Therefore, neither input frequency nor markedness seems to have an affect on their onset production. What

explains the /n/ - /l/ variation then? In fact, /n/ - /l/ variation is a phenomenon that has been found to occur in Cantonese for native speakers of Cantonese (cf. Bauer and Benedict, 1997; Matthews & Yip, 1994) as well as in the English of native speakers of Cantonese (cf. Hung, 2000). In specific, /n - /l/ variation in onsets has been found to be common among young (e.g., young adult) Cantonese speakers (cf. Bauer & Benedict, 1997), such as the participants in this study. Interesting, /n/ - /l/ variation in Cantonese is not solely based on articulation difficulties; Bauer and Benedict (1997) have also found that Cantonese speakers also have difficulty perceiving a difference in the two sounds in Cantonese. Therefore, transfer of L1 variation patterns appears to impact English L2 /n/ - /l/ production (and mostly likely perception, which is not tested in this study). Research on the English of Cantonese speakers (cf. Hung, 2000; Leung, 2011) has also found /n/ - /l/ variation to occur in English L2 onsets and therefore, it appears to be a common phenomenon for some (though not all) speakers of Cantonese. In sum, for the Cantonese data set, the accuracy order of /st/ > /sl/ > /sn/ may on the surface appear to be based on input frequency. However, a closer examination of the data, and the L1 of the speakers, offers a more plausible explanation, that the learners are transferring /n/ - /l/ variation patterns from their native Cantonese into English. L1 transfer is thus the best explanation for the modifications found in this data set, and by default, the low accuracy orders for /sl/ and /sn/ onsets for L1 speakers of Cantonese. Overall, the Cantonese L1 speakers of English can produce all three onset structures with a high level of accuracy but may vary /n/ and /l/ in /sl/ and /sn/ onsets, leading to a lower accuracy rating for these onsets, due to L1 transfer of Cantonese variation patterns.

Interesting, though they had the lowest proficiency of the three groups of speakers, the Vietnamese participants had the most accurate onset production overall. The best explanation

for the findings from this data set is that the participants found the less sonorous, and thus less marked, /sl sn/ onsets easier than the /st/ onset, which violates the SSP. The only onset they had difficulty with was /st/, which they consistently modified to /s/ though only 16% of the time. The question arises as to why the participants modified /st/ to /s/, rather than /t/. This choice cannot be explained by the SSP, which would predict retention of the least sonorous consonant, in this case /t/ rather than /s/, in order to make an optimal syllable due to a greater rise in sonority between the onset consonant and the nucleus of the syllable (cf. Hefter, 2012). Although retention of /s/ rather than /t/ is not predicted by the SSP, it is not a rare occurrence and has been attested in a number of studies of child L1 acquisition of /sC/ onsets. Hefter (2012), for example, in research on L1 English children acquiring /sl sn st/ onsets, found that children typically reduced all three onsets to /s/ in the early stages of acquisition. Hefter explains her findings by noting that perceptual salience of the /s/ versus the /t/ may explain its retention rather than the stop; as she states, "… it may be possible that perceptual salience … played a role in eliciting the preservation of /s/, which vis-à-vis /t/, is acoustically more salient…" (p. 57). This is an interesting observation, in light also of the findings of the perceptual study on /sC/ onsets by Cardoso, John, and French (2008), which also indicates that perception of these onsets is not related to sonority, but rather to input frequency. The role of both these factors – perceptual salience and input frequency – is relatively unexplored for L2 learners' acquisition of these onsets but the findings of both Hefter (2012) and Cardoso, John, and French (2008) indicate that these factors are important areas for future research.

Research by Yavaş and colleagues (Yavaş, 2013; Yavaş & Marecka, 2013) on child L1 acquisition of these onsets has also found that L1 child learners of Dutch, English, Hebrew, Croatian, and Polish may modify /st/ onsets to /s/, though reduction to /t/ is preferred. This

indicates that when children are developing their L1 sound system, reduction of /st/ to /t/ is not categorical; for some children, and possibly in some contexts, reduction to /s/ also occurs. In another study by Jongstra (2003), on child L1 acquisition of Dutch found variation both among children and within one child's data in terms of strategies for cluster reduction – including which consonant was reduced within each cluster. For /s/ + stop onsets clusters, Jongstra found that while the preference was for stop retention, for all three /s/ + stop clusters, /st sk sp/, some children retained the /s/ rather than the stop. In particular, Jongstra found that the /st/ cluster was realized both as /s/ and /t/. Because of the variable nature of the child language data, it is difficult to offer a cohesive theory to explain cluster reduction; sonority appears to be a preference, though it is not categorical. In sum, children learning their L1 may not necessarily adhere to SSP principles when dealing with difficult clusters; other factors, such as salience, may be affecting how clusters are reduced. It is possible, that similarly to the child L1 learners in Hefter's study, the Vietnamese participants in the current study found /s/ to be more salient than /t/ and this impacted their production of the /st/ cluster. It is also possible that the Vietnamese participants in the study behaved more similarly to child L1 learners due to their lower L2 proficiency overall, and were evidencing developmental modification patterns in reducing /st/ to s/, similarly to child L1 learners. While the data from the Vietnamese learners in the current study does not show variation in cluster reduction, this could be due to the fact that the data set is limited to two participants. Perhaps more data – and the analysis of more factors – would shed more light on why these participants reduced the /st/ cluster to /s/.

For the Mandarin Chinese speakers in the current study the most accurately produced onset was /st/, followed by /sl/ and then /sn/. This suggests that input frequency may provide the best explanation for this data set. Another possible explanation for the data is Syllable Contract

Law, which Enochson (2013) posits as an explanation for the /st/ > /sn/ > /sl/ accuracy orders she found for her participants. The Syllable Contract Law posits that the greater the sonority drop between the /s/ and the next consonant, the greater the harmonic the relationship (Murray & Vennemann, 1983). As Enochson notes, while both /sn/ and /sl/ produce a sonority rise, /st/ results in a sonority drop, which thus creates a more harmonic cluster. While both input frequency and Syllable Contract Law, as well as a combination of factors, could explain the findings from the Mandarin Chinese data set in the current study, it is possible that since both part of Enochson's data and this data set stem from L1 speakers of Mandarin Chinese, the L1 of the participants was a factor as well.

For the Mandarin Chinese speakers in the current study although all three onsets had a high accuracy rating, all three were modified; in fact, the Mandarin Chinese speakers had the most variation in production modifications. The onset /st/ was modified both to /t/, which can be explained by the SSP, as well as epenthesized to /s.t/; the next most accurate onset /sl/ was epenthesized to /sə.l/; and the least accurate (though still highly accurate) /sn/ deleted to /n/. Interestingly, Enochson (2013) also found that the Asian L1 learners of English in her study – speakers of Cantonese, Mandarin Chinese, and Japanese – employed epenthesis to modify all three consonant clusters. The Mandarin Chinese learners in her study also had an intermediate proficiency level. It is possible that epenthesis is a more advanced strategy for dealing with these onsets for the Mandarin Chinese speakers, as both consonants are produced in the epenthesized form though as singleton onsets. Deletion, on the other hand, could be a modification strategy that is employed in the initial stages of the acquisition of each onset structure, which may gradually increase as the onset begins to be acquired, at which point

epenthesis may become a more dominant strategy. In order words, for the Mandarin Chinese participants in this study, the acquisition order appears to be:

Initial stage: deletion > middle stage: epenthesis > Final stage: accurate production

How do the results of the current study compare with the results of previous studies of /sC/ onsets, and in particular with Cardoso (2008), which also examined input frequency? Table 3, below, provides a synthesis of this findings from the three speaker groups from the current study and previous research on /sC/ onsets.

As Table 3 indicates, sonority provides the best explanation for the findings for the majority, though not all, of the previous studies of /sC/. Cardoso (2008), which was the only previous study on /sC/ onsets to examine the role of input frequency, also found that sonority provided the best explanation for his findings, and that input frequency was not a significant factor. It therefore appears that either markedness overrides frequency effects for L2 phonology, or as mentioned previously, the effects of L1 transfer, markedness, and input frequency is dependent on the proficiency level of the participants, with the caveat that some L1 effects, such as those for /n/ - /l/ variation for Cantonese speakers, are dominant in the L2 if they are also dominant in the L1.

For the three data sets in the current study, markedness provides the best explanation for only the Vietnamese data set, with L1 transfer the best explanation for the Cantonese data and input frequency providing the best explanation for the Mandarin Chinese data. One major difference between the current study and the previous research is that the current study employed only naturalistic data; the other studies employed word lists or sentence reading tasks in order to obtain sufficient tokens of each onset type as these onsets may not occur frequency in natural

conversation. Therefore, one of the differences between the findings of the current study and that of the previous studies could be the type of data that was collected. Another difference is the language type: the majority of the previous studies focused on either Brazilian Portuguese or Spanish, as these two L1s have complex onsets but do not allow /s(C)/ onsets. Speakers of

Table 3: Onset production hierarchies across studies *

Speaker group	Proficiency Level	L1/L2	Accuracy hierarchy (most to least)	Possible explanation
Current study	Advanced	Cantonese L1 English L2	/st/ > /sn/ > /sl/	L1 transfer
Current study	High intermediate	Mandarin Chinese L1 English L2	/st/ > /sl/ > /sn/	Input frequency
Current study	Low Intermediate	Vietnamese L1 English L2	/sl/, /sn/ > /st/	Sonority (markedness)
Abrahamsson (1999)	Beginner	Spanish L1 Swedish L2	/sn/ > /st/ > /sl/	Partly sonority (markedness)
Cardoso (2008)	Low intermediate & advanced	Brazilian Portuguese L1 English L2	/sl/ > /sn/ > /st/	Sonority (markedness)
Cardoso, John, & French (2008)	No English, intermediate, advanced	Brazilian Portuguese L1 English L2	Perception: /st/ > /sl/ > /sn/	Input frequency
Cardoso & Liakin (2009)	Low intermediate & advanced	Brazilian Portuguese L1 English L2	/sl/ > /sn/ > /st/	Sonority (markedness)
Carlisle (1988)	Not given	Spanish L1 English L2	/sl/ > /sn/	Sonority (markedness)
Carlisle (1991)	Not given	Spanish L1 English L2	/sl/ > /st/	Sonority (markedness)
Carlisle (1992)	Not given	Spanish L1 English L2	/sl/ > /sm/, /sn/	Sonority (markedness)
Carlisle (1997)	Intermediate	Spanish L1 English L2	/sl/ > /sn/, /sm/	Sonority (markedness)

Speaker group	Proficiency Level	L1/L2	Accuracy hierarchy (most to least)	Possible explanation
Carlisle (2006)	Intermediate	Spanish L1 English L2	/sl/ > /sn/ > /st/	Sonority (markedness)
Carlisle & Cutillas Espinosa (this volume)	Intermediate	Spanish L1 English L2	/sl/ > /sn/ > /st/	Sonority (markedness)
Enochson (2013)	Intermediate	Mandarin Chinese L1 Japanese L1 Cantonese L1 English L2	/st/ > /sn/ > /sl/	Syllable Contract Law
Hefter (2012)	2;3 years old to 3;10 (acquisition across time)	Child L1 learners of English	/sl/ > /sn/ > /st/	Sonority (markedness)
Major (1996)	Beginner	Brazilian Portuguese L1 English L2	/st > /sl/	Input frequency
Rebello & Baptista (2006)	Intermediate	Brazilian Portuguese L1 English L2	/st/ > /sl/ > /sn/	Markedness (by voicing, not sonority) Input frequency
Rauber (2006)	Not known	Brazilian Portuguese L1 Spanish L1 English L2	/sl/ > /sn/ > /st/	Sonority (markedness)
Yavaș & Marecka (2013)	Child L1	Polish L1	/s/ + nasal > /s/ + stop > /sw/ > /sx/	Continuancy

*Table based partly on Cardoso (2008)

both L1s are also hypothesized to employ epenthesis in order to manage these onsets, as both these L1s have an /esC/ structure in the L1. However, the current study focused on three Asian languages that did not allow complex onsets, and are overall fairly dissimilar to the two Romance languages in terms of their phonotactic constraints. Overall, the picture that Table 3 presents is that markedness, and not input frequency or L1 transfer, has the greatest effect on the acquisition of /sC/ onset structures.

Conclusion:

This study investigated the role of input frequency, markedness, and L1 transfer in the acquisition of the English /sl sn st/ onsets by native speakers of Cantonese, Mandarin Chinese, and Vietnamese. The study found that all three constraints played a role in both the accuracy orders and production modifications employed by the speakers of the study, in that L1 transfer had a dominant role for Cantonese speakers, input frequency for the Mandarin Chinese speakers, and markedness for the Vietnamese speakers. Only the findings from the Vietnamese speakers, that sonority plays a more significant role than the other factors in the acquisition of /sl sn st/ onset sequences, corroborates previous research on the role of input frequency and markedness on the acquisition of these onsets, as well as previous research on /sC/ onsets in general. A major difference between this study and previous research is the L1 background of the participants, which may affect the results of the study and explain differences among studies. Another difference is the nature of the data collected as this study relied on conversational data, rather than more controlled word lists and reading passages. Finally, the proficiency level of the learners may impact which factors – sonority, input frequency, or L1 transfer – affect the acquisition and modification of /sl sn st/ onsets. These findings demonstrate that further research

is required in order to fully understand the role of input frequency, sonority, and L1 transfer in L2 phonological acquisition.

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