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# Phonotactics in L2 and Pidgin/Creole Languages

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**Abstract**

This study investigates the production of English initial consonant clusters by Arabic L1 learners of English and speakers of the Broad Jamaican Creole. The clusters Stop + /r/, /S/ + nasal, /S/ + stop, in addition to the production of vowel-initial words are focused on. It was found out that whereas Arab learners produced initial Stop + /r/ and /S/ + nasal words with epenthesis and /S/ + stop words with prosthesis as well as epenthesis, speakers of the Broad Jamaican Creole produced Stop + /r/ and /S/ + stop clusters according to the RP norm and /S/ + nasal with epenthesis. As for vowel-initial words, both groups resorted to the strategy of onset filling (Itô, 1989). Specifically, Arab learners produced these words with glottal stop /ʔ/ before the initial vowel, whereas the Jamaican informants inserted glottal fricative /h/ in the same position. Furthermore, the performance of the two groups was additionally analyzed in light of Optimality Theory.

**Keywords:** initial consonant clusters, Arabic L1 learners, Broad Jamaican Creole, optimality theory, onset filling

## 1. Introduction

According to many linguists, the syllable must be related to phoneme distribution (Fudge, 1969; Khan, 1980; Pulgram, 1970; Selkirk, 1982, among others). They view the syllable as an entity in the domain of which the phonotactics of the language can best be defined. In other words, the many phonotactics constraints limiting the distribution of sounds and sound sequences at various positions (initial, medial, and final) in the phonological word or phrase can best be expressed in terms of syllables rather that morphemes or words. For instance, the sequence [tI] is allowed in English as long as the [t] and the [I] belong to different syllables, as in *boot-leg*. But this sequence is not allowed in the same syllable. In other words, *tleg is not allowed as an English word, as it contains [tI] as its onsent. A further example of English phonotactic constraints is expressed in the rule which allows only vowels after syllable-initial affricates. Thus, we tend to find words such as *chair*, *job*, *cheap*, *jail*, but not *chleap* or *jpudge*, for instance. The latter two are neither real nor potential words in English. Likewise, in some African languages initial nasal + consonant sequences such as [nk], as in *nkomo* [ŋkomo] and Nkrumah [ŋkruma] (names of African leaders) are perfect syllable structures, whereas these sequences are outlawed in that position in English, for instance. Thus, English speakers, in their attempt to pronounce these two names, tend to resort to a certain technique to create a syllable structure which transforms these un- English sequences into permissible ones, in accordance with the syllabification rule of English. A short vowel [I] or a schwa [ə] is inserted prothetically, in order to render them pronounceable (Broselow, 1983; Katamba, 1989). From these examples, one would conclude that constraints on syllable structures serve as a filter by allowing only certain sound sequences to occur. However, these constraints are language—specific, in that certain sound sequences that are well-formed syllable structures in language X may not be so in language Y, as we have seen above.

CV syllable structure is recognized as an absolute universal in the languages of the world (Clements, 1988; Cairns & Feinstein, 1982; Battistella, 1990; Belvins, 1995; Vennemann, 1988, among others). Investigation has shown that this type of syllable structure has preference over the other types and that speakers from different linguistic backgrounds resort to varied strategies, in order to secure CV syllable. Research in historical linguistics has provided evidence to this end. For instance, headless (or onsetless) syllables, those beginning with a vowel, acquired constant as an onset, thus creating CV syllable (Vennemann, 1981). Languages also tend to reduce CCV and CVC syllables to CV ones, as Table 1 illustrates.

Table 1. Creation of CV syllable (from Vennemann, 1988)

| Modification | | | Gloss | Language |
|---|---|---|---|---|
| vi. du. a | → | ve. do. va | window | Italian |
| ru. i. na | → | ro. vi. na | ruin | |
| hnigan | → | nigan | to bow | German |
| hlut | → | lut | loud | |
| ambm | → | amba | mango | Pali |
| srotas | → | sota | stream | |
| patrem | → | padre | father | Italian |
| cantat | → | canta | '(he) sings' | |

Despite its importance in linguistic behaviour, L2 phonology has received little attention in the literature of second language acquisition, which is replete with analyses relating to the other areas of grammar. It has always been assumed, though implicitly, that learning L2 phonology involves mainly constructing pedagogical material targeted at enabling learners to accurately produce individual segments. This traditional practice has left much to be desired. That is, learning L2 phonology requires, inter alia, internalizing knowledge of permissible and non-permissible sequences, phonological processes and L2 prosody (James, 1986). Moreover, phonology, according to Arends et al. (1995) and Singh and Muysken (1995), is a relatively neglected domain in pidgin/creole phonology, and a comparison with non-creole linguistics is worth considering. In Singh and Muysken's (1995) view, among the aspects of pidgin/creole phonology that demands urgent scrutiny are epenthesis and phonotactics. In this research, we are concerned with how Arab learners of L2 English and speakers of the Broad Jamaican Creole (BJC) cope with the production of words containing initial bi-lateral consonant clusters and words beginning with a vowel. The purpose is to see what strategies they employ in their attempt to cope with this task. The author is unaware of a similar study, in which the above two groups have been studied, with respect to the same areas. Thus, this seems to be the first investigation of its kind.

## 2. Literature Review

The study of L2 phonology has shown that speakers from varied linguistic backgrounds face difficulties coping with English syllable structures (Broselow, 1983, 1987; Tarone, 1987; Eckman, 1977; Samareh, 1977; Karimi, 1987). Learners have been reported to adopt varied strategies in dealing with English words containing consonant sequences, depending on their length. For instance, many English L2 learners have been reported to prothesize glottal stop before words beginning with a vowel. It is also common practice among these learners to produce the consonants of initial CC words, such as *start*, *spoon*, *school*, etc., with epenthesis or prothesis. The greatest difficulty, however, is manifested when attempting English words containing three consonants word-initially and word-finally, and words containing four consonants word-finally, such as *street*, *accepts* and *texts*, respectively. Here, the learners have been found to resort to the strategy of consonant reduction or vowel epenthesis or a mixture of the two. Thus, it seems that the markedness of the syllable structures of these words dictates the nature of the strategy to be deployed. Thus, Samareh (1977) points to the fact that Farsi learners of English as a foreign language have the tendency of pronouncing every initial vowel by inserting glottal stop before the vowel, hence transferring their mother tongue's behaviour. Broselow (1983) provides another case of glottal insertion in the same environment by her Egyptian and Iraqi subjects. The same strategy was found to dominate the pronunciation of Saudi Arabian learners of English (Mousa, 1994). GIottaI insertion is also known in first languages. For instance, in German, a vowel which is underlyingly in word-initial position or word- internally hosts glottal stop in front of it. This is displayed in the production of *theatre*, which is realized as [teʔatR] (Noske, 1989). According to Moskowitz (1973, p. 61), in the speech of her subject Hildegard, "in all words which begin with a vowel, glottal stop is automatically inserted". As we will see later, this behaviour runs counter to certain constraints in the Optimality Theory (Prince & Smolensky, 1993). But generally speaking, this strategy is taken to be universal, since this insertion is allowed at least in slow speech in every language (Broselow, 1987; Gimson, 1980), among others. Another explanation for the insertion of this glottal is that speakers are trying to alter the syllable to a CV one, possibly in interaction with the hypothesized preference for the open syllable, (Tarone, 1972, 1987; Oller, 1974; Kozhevnikov & Chistovich, 1965), among others. Likewise, English words containing consonant clusters of varied lengths in different positions are treated by learners in different ways. For instance, Egyptian learners of English in Broselow's (1983) study produced the word *black* as [bɪlæk] with an epenthetic vowel between the two members of the initial consonant cluster, whereas Iraqi speakers in the same study opted for the use of a prothetic vowel, in that they produced it as [ɪblæk] (and this behaviour, of course, prompted the strategy of Onset Filling, in which glottal stop is used before the initial vowel), Itô (1989). Words beginning with an initial /s/ followed by a stop, such as *stop*, *station*, *school*, etc., are always produced with the fricative preceded by a vowel. This has been the case in the errors of native speakers of Arabic (Broselow, 1983; Mousa, 1994) Spanish (Tropf, 1987), Sinhalese (Samarajiwa & Abeysekera, 1964), Turkish (Swift, 1963), Persian (Karimi, 1987; Yarmohammadi, 1969) and Hindi (Singh, 1987, 1990). Regarding pidgin/creole speakers, literature has reported a number of strategies used by these speakers to transform the syllable structures of European lexical source languages into norms of African substrate languages (c.f., Holms, 2000). For instance, omission of initial and final member of a bi-literal consonant cluster secures a CV pattern, as in Sranan Creolized English *tan* from *stand*. This CV pattern is also rendered by the omission of an initial weak vowel, as in the pronunciation of the Portuguese word *abrir*, meaning 'to open' which appears as *bi* in Principe Creolized Portuguese. This is because the African substrate language does not allow words beginning in a vowel. These two strategies, namely *procope* and *apocope,* are used by these speakers in order to alter inadmissible syllable structures (in European lexical source languages) into admissible ones according to African substrate languages. The reader is advised to refer to Holms (2000) for more details. Another characteristic of pidgin/creole languages is the tendency of their speakers to insert glottal fricative /h/ word-initially before a vowel. That is, when a word begins with a vowel, it is likely to have this glottal fricative before the vowel in what Wells (1973) calls a *hyper-adaptive* /h/ strategy. For instance, *oil* is produced as [hɔɪl], and so on. Another case related to this is the omission of this fricative where it should exist. Thus, *house*, *high*, etc., are produced without initial fricative. So far, the author is unaware of any study which brings together Arabic L1 learners of English and speakers of BJC, with respect to the production of the above entities. Thus, this seems to be the first investigation of its kind.

## 3. Current Study

Twenty Arabic L1 learners of English at the Department of European Languages and Literature at King Abdulaziz University, Jeddah, were given the list of words (Appendix A) to read. They were asked to read silently and tell of any unfamiliar words, which were then explained to them. When they were ready, they individually read the words aloud and their production was tape recorded. As for the informants, two speakers of the Broad Jamaican Creole, whom the author once lived with in England played the role. They were also given the list (Appendix B) to read, and their production was tape recorded, as well. The two appendices display their performance, together with transcriptions. As the number of informants is limited, the researcher felt it was necessary to supplement their output with findings of other investigations on this creole, such as Wells (1973), Baxter et al. (1997), Cassidy (1961), and Holm (2000).

## 4. Results

As demonstrated in Appendix A, these clusters are found to cause learning problems, especially those containing *sm*-, *sn*-, *sl*-, *gl*-, and those of the nature Stop + /r/. With regards to words beginning with Stop + /r/, our learners produced almost all of them with epenthesis only, and no prosthesis was employed. This was also the case with initial /sm, sn/ words. Explanation will be provided as to why only epenthesis is solely used when dealing with these clusters.

Our learners managed to produce some of the following words without apparent problem: *stop*, *star*, *class*, *school*, *snake*, *spoon*, *speak*, *glass*, though most of S + stop words were modified by use of either prothesis or epenthesis. It seems that in the instances where these words are produced without modification that these words are familiar to them in that they are frequently heard and used in class. Also, one might conclude that our learners have gone beyond the syllable structures of Arabic, which outlaw initial CC-syllables (c.f., Mousa, 1994; Basalamah, 1990; Ingham, 1971). On the other hand, except for the /sn, sm/clusters in whose production they epenthesized a vowel between the members of the clusters, our Jamaican informants did not seem to have any difficulty. The reader will notice that their production of the other initial clusters is native-like (refer to Appendix B). In this paper, we will focus on Stop + r, Stop + nasal, S + stop clusters, and pronunciation of vowel-initial words in the speech of Arab learners of English as well as speakers of Broad Jamaican Creole. When it comes to vowel-initial words, however, the performance of the learners and the informants is uniform. In other words, both groups produced the test words with prosthesis. Thus, whereas Arab learners prothesized glottal stop, the Jamaican informants used glottal fricative. This strategy is called Onset Filling (Itô, 1982). More will be said about why this strategy is employed and why the two groups utilized these different phonemes, though for the same purpose. In what follows a detailed account of the results is discussed.

## 5. Discussion

### *5.1 Production of Stop + /r/ Clusters*

Words such as *great*, *gram*, *pram*, *draw*, *tram*, and *drink* are problematic for most learners, in that trill is produced which does not allow for smooth transition between the two members of the cluster (c.f., Appendix A). The same behaviour had been reported in Mousa (1994) when Arab learners were given more or less similar words to produce. The spectrograms of the words produced in that study marked clear gaps between the two members of the cluster, hence indicating deviation from native speaker's norm in the production of these combinations. English L2 learners from different linguistic backgrounds have been reported to find these clusters problematic. For instance, in Chang et al. (2009) L1 speakers of Japanese and Taiwanese Mandarin failed to master the coordination of the articulatory gestures between the two consonants in the Stop + liquid clusters. This difficulty was also reported by Dupoux et al. (2001). According to them, 79% of Stop + /r/ clusters transcribed by Japanese contained an epenthetic vowel between the members of the clusters. Colantino and Steele (2006) investigated the pronunciation of English L1 learners of Spanish with regard to Stop + /r/ clusters and concluded that although such clusters are alike orthographically and phonologically in the two languages, the learners found difficulty producing them authentically, as they are phonetically different. Even in pidgin and creole languages the production of these clusters is not smooth. For instance, in De couto (2006) pidgin/creole speakers produced initial Stop + /r/ Portuguese words with epenthesis. The justifican given for the difficulty encountered in the pronunciation of these clusters is that they are marked. Optimality Theory will explain this markedness in due course. However, our Jamaican informants did not seem to have difficulty producing the test words containing these sequences. Contact with RP speakers in Britain is believed to have enhanced their speech.

But adult L2 learners of English are not alone in their struggle with clusters involving Stop + liquid. Wintiz (1969) points to the fact that children face difficulties acquiring these clusters and that /pr/ is acquired later than /tr/ and /kr/ clusters. Other studies on child language have come to the conclusion that in clusters with /r, l, w, j/, these sounds are omitted (see Cruttenden, 1979; Crystal, 1976; Smith, 1973). Furthermore, Hawkins (1976) reports that in the production of these clusters, an intrusive /ə/ is sometimes heard between the stop and the liquid and that children will endeavour to produce these clusters even at advanced ages (up to 6). Not only that, but generally, the many clusters of English and the rules governing them (e.g., /pr/, /tr/, /kr/) need to be learned by the child as utterance units in words (Ferguson, 1973). In general, these consonant clusters are reported to cause learning problems for Arab learners of English (Mitchell & El-Hassen, 1989).

*5.2 Production of /s/ + Nasal Clusters*

In the speech of our Arab L2 English, the words *smooth* and *small* are produced as [semu:ð], [sɪmɔ:l] and [sɪmɪl] (c.f., Appendix A). Likewise, the Jamaican informants produced *small* as [səmɑ:l] and [sɪmɑ:l] (c.f., Appendix B). Our Arab learners' renditions with a vowel or a schwa between the two members of the cluster can simply be interpreted as that Arabic does not allow initial CC syllables, as indicated earlier. But we have seen that these learners manage to produce other initial SC clusters (c.f., Appendix A). For instance, "*spoon*, *stop*, *school*, *star*, etc" were all produced correctly. This is, perhaps, as mentioned earlier, because these words are familiar and are frequently used in class. But the word *small* is one of the first adjectives Arab learners are usually exposed to; thus, we should not expect it to be difficult to produce, unlike the word "*smooth*" which is not as frequent. On the other hand, it is surprising that both groups displayed correct as well as erroneous pronunciation of the members of the cluster in "*snake*". However, the correct rendition of the cluster in this word lends support to McLeod et al. (2001), and Kirk and Demuth's (2005) suggestion that when only one of the /s/ + nasal clusters is acquired, it is the /sn/, though one cannot deny the fact that initial /s/ + nasal clusters are marked compared to other cluster types. For instance, Greenberg (1965) documented that obstruent + liquid onsets would be less marked than obstruent + nasal onsets. Likewise, according to Carlisle (1992), the mean frequency of epenthesis before initial /s/ + liquid clusters is significantly less than that of /sm/ and /sn/ clusters.

Literature on pidgin/creole languages as well as foreign/second language acquisition is replete with examples pointing to the difficulty speakers encounter when producing these clusters. For instance, the word "*sneaky*" has been reported to be uttered as [sinnicky] in early Jamaican creole, and the word "*smell*" as [sémèle] in late 19th century Bislama, Avram (in Holm, 2000). This strategy of use of epenthesis in the production of these clusters has been confirmed by Cassidy (1961) who posits that this process holds whenever we have a combination of *sm* or *sn* as in words like *snook*, *snake*, *smooth*, etc. Many learners of English as second/foreign language whose L1 prohibits SC clusters, such as Spanish, Farsi, Portuguese and Arabic resort to this strategy in coping with these clusters; though a prothetic vowel is also used. Thus, although the majority of these learners tend to transform the combination /sc/ into /sic/, it is quite possible to have the alternative /sc/→/i. sc/. This is normally found in the speech of Iraqi, Farsi and Portuguese L2 English. For instance, *snake* is produced as [es.neik] in Farsi (c.f., Karimi, 1987; Yarmohammadi, 1995) and *smoking* is produced as [izmokĩ] by Portuguese (Major, 1987), (c.f., Broselow, 1987, for examples from Egyptian and Iraqi Arabic).As can be seen from Appendices A and B, our learners and informants resort to epenthesis when dealing with these clusters. We will account for this when their speech is dealt with, based on Optimality Theory.

Interestingly enough, even native speakers of English whose L1 permits initial /sm/ clusters have been reported to produce the Russian word *smokavatj* as [səmakavatj] (meaning *fig tree*), with an epenthetic vowel (Ostapenko, 2005). This would suggest that optimality varies within the same natural class. That is, in the natural class of nasals, initial SC clusters with /n/ are more optimal than ones with /m/. Child language provides evidence in favour of this argument. According to Kirk and Demuth (2005), a child could produce the SC cluster in the words *snail* and *snake* but not the one in *smoke*, for instance. Moreover, initial /sn/ cluster has been favoured over other SC clusters on many occasions. For instance, in a longitudinal study of L1 Spanish / L2 Swedish, Abramsson (1999) reported that the learners made use of epenthesis with /sl/ clusters more often than with /sn/ clusters. Likewise, in a study of acquisition of SC clusters in Croatian children with phonological disorders, the percentage of correct production of words beginning with /s/ + nasal sequences appeared to be significantly higher than /s/ + liquids (i.e., /l/ and /r/) sequences (85% vs. 47%), see Mildner and Tomić (2010). These results would go counter to the role of Clement's (1990) Markedness-based principles, the Sonority Sequencing Principle (SSP) and the Minimal Sonority Distance (MSD), which predict order of acquisition of initial SC clusters. Put differently, although cross-linguistically it is preferred that the sonority distance between the members of initial SC clusters is maximized (like in /s/ + liquid) and thus such clusters would be less marked (see Eckman, 1977) and accordingly easier to learn, production of /s/ + nasal clusters (which are taken to be more marked, as the MSD between the segments is lower than the one in /s/ + liquid clusters) would give the indication that a "markedness hierarchy...exists between the two sequences" (Boudaoud & Cardoso, 2009, p. 88). Thus, although both sequences (i.e., /s/ + liquid and /s/ + nasal) do abide by the SSP, the latter seems to be less problematic and, accordingly, it is learned first. More specifically, even when /s/ + nasal sequences are acquired first, /sn/ would be more accessible.

But the fact that the marked /s/ + nasal sequences are acquired before the less marked /s/ + liquid clusters would make one assume that higher sonority may not be indicative of more accurate pronunciation (but see Cardoso, 2008) (Note 1). In fact, this point is clearly manifested in Escartin's (2005) study of initial SC English clusters by Mexican Spanish learners. According to this study, there is no significant difference between pronunciation of /s/ + liquid and /s/ + stop sequences in the speech of these learners (p. 52 and p. 54, respectively). In addition to that, an investigation of the development of acquisition of the homorganic /st/, /sn/, and /sl/ initial clusters by speakers of Farsi learning English as a second language has revealed that "/s/ + nasal onset clusters induce nearly as much error (i.e., epenthesis) as /s/ + stop sequences do" Boudaoud and Cardoso (2009, p. 97).

The Farsi speakers in the above study classified the SSP-abiding initial /s/ + nasal cluster together with the SSP-violating /s/ + stop clusters, instead of grouping the /s/ + nasal ones together with their peers. That is, the sonority abiding /s/ + liquid sequences. Boudaoud and Cardoso (ibid) conclude that "a sonority-based account, which predicts a development pattern of less marked SSP-following versus more marked SSP-violating onset sequences (i.e., /s/, /sn/ > /st/), cannot adequately account for the SC acquisition hierarchy observed in this study (i.e., /sl/ > /sn/, /st/)" (p. 97). Instead, they suggest that a phonetically-based explanation is more promising. Thus, taking into account Hayes et al.'s (2004) phonetically-based approach to phonology "which can capture complex phonological phenomena by appealing to their underlying phonetic conditions…[which consequently]…draws on core phonetic principles which explore the relationship between the relative markedness of the SC clusters and the degree of gestural effort involved in their articulation" (Boudaoud & Cardoso, 2009, p. 97), Boudaoud and Cardoso propose that the articulatory feature 'continuancy' which involves the freedom of airflow through the oral cavity is responsible for the above behaviour of the Farsi learners. That is, production of initial /st/ and /sn/ clusters would prompt more gestural effort, as it involves a transition from [+continuant] to [-continuant], whereas in the articulation of /sl/ "continuancy" is intact, hence, it is less marked.

Along the same argument, we would like to draw conclusion as to why the cluster /sn/ is relatively easier to acquire than /sm/ as indicated by the way they have been treated by our learners, the Jamaican informants, speakers of different languages learning English as a second language, and child language. Our position here is that, the members of the cluster /sn/ do in fact share the same phonetic feature. That is, they are homophones in that they are both alveolars, whereas production of /sm/ would require two gestural steps, one for alveolar fricative and another for bilabial nasal. This indicates, perhaps, that /sn/ is less marked than /sm/. Indeed, child language has shown that this assumption is valid. For instance, in her investigation of sound substitutions made by English speaking children, Kirk (2008) has concluded that almost 70% of the substitutions produced by the children result in clusters in which both initial and final clusters share the same place and/or manner of articulation. The same result has been reached by Kirk and Demuth (2005) who report that 60% of the substitutions made by children appear to be prompted by a preference for securing clusters sharing the same place of articulation. In what follows, the production of S + stop clusters are investigated.

*5.3 Production of Initial /S/ + Stop Clusters*

As indicated by Appendix A and Appendix B, respectively, whereas our Arab learners experience difficulty with /S/ + stop clusters, our Jamaican informants find these clusters easy to produce. We have already mentioned that the words produced by the learners are familiar to them in that they are frequently heard and used in class; otherwise, initial CC clusters are, generally speaking, difficult for them as we have seen (c.f., /pr, tr, kr/ as well as /sm, sn/ clusters). These clusters are easy to produce for the Jamaican informants due to their encounters with native speakers in England.

It is worthwhile to give a brief account of acquisition of these clusters in child language and English L2, as it is thought that they follow the same pattern in terms of processing, Ervin-Tripp (1974). For instance, Higgs (1968) reports a steady increase regarding the percentage of the correct pronunciation of /S/ +stop clusters in child language. Thus, whereas at age 2; 6 the percentages for /sp/, /st/, and /sk/ are 38, 38, and 37, respectively, they are 84, 84 and 84 at age 5;0. Acoustically speaking, Catts and Kamhi's (1984) longitudinal study has shown that children aged 1;9 to 2;10 years consistently produce short-lag stops as substitutes for the above clusters. In another study by Bond and Wilson (1980), some children produce the substitute stop with long-lag voice onset time (VOT), one child produces short-lag VOT, and another two use both. But generally speaking, it has always been the case that in their attempt to produce /S/ + stops, they do it with significantly shorter VOT than that for the singleton target word (c.f., McLeod et al., 2001; Cruttenden, 1979; Crystal, 1976, among others).

This is why, perhaps, though it has been mentioned earlier that /st/ and /sp/ clusters can be acquired as early as the age of three, Stoel-Gamon (1987), Smith (1973) suggests that /S/ + stop clusters appear relatively late. Indeed, even in English L2 acquisition by adults, mastery of these clusters takes time. For instance, Saudi learners of English have been reported to struggle with the production of these clusters compared to the production of native-like VOT, and only advanced learners manage to come up with acceptable performance in this respect (c.f., Flege, 1980; Mousa, 1994, Mitleb, 1985). Moreover, Broselow (1987) has investigated the acquisition of these clusters in the speech of Iraqi and Egyptian learners of English and concludes that, like Spanish L1 and Portuguese L1 learners of English, these Arabs insert an epenthetic vowel before /S/ + stop sequences. That is, they used prosthesis to facilitate the production of these clusters.

When onsets are complex (i.e., when they involve more than one segment), they are governed by a higher-order property of language known as the Sonority Sequencing Principles (SSP), Clements (1990). According to this principle, onsets maximally rise in sonority to the nucleus, and codas fall. This principle thus determines what may be taken as a possible syllable in a language and, specifically, what may constitute an acceptable onset. The sonority hierarchy is defined as a rank-ordering of the sonority values of sounds on a numerical as displayed in Table 2. Sounds and their corresponding values are shown from least to more-sonorous.

Table 2. Sonority Hierarchy scale. (c.f., Clements, 1990)

| | |
|---|---|
| Voiceless stops | (7) |
| Voiced stops | (6) |
| Voiceless fricatives | (5) |
| Voiced fricatives | (4) |
| Nasals | (3) |
| Liquids | (2) |
| Glides | (1) |
| Vowels | |

The above scale is used to calculate sonority differences between sequences of sounds in syllable onset. To exemplify, the sonority difference in /bl/ in the word *bloom* is 4; the voiced stop /b/ with a value of 6 minus the liquid /l/ with a value of 2 will render the difference 4. Likewise, /sm/ in *small* has the difference 2; the voiceless fricative /s/ with a value of 5 minus the bilabial nasal with a value of 3 yields the difference 2, and so on. Among SC sequences voiceless fricative + stop clusters (i.e., /st/, /sp/, /sk/) represent a clear violation of the SSP, in that the more sonorous fricative precedes the less sonorous stop. Indeed, the status of these clusters is controversial in that two propositions are said to account for the behaviour of learners when producing them. That is, those who regard initial /S/ + stop clusters difficult to acquire (c.f., Catts & Kamhi, 1984; Bond & Wilson, 1980; McLeod et al., 2001; Kirk & Demuth, 2005; Smith, 1973) among others, take it that these clusters are highly marked, perhaps because their sonority difference is -2 (i.e., voiceless fricative with a value of 5 minus voiceless stop with a value of 7) (See Gierut, 1990 for more explanation). On the other hand, for those who suggest that they are acquired early

(Stoel-Gamon, 1987; Dyson, 1988; Templin, 1957; Smit, 1993) among others, it seems that the claim that these clusters are viewed by the learners not as real clusters at all, but rather as an adjunct (or an appendix) /S/ followed by a singleton (Gierut, 1990; Kirk & Demuth, 2005, among others), makes sense. It has recently been proposed that /S/ + stop sequences may be structured just like affricates in acquisition (c.f., Barlow, 1997, 1998; Lleo & Prinz, 1997; Menyuk, 1972; Selkirk, 1982, among others). In other words, as indicated by Gierut (1990) (see also Kirk & Demuth, 2005), adjuncts may be displayed as complex segments with a single timing slot. Gierut suggests that learning takes place according to the following pattern. Children first identify syllable onsets with the production of singletons, with a single timing slot, as in Figure 1a. The second step is marked by expanding onsets to include branching structure, though still with a single timing slot, as shown in Figure 1b, with respect to complex segment. Finally, branching onsets develop into two timing slots, with clusters bearing members of varying sonority differences, abiding by the syllable well-formedness of the language in question, as shown in Figure 1c.

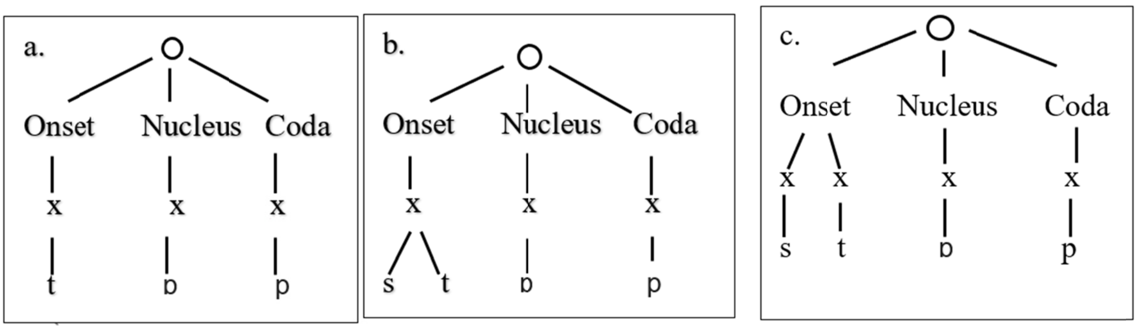


Figure 1. Representations of the syllable structure of the word *stop*

According to Gierut (ibid, p. 722), "by this proposal, S+ stop sequences would be marked relative to singletons but unmarked relative to true clusters."

Thus, if the argument that /S/ + stop sequences are viewed by the child to be an adjunct followed by a singleton and hence they are treated the same way as affricates (i.e., single sounds), this would suggest that they are unmarked, as mentioned earlier, and this is why they are acquired at an early stage of language acquisition. In fact, Yoo (2004) has provided additional evidence in favour of this position. In a longitudinal investigation (which lasted for three years) of phonological development in the production of English consonant clusters by Korean children, Yoo has concluded that "the acquisition order of consonant clusters to an accuracy rate over 80% is /sk, st, sp, sn, sm, tw, pl, kl, dr/, /-st/ > /bl/, /spr/, /-nt, -mp/ > /gl/, /str/, /-sk/" (p. 499). Moreover, the accuracy rankings for initial two member clusters across time are /sk, st, sp, sn, sm, tw, pl, kl, dr/ > /bl/ > /gl/ (Yoo, ibid). This pattern goes hand in hand with the one mentioned earlier by Eckman and Iverson (1993), which suggests that less marked onsets would reach the level of 80% accuracy before more marked onsets. That is, voiceless C + C is less marked than voiced C + C. Along the same argument, one would add that it is not only familiarity that has led to mastery of these sequences by our Arab learners (we are referring to the correct instances of S + stop sequences uttered by Arab learners) and our Jamaican informants, but their unmarkedness does also play a role. But one would still question why some children reduce these clusters to stops with significantly shorter VOT, as mentioned earlier. In other words, it is not clear at which stage of learning the child reduces these clusters to stops, if we take it for granted that these sequences are acquired early. However, though our Jamaican informants do not find difficulty in the pronunciation of S + stop clusters, because their encounters with RP speakers in Britain has led to the enhancement of their production, our Arab learners do still experience difficulty with these clusters, as one can see from their performance in Appendix A. Once these clusters are prevalent source of difficulty (and this is reflected in the strategies deployed by the child in their production, i.e., the three phases illustrated above in Figure 1), coupled with the struggle learners from CV linguistic background go through when attempting them as shown in Table 3 below, one would not hesitate to view them as marked entities. Notice that the S + stop clusters in the table are produced with either prothesis or epenthesis. Now we move on to the production of English words beginning with a vowel.

Table 3. Realizations of S + stop clusters by L2 learners

| Languages | Pronunciation | L2 | Gloss | Source |
|---|---|---|---|---|
| Kazakh | [pɪrava] | RUS. [prava] | Right | Sulejmenova (1965) |
| Egyptian | [ʔiskii] | Eng. [ski:] | Ski | Broselow (1987, 1992, 1993) |
| | [ʔistadi] | Eng. [stʌdɪ] | study | |
| Iraqi | [istadi] | Eng. [stʌdɪ] | study | |
| Hindi | [ɪskul] | Eng. [skʊ:ɫ] | school | Singh (1985) |
| | [ɪsteʃən] | Eng. [steɪʃ(ə)n] | station | Broselow (1992) |
| Catalan | [əstop] | Eng. [stɒp] | Stop | Bonet and Lloret (1998) |
| Korean | [sitʰim] | Eng. [sti:m] | steam | Nam and Southard (1994) |
| | [sipʰidɨ] | Eng. [spi:d] | speed | |

*5.4 Production of Vowel-Initial Words*

In the production of words beginning in a vowel in our learners' speech, almost all these words were produced with a prothetic glottal stop, in what is called onset filling (Itô, 1989) (c.f., Appendix A). This is because one language specific rule of Arabic requires that no syllable should begin with a vowel. That is, syllable onsets are obligatory in Arabic. Thus, when pronouncing an English word which begins with a vowel, glottal stop is inserted before the vowel to form a CV-syllable pattern. This is exactly what happens in the pronunciation of *ice*, *oil*, *orange*, *accept*, etc. The reader is referred to Broselow (1987), Tropf (1987), and Mousa (1994) for a fuller account on how Arab learners of English treat English onsetless words. But this seems to be a familiar practice in the speech of adults from different linguistic backgrounds. For instance, Samareh (1977) reports that, in Farsi, every initial vowel is preceded by glottal stop, and this affects the speech of Farsi learners of English. Furthermore, Borselow (1987) has reached the general conclusion that learners' strategy in pronunciation of words which begin with a vowel seems to be universal, since "insertion of a glottal stop before an initial vowel, is allowed, at least in slow speech, in every language of the world" (p. 374).

It is very interesting that our Jamaican informants do also prothesize a sound to fill in syllable onset, but it is not glottal stop. Our informants choose to insert glottal fricative /h/ word initially in words beginning with a vowel (c.f., Appendix B). This treatment has been observed by a number of creolists, among whom are, Wells (1973), Holm (2000), and Cassidy (1961, p. 37) who maintains that "one other consonant, h, behaves in a non-standard way. It is as often as not, prefixed to stressed vowels or diphthongs, as in 'heggs' and 'hice', meaning *eggs and ice*, and dropped irregularly from other words such as 'ow', 'igh', and 'ouse', meaning *how*, *high*, *and house*". A rule accounting for this process may look as follows:

1- h → Ø /# — [+syll-cons]

2- Ø → h /# — [+syll-cons]

It is controversial whether or not the Broad Jamaican Creole contains the glottal fricative /h/ in its inventory (c.f., Wells, 1973). We will assume that the informants do not have this fricative as a phoneme. This is because, according to Hessling (in Holms, 2000), use of the prothetic /h/ reflects a general phenomenon in creole languages resulting from the lack of initial vowels in many West African languages (i.e., the substrate languages of the Atlantic Creoles), hence the employment of this fricative "to conform to substrate phonotactic rules" (Holm, 2000, p. 110).

Furthermore, the placement of glottal fricative /h/ between parentheses in the phonemic inventory of Jamaican Patois proposed by Harry (2006) seems to suggest its dubious phonemic status. Another argument in favour of use of glottal fricative in Jamaican Creole for the purpose of onset filling is the salient characteristic of this fricative in that it is vulnerable to be added and dropped unsystematically, to the extent that most of the times when an alien sound is added or dropped, it is assumed to be glottal fricative by default, (c.f., Lass, 1984).

On the other hand, there is no singular instance of use of glottal fricative before vowel-initial words in the speech of Arab learners. The reason is that glottal fricative and glottal stop are two distinct sounds in all varieties of Arabic. Consider the minimal pairs in Table 4.

Table 4. Arabic minimal pairs containing the glottals /h/ and /ʔ/

| Arabic Word | Meaning |
|---|---|
| ʔæræb | *Desire, aim* |
| Haræb | *He fled.* |
| Næhæ | *He prohibited.* |
| næʔæ | *He went away.* |
| rædʒæːʔ | *Hope* |
| rædʒæːh | *He begged him earnestly.* |

It is clear from the examples in the table above that glottal stop and glottal fricative are, without dispute, two separate phonemes and substituting one for the other will result in change of meaning.

The tendency of onset filling results in the creation of a CV syllable, which seems to be the optimal syllable in the world's languages, and a syllable that begins with a vowel is ill-formed. Therefore, a repair strategy (Paradis, 1988) is implemented to deal with this situation. The data in Table 5 below lend further support to the view that, in pidgin and creole languages, syllables with onsets have preference over onsetless ones, especially the CV forms. The examples therein are provided by Holm (2000) from a number of pidgin / creole languages which are based on different European superstrate languages.

Table 5. Evidence for preference of syllables with onsets

| Pidgin/Creole form | Etymon | Gloss | Superstrate Language |
|---|---|---|---|
| Kupa | Ocupar | occupy | Portuguese |
| Vale | Avaler | swallow | French |
| Rive | Arrive | arrive | French |
| Sukú | oscuro/escuro | dark | Portuguese, Spanish |
| Merican | Merican | American | English |
| Merkin | Merkin | American | Dutch |
| Géza | Igreja | church | Portuguese |

Notice that all the above words begin with onsetless syllables in the superstrate languages which are reduced to syllables with onsets in the pidgin/creole languages.

Thus, the structural constraint that is relevant here (c.f., Optimality Theory below) is: Onset. According to this constraint, and as Kiparsky (2012) puts it, a syllable should have an onset, otherwise the syllable will be structurally marked and, according to Kiparsky (2012), syllable markedness predicts that marked inputs are changed into unmarked outputs. This is exactly what happens in the speech of the two groups (i.e., Arab learners and Jamaican informants). We have seen that Arab learners and Jamaican informants produce vowel initial words by adding either glottal stop or glottal fricative, respectively. In both cases, it is assumed that in their speech structural constraints outrank faithfulness. In other words, their grammar prefers structurally unmarked outputs over faithful outputs in which these words are produced with initial vowels.

Now, the performance of our Arab learners and Jamaican informants is explained in light of Optimality Theory, according to which more of the practice of the two groups is expected to be revealed.

## 6. Optimality Theory (OT)

The principal assumption of this theory is that Universal Grammar comprises a set of ranked and violable constraints on output structures along with a general mechanism for resolving their conflicts. The mechanism employed by OT to resolve these conflicts is to rank constraints in a strict dominance hierarchy in such a way that higher-ranked constraints dominate lower-ranked ones. Thus, variation among languages is ascribed to languages specific rankings. There are mainly two types of constraints. The Structural Constraint (or Well-formedness Constraints) demand that outputs should be structurally unmarked, whereas Faithfulness Constraints demand that outputs are structurally marked or unmarked. It has been emphasized that in child language, initially, structural constraints are usually ranked above faithfulness constraints resulting in core syllable (CV) productions (Vennéman, 1988; Battistella, 1990; Belvins, 1995; Fikkert, 1994) among others. CV is considered to be a universal default maximally unmarked syllable (Fikkert, 1994). Moreover, Moskowitz (1973, p. 74) has gone as far as suggesting that "beyond the primary acquisition of the (CV), there is no unique and specific pattern or order of acquisition of syllable types, which could reasonably be predicted as that which all children follow". This tantamounts to the saying that CV is the optimal syllable structure in the world's languages.

Our learners' production with respect to sibilant + stop (ST) (Note 2) clusters and obstruent + sonorant (OR) clusters corroborates Singh's (1985) statement that "an unacceptable word-initial consonant cluster is broken up by the insertion of a vowel before the more sonorous segment" (p. 273). In other words, the epenthetic vowel is inserted into rising sonority clusters, but before non-rising sonority clusters. Although our learners do not encounter difficulty with some (ST) clusters in this study (perhaps because the words are familiar to them) one cannot rule out the possibility that they would opt for prothesis had they been given unfamiliar (ST) clusters. This argument is supported by the fact that Arab learners of English are known for use of this strategy with this kind of clusters (c.f., Broselow, 1987, 1992, 1993). As for the (OR) clusters, we have seen that our Arab learners as well as the Jamaican informants resort to epenthesis in their attempt to produce /sm/ and /sn/ clusters. The data in Table 3 display the same behaviour of prothesizing and epenthesizing in the production of (ST) and (OR) clusters, respectively used by learners of English from different linguistic backgrounds. The choice to employ either of these strategies does not seem to be haphazard. Rather, Fleischhacker (2001, p. 1) argues that "in languages displaying anaptyxis-prothesis asymmetries, the epenthesis site is chosen to maximize auditory similarities between the non-epenthesized input and the output". According to Fleischhacker, "for input obstruent + sonorant anaptyctic [epenthesis, emphasis mine] outputs are judged as sounding more like the input than prothetic outputs; but the opposite is true for input sibilant + stop clusters" (2001, p. 1). More precisely, epenthetic vowels are placed exactly inside obstruent + sonorant cluster, but before a sibilant + stop cluster (our learners used both prothesis and epenthesis). An analysis suggested by Fleischhaacker (2001) which accounts for the placement of vowels in the two clusters in question (i.e., OR and ST) is viewed as the combinal effect of two well-known phonological constraints proposed by Bat-El (1996), Morell (1999) among others, and McCarthy and Prince (1995), respectively. These constraints are *Syll*(able) *Cont*(act) which states that: a syllable onset should be less sonorant than the preceding coda, and *Contiguity* which dictates that segments in the input should be contiguous at output. As can be seen in Table 6 which is adopted from Fleischhacker (2001), the constraints SyllCont drives epenthesis (anaptyxis) before the more sonorous member of OR cluster, and Contiguity (which is ranked below SyllCont) dictates prothesis in the ST cluster of falling (or level) sonority.

Table 6. Syllable contact analysis (Fleischhacker, 2001, p. 12)

| | /ORV/ | | | /STV/ | | |
|---|---|---|---|---|---|---|
| | Oə.RV | əO.RV | ORV | əS.TV | Sə.TV | STV |
| * COMPLEX | | | * ! | | | * ! |
| SYLLCONT | | * ! | | | | |
| CONTIGUITY | * | | | | * ! | |
| * CODA | | * | | * | | |
| ONSET | | * | | * | | |
| LEFT-ANCHOR | | * | | * | | |
| DEP-[ə] | * | * | | * | * | |

It is clear that initial CC-clusters are ill-formed and unacceptable, according to the constraint *Complex-Onset (Prince & Smolensky, 1993). This is the case in Arabic (the language of our learners), in pidgin and creole languages (Cassidy, 1961; Holm, 2000) among others, and child language (we have mentioned earlier that the child tends to reduce initial CC-clusters into singletons). This seems to be a universal tendency, as the CV syllable structure is most preferred in the world's languages. The table also indicates that prothesis is ruled out as the possible candidate in coping with an input that contains an initial rising-sonority cluster such as OR. SyllCont suggests that anaptyxis is the right candidate. But in an input contianing an initial ST sequence, anaptyxis and prothesis are both satisfactory, according to SyllCont, though Contiguity favours prothesis. Thus, it seems that Arab learners of English treat OR clusters and ST clusters in the same way displayed in the above table (including the learners in this study).

The data in our study lends support to Fleischhacker's (2001) findings that not all OR clusters are equal. That is, stop + sonorant clusters are more likely to instigate use of anaptyxis than sibilant + sonorant sequences. We have seen that almost all instances of *pr*, *kr*, *gr*, *br* clusters are produced with epenthetic vowel in the speech of our learners, and that /sm/ and /sn/ clusters are sometimes produced without epenthesis. Fleischhacker (2001, p. 15) has proposed the following interpretation to account for this fact. Stop offsets are relatively more abrupt than fricative offsets; and that unlike sibilants, "stops-by virtue of their silent closures-contain a built-in auditory rebound interval, and thus benefit from a perceptual boost at release". According to Fleischhacker, these facts would mean that one expects a stronger perceptual break at stop release than at sibilant release. That is, the strength of a cluster-internal perceptual break is of vital importance in determining whether the cluster is vulnerable to intrusion by an epenthetic vowel. In fact, stop + consonants are prone to be most problematic in our learners' pronunciation, in that almost all of them (especially voiced stop + r sequences) are produced with epenthesis. This would suggest that presence of a fully voiced environment may instigate anaptyxis more than when the cluster involves voiceless segments. This is why, perhaps, /sp/, /st/ and /sk/ clusters were produced with prothesis (though epenthesis was also used) in the speech of Arab learners as well as other learners from different linguistic backgrounds. Davidson (2000) provides evidence in support of this view. In his study English speakers are asked to produce pseudo-Polish words with initial CC-clusters that are illicit in English. The subjects resort to a variety of repair strategies (c.f., Paradis, 1988) including vowel epenthesis, consonant reduction, and consonant substitutions, but use of vowel epenthesis (anaptyxis) is the most frequent strategy, accounting for 74% of all errors. More specifically, the voiced clusters [*vn, vz, dv*] are prone to be more vulnerable to epenthesis than the voiceless clusters [*kt*, *pt*, *kp*, etc.]. This suggests that vowel insertion into a voiced sequence is less auditorily intrusive than epenthesis into a voiceless sequence (Fleischhacker, 2001) (Note 3).

Returning to Fleischhacker's (2001) point that the choice to employ epenthesis or prothesis has to do with the maximizing of auditory similarity between the non-epenthesized input and the output, Fleischhacker provides evidence to the effect that "anaptyctic modifications of obstruent + sonorant clusters are auditorily more similar to the input than prothetic modifications, while prothetic modifications of sibilant + stop clusters are more similar to the input than anaptyctic modifications" (p. 16) (Note 4). The reader is referred to the above work for a detailed account.

So far, three types of initial CC clusters have been dealt with in our study, namely, Stop + Liquid (e.g., *pr*, *tr*, *kr*, *br*, *dr*, *gr*), Sibilant + Nasal (e.g., *sm*, *sn*), and Sibilant + Stop (e.g., *sp*, *st*, *sk*). The types Stop + Liquid and Sibilant + Nasal are also referred to as OR (i.e., obstruent + sonorant). Following Fleischhacker (2001), we would like to employ a mechanism that mediates between the demand of similarity to input and the selection of output candidates in terms of a family of DEP-Vowel (DEP-V) constraints that differentially penalize vowel insertion in different segmental contexts. According to DEP-V, sites of vowel insertion are not equal. Rather, the context in which insertion takes place is crucial in calculating correspondence between input and epenthesized output. Fleischhacker suggests the following context-sensitive DEP-V constraint: DEP-V/X_Y (which reads: A vowel in the output context X_Y has a correspondent in the input context X_Y). To account for the behaviour of our learners and Jamaican informants with respect to the pronunciation of the initial consonant clusters under study, we would like to use the universally-ranked partial scale of context-sensitive DEP-V constraints proposed by Fleischhacker (2001) below.

DEP-V / S_T » DEP-V / S_N » DEP-V / S_L » DEP-V / T_R

These constraints are instigated by the findings of Fleischhacker's experiments which clearly manifest an ST_OR distinction with respect to the relative auditory similarity of the output [CVC] and the input /CC/ we have seen, and which point to the need of establishing finer distinctions among OR clusters. The above partial DEP-V scale provides a priori ranking suggesting that "epenthesis between a voiceless sibilant and a stop is always more costly than epenthesis between a voiceless sibilant and a nasal, which is more costly than epenthesis between a voiceless sibilant and a liquid, which is more costly than epenthesis between a stop and a sonorant" (2001, 1992. p. 31).

Based on this ranking one can easily see that our Arab learners are not different from Fleischhacker's subjects with respect to the pronunciation of the clusters in question. In other words, mention has been made of the fact that Arab learners generally prothesize (and to some extent epenthesize) for ST clusters but epenthesize for OR clusters. But within OR clusters, our learners have produced almost all stop + sonorant clusters with epenthesis, thus, abiding by the heirarchy provided in the above ranking. This would mean that epenthesis between a stop and a sonorant is the least costly manoeuvre in the above-mentioned ranking. On the other hand, epenthesis between a voiceless sibilant and a stop is the most costly option, therefore, speakers would opt for prothesis to cope with the production of this kind of cluster. Indeed, the learners prothesized more frequently in the production of these clusters. This is exactly what Arab learners of English have always exhibited. The reader will notice that /sm/ and /sn/ clusters were among OR clusters; they were less vulnerable to epenthesis than /pr, tr, kr, br, dr, gr/ clusters. Evidence in favour of this position is provided in that although our learners and informants epenthesized, in addition to native-like production of sibilant + nasal clusters, almost all stop + r instances in the speech of our learners were with epenthesis.

The reader will notice that in the production of most English words containing initial CC, our Arab learners resort to the strategy of epenthesis to break up the clusters in question. We have seen that the placement of the vowel depends on the nature of the members of the cluster. More illustration of the treatment of these clusters can be provided by considering a number of markedness and faithfulness constraints Fleischhacker (2001) has utilised to display the predictive power of the context-sensitive DEP-V constraints. Consider (1) and (2), respectively.

(1) Markedness Constraints

a. C/V: A consonant is prevocalic.

b. C//V: A consonant is adjacent to a vowel.

c. Onset: A vowel is preceded by a consonant.

(2) Faithfulness Constraints

a. Contiguity: Segments adjacent in the input are adjacent in the output, and vice versa.

b. DEP-[ʔ]: Output [ʔ] must have an input correspondent.

c. LEFT_ANCHOR: A segment at the left edge of the input must have a correspondent at the left edge of the output.

As mentioned above, the constraint C//V discards initial and final consonant clusters (i.e., CC-and-CC), while C/V disallows medial clusters, as well, (c.f., Steriade, 1999). The constraint ONSET (Prince & Smolensky, 1993) outlaws vowel-initial words. Accordingly, our Arab learners and Jamaican informants-as we have seen earlier-opt for the strategy of Onset-Filling (Itô, 1989) to get by in the production of such words. The two groups, however, made use of two different glottal sounds to fill in the onset position, namely, glottal stop [ʔ] in the case of Arab learners and glottal fricative [h] in the case of Jamaican informants.

Thus, in Fleischhacker's (2001, p. 29) terms, "the goal of maximal auditory similarity to input claimed to be active here is presumably the same force that pressures epenthetic segments to be minimally obtrusive themselves, e.g., [ʔ] and [h], which have no supraglottal articulation and thus do not impose transitions on neighbouring segments". But once use of glottal stop for the purpose of onset-filling seems to be universal, according to Broselow (1987), the constraint DEP-[ʔ] is rightly included to allow for the possibility of consonant epenthesis dictated by ONSET. The constraint CONTIGUITY bans intrusions in general, thus according to this constraint, both epenthesis and prothesis represent a clear violation, but due to the need of maximal auditory similarity to input mentioned above, epenthesis is used by our learners and informants in the production of OR cluster, whereas for Arab learners in general prothesis is the choice when ST cluster is dealt with. Finally, LEFT-ANCHOR prohibits prothesis which is the use of an external [ə] (i.e., vowel) to the contiguous string which corresponds to the input. This takes place with ST clusters. For instance, in the production of *spa* as [əspa] use of prothesis earns one LEFT-ANCHOR violation, but no context sensitive-DEP-[ə] violations. On the other hand, the production of the same word with epenthesis (i.e., anaptyctic) [səpa] earns one DEP-[ə]/S-T violation but no LEFT-ANCHOR violation. Markedness constraints and Faithfulness constraints are displayed in the following table (adapted from Fleischhacker, 2001).

Table 7. Canonical anaptyxis-prothesis asymetry (Fleischhacker, 2001, p. 35)

| | /STV/ | | | | /SNV/ | | | |
|---|---|---|---|---|---|---|---|---|
| | ʔəSTV | əSTV | SəTV | STV | ʔəSNV | əSNV | SəNV | SNV |
| DEP-[ə]/S-T | | | * ! | | | | | |
| ONSET | | * ! | | | | * ! | | |
| C//V | | | | * ! | | | | * ! |
| C/V | * | * | | * | * ! | * | | * |
| L-ANCHOR | * | * | | | * | * | | |
| DEP-[ʔ] | * | | | | * | | | |
| CONTIGUITY | | | * | | | | * | |
| DEP-[ə]/S-N | | | | | | | * | |
| DEP-[ə]/S-L | | | | | | | | |
| DEP-[ə]/T-R | | | | | | | | |

As can be seen from the table, in the input /STV/ undominated DEP-[ə]/S-T and C//V dictate a prothetic output. It is also clear that epenthesis is inforced as a result of domination of DEP-[ʔ] by ONSET. Applying this to Arabic, this is because Arabic does not allow more than one consonant word-initially.

Arabic also outlaws beginning a word with a vowel. In other words, onsetless syllables are not allowed, hence the need for onset filling. As for the input /SNV/, either prothesis or epenthesis (anaptyxis) are satisfactory, but once the prothetic output* [ʔəSN] violates the constraints DEP-[ʔ], LEFT ANCHOR, and C/V which are ranked low, the choice falls on anaptyctic [SəN]. Thus, one can see that OT is a valuable model of representation that can be employed to account plausibly for the production of speakers in different language contexts.

## 7. Conclusion

From the above discussion one would conclude that the strategies Arab learners and Jamaican informants employ are not different from those witnessed in loan phonology (Jarrah, 2013; Coetsem, 2016; Yildiz, 2010) and interlanguage phonology (Broselow, 1979, 1984; Eckman, 1977; Carlisle, 1991). That is, these strategies are characterized by use of epenthesis (anaptyxis) into obstruent + sonorant clusters and by use of prothesis mainly (in addition to epenthesis) before sibilant + stop sequences. Following Fleischhacker (2001, p. 1), we will take it that the ultimate stance behind such strategies is “to maximize perceptual similarity between input and output”. This claim has been supported by the results of experiments held by Fleischhacker on “English speakers’ judgements of auditory similarity and preference for epenthesized modifications of cluster-initial words” (p. 38). Moreover, the discussion has shown that native-like production of the clusters in question is possible, especially regarding familiar and frequently used sequences. Thus, although it is common practice for Arab learners to produce sibilant + stop clusters with prothesis (and sometimes with epenthesis), our learners in this study did not face difficulty with some words, perhaps because they were familiar and frequently used in class. Regarding obstruent + sonorant sequences, however, the behaviour varies. Thus, whereas Stop + /r/ clusters were almost all produced with epenthesis, sibilant + nasal sequences were sometimes produced with epenthesis and sometimes without. We have seen that errors with /sm/ sequences were greater. As for the production of English words beginning with a vowel, both groups resorted to the strategy of onset filling, to repair the illicit syllable structure in these words according to the constraint ONSET, which dictates that a syllable must have an onset. Finally, as we have seen throughout the discussion, when Arab learners of English and Jamaican informants choose to modify the test words, the end results are creation of CV syllable structure.

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**Notes**

Note 1. Cardoso (2008) investigates acquisition of /st/, /sn/, and /sl/ onset clusters in the speech of Brazilian Portuguese speakers learning ESL and concludes that the higher the degree of sonority in the sound after the /s/, the lower the proportions of e-epenthesis.

Note 2. The reader is reminded that ST = sibilant + stop (e.g. /sp/, /st/, /sk/), SN = sibilant + nasal (e.g. /sm/, /sn/), SL = sibilant + liquid / lateral (e.g. /sl/), TR = stop + liquid (e.g. /pr, tr, kr/). Apart from ST, all other sequences are classified under the umbrella of OR (obstruent + sonorant).

Note 3. But use of prothesis before a voiceless sibilant + stop is also worth accounting for. Fleischhacker (2001) assumes that the transition from sibilant to stop results in a rapid decrease in intensity; it involves moving from noise to silence, thus there is no formant structure. In the absence of these properties, the use of epenthesis at the s + stop juncture would necessarily prompt a rather salient departure from the input (hence a clear violation of "Contiguity"). Thus, prothesis is a much better candidate of the two alternatives, with respect to maximizing auditory similarity to the input form. More specifically, "the output string corresponding to the input is not interrupted by an inserted element" (Fleischhacker, 2001, p. 10).

Note 4. In short, use of prothesis before voiceless sibilant + stop clusters renders them sound more like the non-epenthesized input than use of anaptyxis (i.e., epenthesis), whereas the opposite is true for obstruent + sonorant sequences.

## Appendix A

## Production of Arab Learners

| Word | Arab Learners | RP |
|---|---|---|
| Stop | ɪstɒp, sətɒp, stɒp | stɒp |
| Star | stær, sətær, | stɑ: |
| Craft | Kəraft | krɑ:ft |
| Pram | pərɑ:m, pɪræm | præm |
| Train | təre:n | treɪn |
| Crane | kəre:n | kreɪn |
| Pricks | pərɪks, pərɪkɪs | prɪks |
| Trout | təræwʊt | traʊt |
| Smile | səmaɪl | smaɪl |
| Small | səmɔ:l, smɔ:l | smɔ:l |
| Sniper | sənaɪber, snɪpær | snaɪpə |
| Smart | Səmært | smɑ:t |
| Cream | kɪri:m, kari:m | kri:m |
| Snack | sənæk, snɑ:k | snæk |
| Smell | səmɪl | smel |
| Glass | Gəlæs | glɑ:s |
| Sleep | səli:p, səli:b | sli:p |
| School | əsku:l, sku:l | sku:l |
| Smooth | səmu:θ, səmu:s | smu:ð |
| Glow | gəlɔ:, gəlaʊ | gləʊ |
| Slim | səlɪm, slɪm | slɪm |
| Ice | ʔaɪs | aɪs |
| Egg | ʔɪg | eg |
| Oil | ʔɔ:ɪl, ʔɔ:jəl | ɔɪl |
| Orange | ʔɔ:rʌŋg, ʔɔ:rʌdʒɪ | ɒrɪndʒ |
| Around | ʔæraʊnd | əˈraʊnd |
| About | ʔæbæwʊt | əˈbaʊt |
| October | ʔɒkto:bʌr | ɒkˈtəʊbə |
| Opt | ʔɒbət | ɒpt |
| Spoon | əsbu:n, səpu:n, spu:n, sbu:n | spu:n |
| Speak | əspi:k, əsbi:k, səbi:k | spi:k |
| Stick | əstɪk, səti:k, sətɪk | stɪk |
| Class | klæs, kəlæs | klɑ:s |
| Clean | kəli:n | kli:n |
| Clear | kəli:r | klɪə |
| Ugly | ʔæglɪ, ʔæglaɪ | ʌgli |
| Optical | ʔɒbtɪkæl | ɒptɪkl |
| Olive | ʔɒlɪf, ʔɒli:v | ɒlɪv |
| Eight | ʔe:t | eɪt |
| Glimpse | gəlɪmbəs | glɪmps |
| Glare | gəle:r | gleə |
| Snake | səne:k, snækɪ, sne:k | sneɪk |
| Great | gəre:t | greɪt |
| Draw | dərɔ: | drɔ: |
| Drink | dərɪŋk | drɪŋk |
| Slow | səlɔ: | sləʊ |

**Appendix B**

**Production of Jamaican Informants**

| Word | Jamaican Informants | RP |
|---|---|---|
| Stop | stɒp, stɑp | stɒp |
| Star | stɑ:, stɑ:r | stɑ: |
| Craft | krɑ:ft | krɑ:ft |
| Pram | Pram | præm |
| Train | tre:n | treɪn |
| Crane | kre:n | kreɪn |
| Pricks | prɪks, prɪk | prɪks |
| Trout | traʊt | traʊt |
| Smile | səmaɪɫ | smaɪɫ |
| Small | səmo:l, səma:l | smɔ:ɫ |
| Sniper | sənaɪpə | snaɪpə |
| Smart | sma:rt, səma:t | smɑ:t |
| Cream | kri:m | kri:m |
| Snack | sna:k, sənæk | snæk |
| Smell | səmeɫ | smeɫ |
| Glass | glæs, gla:s | glɑ:s |
| Sleep | sli:p | sli:p |
| School | sku:ɫ | sku:ɫ |
| Smooth | səmu:θ, səmu:t | smu:ð |
| Glow | glɔ: | gləʊ |
| Slim | slɪm | slɪm |
| Ice | haɪs | aɪs |
| Egg | eg, heg | eg |
| Oil | hɔɪɫ | ɔɪɫ |
| Orange | ɒrɪndʒ, hɒrɪndʒ | ɒrəndʒ |
| Around | araʊnd, araʊnd | araʊnd |
| About | abaʊt | abaʊt |
| October | ɒktɔ:bə | ɒktəʊbə |
| Opt | hɒpt, ɒpt | ɒpt |
| Spoon | spu:n | spu:n |
| Speak | spi:k | spi:k |
| Stick | stɪk | stɪk |
| Class | klæs, klɑ:s | klɑ:s |
| Clean | kli:n, kəli:n | kli:n |
| Clear | kli:r, kəli:r | klɪə |
| Ugly | hɒglɪ | ʌglɪ |
| Optical | hɒptɪkaɫ | ɒptɪkəɫ |
| Olive | hɒlɪv | ɒləv |
| Eight | he:t | eɪt |
| Glimpse | glɪms | glɪmps |
| Glare | gle:r | gleə |
| Snake | səne:k , sne:k | sneɪk |
| Great | gre:t | greɪt |
| Draw | drɑ:, drɔ: | drɔ: |
| Drink | drɪŋk | drɪŋk |
| Slow | slɔ:, səlɔ: | sləʊ |

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