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The Intelligibility of the Onset Cluster [pl] and the Coda Cluster [ɳz] in Arabic-Accented English

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THE INTELLIGIBILITY OF THE ONSET CLUSTER [pl] AND THE CODA CLUSTER [ŋz] IN ARABIC-ACCENTED ENGLISH

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ABSTRACT

This paper analyzes two specific instances of English consonant-cluster production among native Arabic speakers of English. We analyze the onset cluster /pl/ and the coda cluster /ŋz/. These clusters are of interest because the first segment in each cluster does not exist in Arabic but the second is shared by both Arabic and English. Five Arabic-speaking subjects were selected based on a number of shared features, including a shared city of origin, beginning their acquisition of English after the critical period, and having spent no more than one year in an English-speaking environment at the time of the recordings. The findings give us the opportunity to assess the participants' pronunciations of these clusters in light of the two syllable phonotactic constraints: Sonority Sequencing Principle (SSP) and the Minimal Sonority Distance Parameter (MSDP). Other issues investigated have to do with the segmental transfer hierarchy and ranking.

1.0 Introduction

One of the central focuses of contemporary phonology is the principles guiding the organization of individual segments into clusters. This is particularly important in L2 phonology because phonotactic constraints vary from one language to another. Therefore, learning to speak an L2 is also learning to produce its clusters even when some are different from the L1 of the speaker. This paper examines two English clusters [pl] and [ŋz] that do not have their equivalents in Arabic. Their production patterns are analyzed and discussed with respect to their overall impact on intelligibility. However, prior to investigating the Arabic-accented pronunciation of these clusters, we must provide a quick overview of phonotactic constraints on onset and coda clusters in Arabic. This background information will allow us to explore further the pronunciation issues that the participants in our study face when producing English words that contain [pl] in the onset and [ŋz] in the coda.

1.1 An Overview of Arabic Onset Phonotactics

Arabic, the native language of the five participants in our study, is a member of the Afro-Asiatic language family, and more specifically part of the Semitic family of languages that includes Hebrew and Aramaic. Most of the Arabic lexicon is composed of words derived from sets of three consonants. This is referred to as "tri-lateral roots" in the Semitic linguistic literature. These roots combine in various ways to produce all the content words within the language. They undergo fairly predictable morphophonological changes to form different parts of speech and verb conjugations, as in the example below:

Trilateral root: **k – t – b**

Base form: ***k****a****t****a****b****a*** (he wrote)

Morphological change as a prefix: *a****k****t****u****b****u*** (I write)

Morphological change as a suffix: ***k****a****t****a****b****tu*** (I wrote)

Morphological vowel change between roots: ***k**aat**i**b* (writer)

Morphological consonantal interfix between roots: ***ak**tat**ab**a* (I enroll)

We see that vowels are interposed between the three consonants that make up the [k-t-b]. Prefixes, suffixes, or interfixes are added to the root as required by the word formation rule of the structure under consideration. Morphological rules make it easy to identify the parts of speech of most words. These regular morphological patterns have important implications for Arabic segmental phonology. It means that some segmental patterns will occur frequently, others infrequently, and others not all. This is especially true for consonant clusters. Ibrahim (2012:27) explains it as follows:

> … languages differ as to the types of the syllable structure that they admit. The difference is mainly a matter of the extent to which different languages permit consonant clusters to occur at the beginning or end of syllable. For example, many varieties of Modern Standard Arabic admit no onset consonant clusters at all, but allow final clusters of two or three consonants. In some occasions, not only the number of consonants occurring initially and finally in syllables is always subservient to constraints imposed by the phonological structure of the language, but the particular sequences of consonants occurring in clusters are also limited.

2.0 An Overview of Arabic Onset Phonotactics

As Ibrahim (2012) mentioned, most varieties of Arabic in use today do not allow for onset consonant clusters, although coda consonant clusters frequently occur. Because of the morphological patterns of Arabic, even the circumstances which would allow for consonant clusters to occur in the initial position of a word are rare. As a result, onset clusters are illicit for the most part. Even in circumstances where such a construction is expected, an epenthetic vowel is used to break up the onset cluster. Consider the words <akram> (he honors) in Figures 1 and 2 examples below:

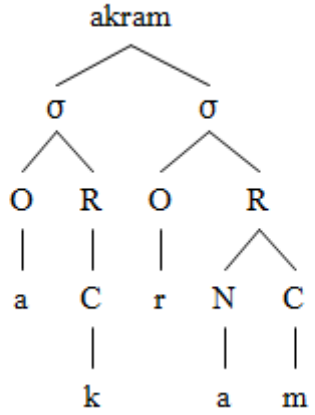

Figure 1: Resyllabification

In this example, the consonant cluster [kr] is illicit in Arabic phonology. Therefore, [k] and [r] belong to two different syllables, as show in the diagram above. Let's also consider the word <istisla:m> (submission) in Figure 2:

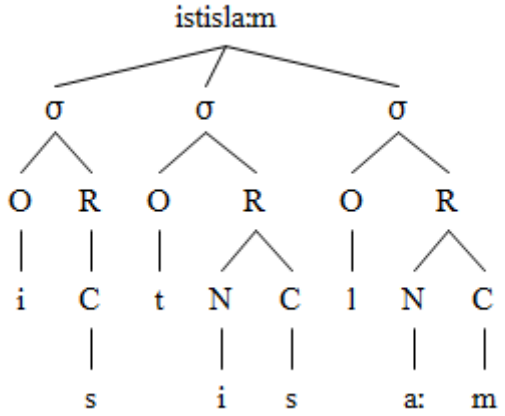

Figure 2: Resyllabification

Here, the tri-lateral root is [s – l – m]. The derived word consists of the prefix [i] and the consonant interfix [t]. In this example, there are two instances where English phonology would permit consonant clusters, namely [st] and [sl]. However, Arabic phonology does not allow such clusters in syllable onsets. There, [st] and [sl] are disallowed from occurring. As a result, [s] and [t] belong to two different syllables. The same is true for [s] and [l]. Both in Figures 1 and 2, we have resyllabification.

3.0 An Overview of Arabic Coda Phonotactics

Arabic phonology allows consonant clusters in the coda. In fact, because of the morphological patterns of Arabic, coda consonant clusters are fairly common. VCC or VCCC clusters are common, as indicated in the above-mentioned quote (Ibrahim 2012). One of the frequently-occurring morphological patterns in Arabic, one form of the noun, is characterized by the final two letters of the tri-lateral root forming a consonant cluster, as in the word [ʃukr] (gratitude) below:

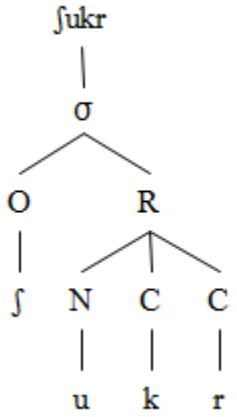

Figure 3: Coda Cluster

In both the words [ʃukr] and [akram], the segments [k] and [r] occur in succession. However only in the coda position do they form a consonant cluster [kr]. In [akram], [k] and [r] belong to two separate syllables as indicated by the following syllabification [ak•ram]. Coda clusters of the CVCC-type are very common in Arabic nominals, as exemplified by [qistˁ] (fariness). However, it is important to also note that resyllabification happens in coda clusters. This generally occurs if a vowel follows the second consonant in the cluster, as seen in Figures 4 and 5.

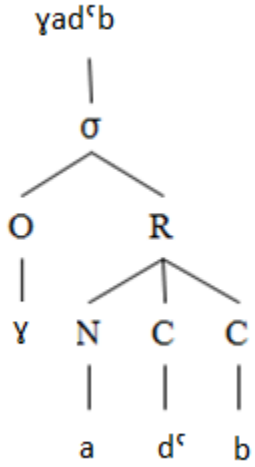

Figure 4: Monosyllabic Word

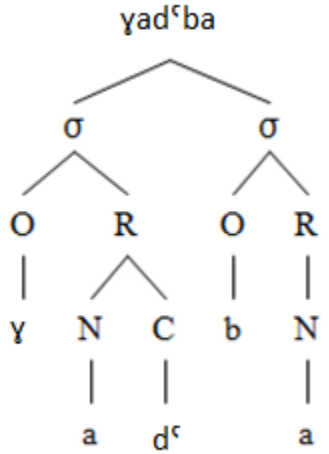

Figure 5: Disyllabic Word

As a result of a morphophonological rule, the syllable structure of [ɣadˁb] (anger) has changed to [ɣadˁba] (wrath). The addition of the suffix [a] has caused [b] to change from being a coda segment to becoming the onset of the next syllable. This resyllabification is very common in Arabic. A CVCC pattern resyllabifies into CVC•CV as a result of suffixation. This a derivational profess that changes a masculine noun into a feminine noun. This type of resyllabification is also common in connected speech. The result would be the same. The word [ɣadˁb] would resyllabify as [ɣadˁ•ba]. Arabic phonology has a name for this process. It is called *sukuun*. Alhawary (2012:8) provided the following helpful rule of thumb on this topic by writing, "a good way to conceptualize the *sukuun* in Arabic, if a word contains a *sukuun*, is to consider it the point at which a word can be broken into parts/syllables."

4.0 Data Set and Participants

The background information presented above gives us a glimpse of the kinds of phonological issues Arabic speakers are likely to face when producing English words that have complex onsets and codas. There are hundreds of such clusters in English but we limit the investigation to two clusters: [pl] in syllable onsets and /ŋz/ in syllable codas in this paper. They are chosen specifically because the first segment of each cluster does not exist in Arabic, while the second segment has a counterpart in Arabic.

There are five participants in this study. They hail from the same city of Jeddah, Saudi Arabia. Although it cannot be determined with absolute certainty, this geographic commonality

likely also coincides with a shared dialect, namely the Hijazi dialect of Arabic common to the western part of Saudi Arabia. The similarities among the subjects are not limited to their first language, but also extend into their second language. All five subjects have had exposure to American English, and at the time of their recordings, each subject had been immersed in an English-speaking environment for no more than one year. The data used in this analysis comes from *The Speech Accent Archive*.[1] The participants are Arabic 40M, 42M, 46M, 47M, and 50M. The subjects differed in their ages and age of onset of English instruction, but all subjects were adults and had begun English study after the critical period. The average age of English onset was 15.4 years old, while the average age of the subjects was 28.8 years with a range of 18. The average length of exposure to English was 11.4 years. The biographical data available at the website shows that none of the subjects had spent more than a year in an immersive language environment at the time of their recordings. The subjects were each recorded reading the following passage:

> ***Please*** *call Stella. Ask her to bring these* ***things*** *with her from the store: Six spoons of fresh snow peas, five thick slabs of blue cheese, and maybe a snack for her brother Bob. We also need a small* ***plastic*** *snake and a big toy frog for the kids. She can scoop these* ***things*** *into three red bags, and we will go meet her Wednesday at the train station.*[2]

The words in the text containing the complex onset and coda clusters under investigation are in bold. To date, 2,546 people have read the same text.[3] As noted on their website, the Speech Accent Archive text makes it possible to do all kinds of phonetic and phonological analyses. One can compare specific phonological and phonetic features between native speakers, between non-native speakers and native speakers, between dialects, etc. Some of the recordings have been transcribed phonetically by George Mason University linguists. Their methodology is described at the website. The owners of the website vouch for the accuracy of the phonetic transcriptions. We take their claim at face value since so far, we have not seen evidence to the contrary. For the purposes of this paper, the five Arabic participants' pronunciations of [pl] and [ŋz] are compared and contrasted with MN 143M, that is, a male speaker from the state of Minnesota, in the USA. He is taken as the "model" native speaker against whose pronunciation we compare the five Arabic non-native speakers of English for two reasons. First, we are more familiar with this accent and secondly, because this research was conducted in Minnesota.

5.0 The Production [pl] Cluster in Syllable Onsets

The cluster [pl] occurs in two words, <please> and <plastic>. As mentioned above, Arabic lacks the voiceless bilabial stop [p] but has the lateral liquid [l] in its phonetic inventory. The segment [p] was produced in a number of different ways, as displayed in Table 1 below:

[1] Biographical information about the participants is available at: http://accent.gmu.edu/browse_language.php?function=find&language=arabic.
[2] The text and various other information are found at: http://accent.gmu.edu/howto.php.
[3] Retrieved on March 13, 2018 from http://accent.gmu.edu/.

Words	**Please**	**Plastic**
Onset cluster	/pl/	/pl/
MN143	[pʰl]	[pʰl]
Arabic 40M	[bə̆l]	[bl]
Arabic 42M	[bl]	[əb]
Arabic 46M	[əp̬l̥]	[pʰl]
Arabic 47M	[pəl]	[bl]
Arabic 50M	[pəl]	[pl]

Table 1: Onset [pl] Clusters

In 5 out 10 occurrences, /p/ was produced as /b/, that is, the voiceless bilabial stop was pronounced as a voiced bilabial stop. This amounts to the voicing of [p] in 50% of the cases. In the remaining 50%, an epenthetic vowel was inserted between [p] and [l] in such a way that [pl] became [pəl] or [bə̆l]. In two instances, the vowel was placed before [p] or [b] as in [əp̬l̥] or [əb]. The substitution of [p] for [b] is not surprising because, as noted previously, the phoneme /p/ does not exist in Arabic. The simplification of the cluster [pl] to [pəl] or [bə̆l] is also not surprising because complex onset clusters do not exist in Arabic.

5.1 Syllable Diagrams and the SSP

Phonologists sometimes invoke a quasi-universal constraint known as the Sonority Sequencing Principle (SSP) to explain why epenthetic vowels are used to break up onset clusters such as [pl]. The SSP states that the sonority profile of syllable must rise until it peaks and then fall. According to Fry (1979:127), the sonority index of /p/ is 7 dB, that of /l/ is 20 dB.[4] These intensity measurements are based on a logarithmic scale. The two sonority diagrams in Figures and help to visually compare the pronunciation of <please> by MN 143 and Arabic 40M. In Figure 6, the onset cluster [pl] is produced as expected, whereas in Figure 7, Arabic 40M introduces an epenthetic vowel to break up the complex onset cluster.

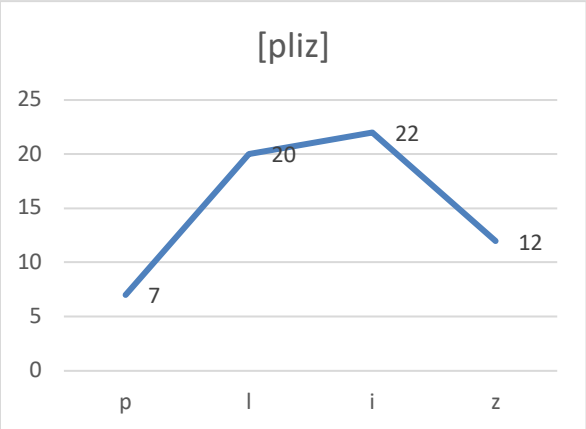

Figure 6: “Please” by MN 143

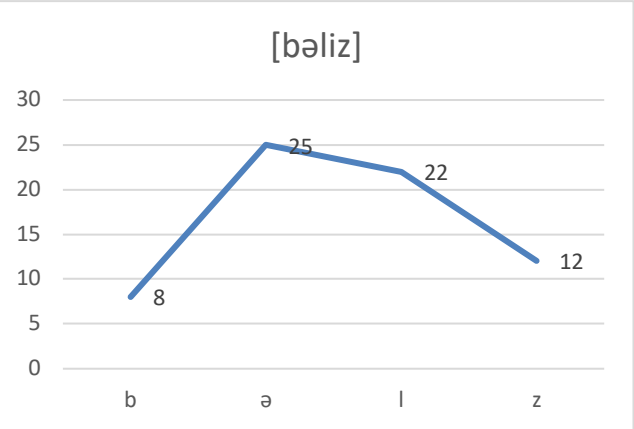

Figure 7: “Please” by Arabic 40M

Since the sonority rises from [p] (7 dB) to [l])20 dB), the SSP is not violated. So, SSP cannot be used to explain why half of the participants resort to an epenthetic vowel to pronounce [pl]. It

[4] The sonority indices used throughout the paper are based on Fry (1979:127).

seems, therefore, that the prohibition against onset cluster may be the chief reason why half of the participants could not produce [pl] without the help of an epenthetic vowel. It is unclear why in five instances the participants broke up the onset cluster but in five others they did not. If the participants transferred the prohibition against onset clusters from Arabic into English, we would expect vowel epenthesis in all 10 instances; but such was not the case. This is an indication that L2 learners are not necessarily bound by the phonotactic constraints of the onset of their L1. Some speakers will break free from it while others will abide by it. Length of exposure to English has very little effect on this for the participants in our study. They have had 11. 4 years of exposure to English. Yet, the mastery of [pl] clusters in the onset remains haphazard. Arabic 46M and 50M were able to produce it accurately in <plastic> but resorted to an epenthetic vowel in <please>. Collectively, the participants made 10 attempts to produce the complex onset cluster [pl]. Only in 1 out 10 attempts was the pronunciation successful. The sole accurate pronunciation is attributed to Arabic 46M who aspirated the [pl] cluster in <plastic>. In the remaining instances, either [p] was pronounced as [b] or the cluster was simplified through epenthesis. All in all, the error rate for the pronunciation of [pl] is staggering. In 90% of the cases, the pronunciation was erroneous either because [b] was used instead of [p] or because an epenthetic vowel was inserted to break up the cluster. The pronunciation of [p] as [b] is particularly detrimental to intelligibility because the relative functional load between them in syllable onsets is 98% (Catford 1987:88).

6.0 The Production of the [ŋz] in Syllable Codas

The coda cluster [ŋz] occurs twice in the phrases <bring these things> and <scoop these things>. The two segments in [ŋz] have the following characteristics: [ŋ] does not exist in Arabic, but [z] is a full-fledged segment of Arabic. The subjects produced this cluster in a variety of ways, as shown in Table 2 below:

Words	**Things**	**Things**
Coda cluster	/ŋz/	/ŋz/
MN143	[ŋz]	[ŋz]
Arabic 40M	[ŋz̥]	[ŋz̥]
Arabic 42M	[ŋz̥]	[ŋz]
Arabic 46M	[ŋs]	[ŋs]
Arabic 47M	[ŋk]	[ŋks]
Arabic 50M	[ŋks]	[ŋs]

Table 2: Coda [ŋz] Clusters

Even though [ŋ] is a foreign sound, the phonetic transcription shows that the five participants produced it with 100% accuracy. In other words, the fact that an L2 segment does not exist in L1 does not automatically lead to a negative transfer. Yet, in three instances [ŋz] is pronounced as [ŋkz] by Arabic 47M and 50 M. The presence of [k] can be construed as a case of velar germination. Koffi (2016:242) reports that the germination of /ŋ/ is fairly common in L2 English. In 210 cases that he investigated, 24 involved the germination of the velar nasal /ŋ/. When this happens, we see a sequence of two [ŋŋ]s. However, in the case of Arabic 47M and 50M we have [ŋk] instead of [ŋŋ]. The [k] is there as a result of a regressive devoicing assimilation rule that turns [ŋ] into [k] due to the presence of [s]. Where does this [s] come from? It comes from a coda devoicing rule. In eight out of 10 occurrences, the [z] in [ŋz] was devoiced to [z̥] or was produced as a voiceless segment. According to Catford (1987:88) the

relative functional load of [s] or [z̨] vs. [z] is 38% in syllable codas. Therefore, mispronouncing [z] as [z̨] or [s] leads only to low unintelligibility.

6.1 Syllable Diagram and the Coda Condition

In the case of syllable codas, the Sonority Sequencing Principle states that sonority will fall from the nucleus. This occurs in the pronunciation of MN143. Even producing [ŋz] as [ŋs] does not violate the coda condition. However, a violation occurs when [ŋz] is pronounced as [ŋks], as shown by the sonority diagrams in Figures 8 and 9:

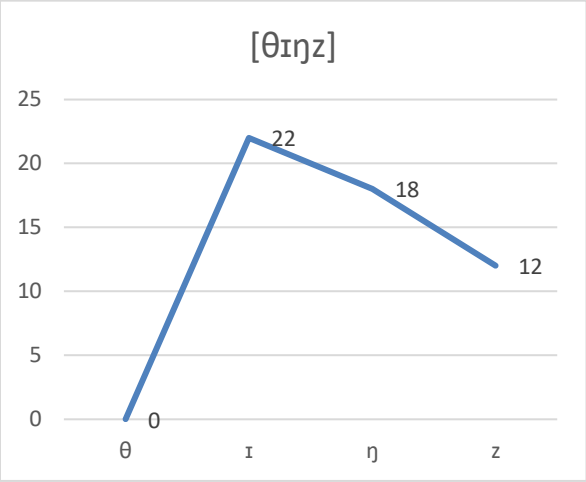

Figure 8: "Things" by MN 143

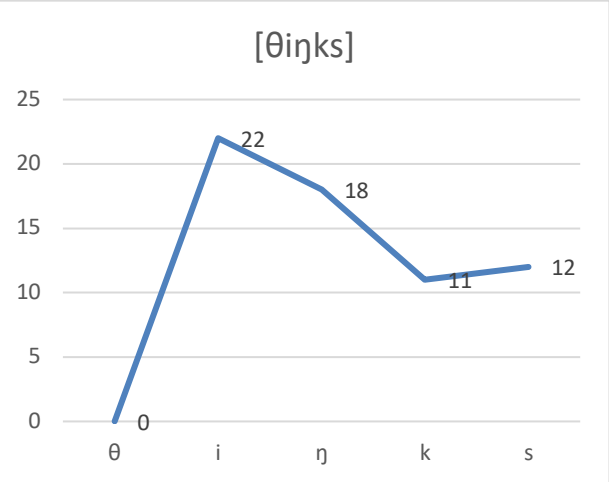

Figure 8: "Things" by Arabic 47M

Arabic 47M and Arabic 50M both produced the coda [ŋz] as [ŋks]. This pronunciation violates the Coda Condition of the SSP which states that sonority should fall from the nucleus. It does fall in the pronunciation of MN 143 because the sonority index goes from 22 dB for [ɪ] to 18 dB for [ŋ] to 12 dB for [z]. The Coda Condition is not violated in any other instance among Arabic speakers, except in two instances when Arabic 47M and 50M produced it as [ŋks]. The Coda Condition is violated in these two instances for two reasons: first because after the sonority level has dropped to [k] (11 dB), it rises again to [s] (12 dB). This pronunciation also violates another important constraint in coda cluster, which is known as the Minimal Sonority Distance Parameter (MSDP). It states that many languages do not accept coda clusters in which the segments are not separated by at least 2 dB. We see here that the intensity difference between [k] (11 dB) and [s] (12 dB) is only 1 dB.

6.2 Arabic Exceptionalism?

The MSDP constraint leads us to ask the following question: Is there an exception for Arabic when it comes to the MSDP? Ryding (2005) notes that Arabic's tri-lateral root system allows for the combinations of any two segments into coda consonant clusters in the (CVCC) pattern. If that is the case, then some CC-clusters in the coda violate not only the Coda Condition of the SSP but most notably the MSDP. Al Tamimi and Al Shboul (2013:12) investigated coda clusters in MSA in light of the SSP and concurred, "Contrary to what is taken for granted in the literature that MSA CC coda normally complies with SSP, the study reveals compliance in only 42% of the data, and, consequently, breaking in 58%; distributed between

sonority reversals (49%) and sonority plateaus (9%)." We have no reason to doubt Al Tamimi and Al Shboul's findings. However, what is sometimes taken as an exception to the SSP is not really the case. Take the coda cluster [kr] in a word /ʃukr/ as an example. A cursory analysis would claim that [kr] is a case of sonority reversal because the sonority rises from [k] (11 dB) to [r] (20 dB). However, this is not so if we consider coda [r] to be a sonorant in Arabic as it is in many other languages. As such, [r] can stand alone as a full-fledged syllable by itself, as shown by the resyllabification of [ʃukr] as [ʃuk•r̩].

The coda cluster in [ɣadˤb] also seems to violate the SSP and the MSDP. The sonority index of /d/ is 8 dB, and that of /b/ is also 8 dB. A casual analysis would conclude that the cluster [dˤb] violates the SSP because we have a sonority plateau between /d/ and /b/. However, upon a closer examination, this may not be the case at all because Arabic grammarians refer to /dˤ/ as being more "emphatic" that [d] (Alhawary 2012:9). As such, a coda cluster such as [dˤb] may not violate the SSP nor the MSDP.

7.0 Summary

Three observations can be drawn from the consonant clusters examined in this paper. The first is that the phonological prohibition against onset clusters in Arabic may help to explain why in 50% of the instances, an epenthetic vowel was inserted in the [pl] cluster. The epenthesis itself does not threaten intelligibility. What does is the fact that [p] was produced as [b] in 50% of the occurrences. The participants' inability to produce [p] accurately is a serious impediment to intelligibility because the relative functional load between the two segments is 98%. Length of exposure to has an inconsequential effect because the participants had been learning English for 11.4 years. Yet, they were still unable to produce [p] intelligibly. The pronunciation of [p] is a serious problem whether it occurs in a cluster or as a singleton. The second observation has to do with the coda cluster [ŋz]. Even though [ŋ] does not exist in Arabic, the participants produced it accurately 100% of the time. Pronouncing it as [ŋkz̥] violates the Coda Constraint and the MSDP, this violation has only a marginal effect on intelligibility. The third observation is also a challenge for L2 phonological theory. It must be "smart" enough to rank segments with regard to whether or not they are transferable. Both the segments [p] and [ŋ] do not exist in Arabic, yet the latter is transferred positively whereas the former is not. We note in passing that markedness has nothing to do with transferability. According to UPSID (UCLA Phonological Segment Inventory Database), [p] is more commonly found in world languages (82.96%) than [ŋ] (52.68%), (Maddieson 1984: 35, 60). Yet, the latter is transferred more positively into Arabic-accented English than the former, notwithstanding the fact that both are non-existent segments in Arabic.

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