Phonemic Characterization of the Production of English Consonants by Nonnative Saudi Speakers

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Abstract
The current study characterizes the production of English consonants by Saudi L2 speakers and offers pedagogical implications for teachers and curriculum designers. Fifteen nonnative Saudi speakers, with at least one year of residence in an English-speaking country, were recorded individually reading an English passage containing all the English consonants. Their recordings were subjected to a segmental phonemic analysis to identify and describe any phonemic mispronunciation. The following consonants were found challenging to the Saudi L2 speakers: /v/, /ŋ/, /p/ and /ɹ/. Their production of these consonants was characterized by devoicing of /v/, inserting /g/ after /ŋ/, voicing or lack of aspiration of /p/, and trilling or tapping of /ɹ/. L1 influence played the main role in their mispronunciation. Their production of /v/ and /p/ resulted in phonemic substitutions with /f/ and /b/, respectively. These substitutions can potentially be detrimental to speech intelligibility according to the Functional Load Principle and Lingua Franca Core; therefore, they should be prioritized in teaching English pronunciation to Saudi learners. The paper concludes by outlining pedagogical implications and offering tips for teaching English pronunciation to Saudi learners.

1. INTRODUCTION

The speech of nonnative speakers is usually characterized by systematic and perceptible differences from the target native speech (e.g., Flege, 1981; Gut, 2007). These differences can negatively affect the speech intelligibility of nonnative speakers and be detrimental to effective communication (e.g., Derwing & Munro, 2009). Therefore, teaching pronunciation explicitly is important in language classrooms and is effective (Lee et al., 2015; Pennington, 2021; Thomson & Derwing, 2015).

Despite its importance and effectiveness, much less time and space are given to pronunciation teaching in language classrooms and curricula compared to other language skills, such as reading and writing (Pennington & Rogerson-Revell, 2019). For example, Foote et al. (2016) showed that pronunciation teaching was infrequent in English language classrooms in Canada. Bai and Yuan (2019) also showed that English language teachers in Hong Kong lacked confidence and training to teach pronunciation. In the context of Saudi Arabia, Alsofyani and Algethami (2017) found that more than 50% of their surveyed teachers taught pronunciation for fewer than 30 minutes per week in a regular English language classroom, and most of them wished they had more knowledge and training on how to teach pronunciation.

Given the limited time allotted to pronunciation teaching in language classrooms (Pennington & Rogerson-Revell, 2019), teachers need to prioritize which aspects of pronunciation to teach their students. They can refer to evidence-based published resources on aspects of pronunciation that are both challenging to their students and problematic for speech intelligibility. This task is easier in a context where learners share the same native language background, as L1 influence has long been shown to be a contributing factor to learners' mispronunciation (Major, 2008).

The current study aims to provide an empirical characterization of the English consonants in the speech of Saudi nonnative learners. This characterization is hoped to inform language teachers and curriculum designers about the most challenging English consonants for Saudi learners. Several studies have actually discussed the pronunciation of English consonants by nonnative Saudi learners (Ahmad, 2011; Ahmad & Muhiburrahman, 2013; Al-Rubaat, 2017; Altaha, 1995; Alzinaidi & Abdel Latif, 2019; Ammar & Alhumaid, 2009; Hago & Khan, 2015; Hameed & Aslam, 2015). However, these studies are limited to pointing out errors in the production of consonants without describing or characterizing the nature of errors produced by learners. An exception to this was Ammar and Alhumaid (2009). However, they described the errors only in terms of L1 phonemic transfer. Teachers and curriculum designers need to know which consonants are inauthentically produced by learners, how they are produced, and how they may affect speech intelligibility. In addition, all these studies have focused on English as a foreign language (EFL) learners who may not have been exposed to substantial native speech input, so it is difficult to tease apart the areas of genuine difficulty from the areas that are a product of not being exposed to native speech input. The current study attempts to contribute to the existing body of research by examining relatively experienced Saudi learners of English who have been exposed to native input in an English-speaking country. In addition, it provides phonological characterization of the English consonants mispronounced by nonnative Saudi speakers.

2. BACKGROUND
2.1. Arabic and English Consonantal Systems

Arabic has a rich and complex consonantal system. It consists of 28 consonant phonemes and is well-known for its guttural and emphatic sounds (Ryding, 2014; Watson, 2007). On the other hand, English has "an average-sized consonant inventory" consisting of 24 consonants (Cohn, 2001, p. 183). While English has an almost stable consonant inventory across dialects, Arabic exhibits some dialectal variation (Ryding, 2014; Schreier, 2005; Watson, 2007). The current study focuses on the variety of Arabic spoken in Saudi Arabia because the scope of the study is limited to Saudi learners of English. Another major difference between Arabic and English lies in the degree of correspondence between sounds and orthography. While there is almost a complete one-to-one correspondence between consonant sounds and the letters of the alphabet in Arabic, there is only a loose correspondence in English (Ryding, 2014).

Consonants are usually described in terms of their place and degree of constriction in the vowel tract (also known as place and manner of articulation), as well as in terms of whether the vocal folds are vibrating (i.e., voicing) (Cohn, 2001). In Arabic, there is additional secondary place of articulation for emphatic or velarized consonants (Ryding, 2014). Table 1 below presents the consonant phonemic inventory of both English and Saudi Arabic (Cruttenden, 2014; Prochazka, 1988; Ryding, 2014; Watson, 2007).

Table 1: Saudi Arabic and English consonant phonemic inventories

Arabic	Description	English	Description
b	Voiced Bilabial Stop	p	Voiceless Bilabial Stop
t	Voiceless Alveolar Stop	b	Voiced Bilabial Stop
tˤ	Emphatic Voiceless Dental Stop	t	Voiceless Alveolar Stop
d	Voiced Alveolar Stop	d	Voiced Alveolar Stop
dˤ	Emphatic Voiced Alveolar Stop	k	Voiceless Velar Stop

k	Voiceless Velar Stop	g	Voiced Velar Stop
g	Voiced Velar Stop	m	Voiced Bilabial Nasal
ʔ	Glottal Voiceless Stop	n	Voiced Dental Nasal
m	Voiced Bilabial Nasal	ŋ	Voiced Velar Nasal
n	Voiced Dental Nasal	f	Voiceless Labiodental Fricative
r, ɾ	Voiced Alveolar Trill or Tap	v	Voiced Labiodental Fricative
f	Voiceless Labiodental Fricative	θ	Voiceless Interdental Fricative
θ	Voiceless Interdental Fricative	ð	Voiced Interdental Fricative
ð	Voiced Interdental Fricative	s	Voiceless Alveolar Fricative
ðˤ	Emphatic Voiced Interdental Fricative	z	Voiced Alveolar Fricative
s	Voiceless Alveolar Fricative	ʃ	Voiceless Palato-alveolar Fricative
sˤ	Emphatic Voiceless Alveolar Fricative	ʒ	Voiced Palato-alveolar Fricative
z	Voiced Alveolar Fricative	h	Voiceless Glottal Fricative
ʃ	Voiceless Palato-alveolar Fricative	tʃ	Voiceless Palato-alveolar Affricate
x	Voiceless Velar Fricative	dʒ	Voiced Palato-alveolar Affricate
ʁ	Voiced Velar Fricative	w	Voiced Labial-velar Approximant
h	Voiceless Glottal Fricative	ɹ	Voiced Post-alveolar Approximant
ħ	Voiceless Pharyngeal Fricative	j	Voiced Palatal Approximant
ʕ	Voiced Pharyngeal Fricative	l	Voiced Lateral Approximant
dʒ	Voiced Palato-alveolar Affricate		
w	Voiceless Bilabial Approximant		
j	Voiceless Palatal Approximant		
l	Voiced Lateral Approximant		

Comparing the phonemic inventories of Saudi Arabic and English reveals that the following English consonants do not seem to have counterparts in Saudi Arabic: /p/, /ŋ/, /v/, /ʒ/, /tʃ/ and /ɹ/. It should be pointed out that this is not a direct phonetic comparison between the two languages' phonemes, as even similar phonemes can vary phonetically across languages. For example, although the phoneme /t/ exists in both Saudi Arabic and English, its phonetic realization differs. The English /t/ has a longer voice onset time than the Saudi Arabic /t/ (Flege & Port, 1981).

2.2.Second Language Speech

Second language speech is a highly complex and variable system affected by many factors, such as speakers' native language background and second language experience. It can be perceptually assessed across four related but different dimensions: foreign accentedness, fluency, comprehensibility, and intelligibility (Derwing & Munro, 1997). *Foreign accent* refers to L2 phonetic deviation from the native phonetic norms. *Fluency* refers to the automaticity of L2 speech production. *Comprehensibility* refers to the difficulty of understanding L2 speech. Lastly, *intelligibility* refers to understanding L2 speech (Derwing & Munro, 1997; Derwing et al., 2008). For example, a nonnative speaker may speak fluently with a mild degree of foreign accent but be difficult to understand.

For most adult language learners, the goal of attaining a native-like accent or eliminating foreign accent is almost always unattainable; therefore, intelligibility should be prioritized over the elimination of foreign accents in language classrooms, especially in regular language classes where the time allotted for pronunciation is usually limited (e.g., Levis, 2020; Pennington, 2021). This prioritization of intelligibility in language classrooms necessitates identifying the L2 pronunciation features that are expected to interfere with learners' intelligibility. Previous attempts have been made to identify the pronunciation features that are important for intelligibility in English, such as the Functional Load Principle (Brown, 1988) and the Lingua Franca Core (Jenkins, 2000). The Functional Load Principle proposes a ranking order of importance for phonemes according to their impact on speech intelligibility. The Lingua Franca Core provides a list of pronunciation features important for speech intelligibility and should be prioritized in English language classes.

Several theoretical frameworks have attempted to understand and explain the phenomenon of foreign accents and why certain L2 sounds are difficult or challenging to a particular group of nonnative speakers. L1 influence has been a fundamental component in

formulating the premises of these theoretical frameworks. The earliest framework that has attempted to predict the difficulty of learning L2 sounds is the Contrastive Analysis Hypothesis (Lado, 1957; Wardhaugh, 1970), which hypothesized that L1 transfer could explain all language learners' errors. Thus, by comparing learners' L1 and L2 phonological systems, one could predict the specific sounds that would be challenging to L2 learners. It was later shown that not all learners' pronunciation difficulties or errors are a result of L1 influence or transfer (Major, 2008). For example, Eckman's Markedness Differential Hypothesis (Eckman, 1977) suggested that L1 influence is insufficient for explaining all learners' pronunciation errors or difficulties. He proposed that marked phonological features, which can be defined as features occurring less across the world's languages, are more likely to be difficult for L2 learners. Flege (1995), in his Speech Learning Model, pointed out that perceptual similarity between learner's L1 and L2 sounds can also be a source of difficulty for language learners.

2.3. Previous Studies

One of the earliest studies that examined the production of English consonants by Saudi L2 speakers was Flege and Port (1981). However, their study was limited to examining stop consonants. Although cross-linguistic influence was evident in the speakers' production of all stop consonants, it only negatively affected the intelligibility of /p/. More recent studies took a more pedagogical perspective in examining the production of English consonants by Saudi nonnative speakers (Ahmad, 2011; Ahmad & Muhiburrahman, 2013; Al-Rubaat, 2017; Altaha, 1995; Alzinaidi & Abdel Latif, 2019; Ammar & Alhumaid, 2009; Hago & Khan, 2015; Hameed & Aslam, 2015). This growing body of research has several limitations. First, a number of these studies were observational in nature, based on teachers' perspectives of which English consonants were problematic to Saudi learners (e.g., Ahmad & Muhiburrahman, 2013; Hameed & Aslam, 2015). Second, most of these studies presupposed that areas of difference between Arabic and English in phonemic inventory are difficult for Saudi L2 learners, thus limiting their studies to these areas. Third, none of them includes a detailed characterization of the nature of mispronunciation by their participants. The only exception was Ammar and Alhumaid (2009), which focused only on cases of L1 transfer. Fourth, they examined the speech of learners in minimal input settings (i.e., EFL) where it is difficult to determine whether the learners' mispronunciations resulted from insufficient L2 input or genuine pronunciation challenges.

To sum up, previous studies relied mainly on cross-linguistic, phonemic differences between Arabic and English to identify and explain pronunciation errors among Saudi EFL learners. The following consonants were identified as the most common errors among Saudi EFL learners: /p/, /v/, /ŋ/, /ʒ/, /dʒ/ and /tʃ/. However, there was almost no description of the nature of errors and how they would affect speech intelligibility. Previous studies also identified other unexpected pronunciation errors, such as /d/ (Ahmad & Muhiburrahman, 2013; Hago & Khan, 2015; Hameed & Aslam, 2015) and /ð/ (Al-Rubaat, 2017; Alzinaidi & Abdel Latif, 2019; Ammar & Alhumaid, 2009). Given that both /d/ and /ð/ exist as part of the phonemic inventory of Saudi Arabic, and based on my anecdotal observational experience, one would not expect such pronunciation errors. The only explanation I can provide for these pronunciation errors is that they were the result of orthographic confusion on the part of the speakers due to their unfamiliarity with some of the test words used in previous studies. In fact, Altaha (1995) pointed out that one of the pronunciation errors his Saudi EFL students made was substituting /s/ with /k/ in their pronunciation of the word *city*.

3. RESEARCH OBJECTIVE

The current study aims to examine and characterize the production of English consonants by Saudi L2 speakers exposed to native English. It also offers pedagogical implications for Saudi learners of English, their teachers, and curriculum designers.

4. METHODS
4.1. Participants

Fifteen male Saudi L2 speakers of English were recruited to provide the speech data for the current study. They were international students living in the UK for more than one year. Their ages ranged between 19 and 37 at the time of recording. They all went to Saudi public schools in Saudi Arabia and studied English as part of their curriculum. In addition, they all took English language courses in language schools in the UK. None of the participants reported any speech or hearing disorders.

4.2. Speech Data

A short reading passage of the fable *The North Wind and the Sun* was chosen to elicit the speech data for the current study. The passage, along with its many translations, is widely used in the phonetic description of the world's languages. The International Phonetic Association also recommends it for analyzing English language dialects (IPA Handbook, 1999). The passage includes all English consonants in various word positions except for the consonant /ʒ/ (Deterding, 2006). This shortcoming was not considered a major problem for the current study, given the very limited occurrence of the consonant /ʒ/ in the English language and its weak functional load (Cruttenden, 2014). The passage reads:

> The North Wind and the Sun were disputing which was the stronger, when a traveler came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the traveler take his cloak off should be considered stronger than the other. Then the North Wind blew as hard as he could, but the more he blew the more closely did the traveler fold his cloak around him; and at last the North Wind gave up the attempt. Then the Sun shined out warmly, and immediately the traveler took off his cloak. And so the North Wind was obliged to confess that the Sun was the stronger of the two.

Each participant met individually with the researcher in a sound-attenuating environment. The participants were handed a piece of paper on which the text was printed in English. They were given some time to read the text silently and ask them questions regarding unfamiliar words. They were then asked to read the text aloud and at a natural pace into a headset microphone. Each participant's rendition was recorded and transferred to a computer drive for analysis.

4.3. Analysis

The researcher, an applied phonetician specialising in second-language speech, listened to each participant's recording in Praat (Boersma & Weenink, 2022). Consonants in each recording were analyzed phonemically, and mispronunciations were identified and counted. A mispronunciation was identified based on segmental accuracy and was procedurally defined as any phonemic substitution or omission. No fine phonetic or acoustic analysis was attempted, apart from the visual inspection of the spectrogram in Praat when in doubt. For example, visible voicing striations and duration of voice onset time were inspected by examining the spectrogram to confirm my auditory judgment. Phonemic analysis was deemed appropriate because of the pedagogical nature of the current study. Moreover, phonemic errors are more likely to be detrimental to intelligibility than sub-phonemic (i.e., phonetic) errors (Munro & Derwing, 2006). Each common mispronunciation was characterized to describe its nature and explain its occurrence, as well as its possible impact on communication.

5. RESULTS AND DISCUSSION

The mispronounced consonants in the analyzed data were: /v/, / ŋ/, /ɹ/ and /p/. No phonemic substitution or omission for any other consonant was detected. Table 2 below shows the percentage of occurrences that exhibited pronunciation errors for each consonant across all speakers. It should be noted that the number of occurrences for each consonant varies significantly (see *The North Wind and The Sun* text above).

Table 2: Percentage of pronunciation errors for each consonant

Sound	Percentage of error occurrences
/v/	70%
/ŋ/	67%
/ɹ/	46%
/p/	40%

The current study's findings corroborate previous studies examining the production of English consonants in EFL contexts (Ahmad, 2011; Altaha, 1995; Ammar & Alhumaid, 2009; Hago & Khan, 2015). However, many of the consonantal pronunciation errors that were identified by previous studies were not shown in the production of the L2 speakers in the current study. For example, none of the L2 speakers in the current study made phonemic errors in their pronunciation of /dʒ/, /tʃ/, /d/ or /ð/, which were identified by many previous studies as problematic for Saudi EFL learners. This finding substantiates my explanation in the background section above regarding the confusion between genuine pronunciation difficulty and word unfamiliarity.

While cross-linguistic phonemic comparison (i.e., Contrastive Analysis Hypothesis) between Saudi Arabic and English can explain the mispronunciation of /ŋ/, /v/, /p/ and /ɹ/, it fails to provide explanation for success in accurately producing /tʃ/. The Speech Learning Model (Flege, 1995) may provide an alternative explanation. The phonological similarity between the Saudi Arabic /n/, /f/, /b/ and /r/ and the English /ŋ/, /v/, /p/ and /ɹ/, respectively, may have perceptually confused the L2 learners and led them to perceive them as equivalent, hence resulting in mispronunciation. Evans and Alshangiti (2018) found that some Saudi L2 learners perceptually confuse the English /p/ and /b/, /v/ and /f/, and /n/ and /ŋ/. In addition, many of the Saudi L2 speakers were found to confuse the English sounds /tʃ/ and /ʃ/, which provides counterevidence for the claim of the Speech Learning Method since mispronunciation of /tʃ/ was not found in the current study. Therefore, both theoretical frameworks fail to explain the accurate pronunciation of /tʃ/ by the Saudi learners. However, this is a simplistic test of the Speech Learning Model, as one needs to examine empirically the perceptual degree of similarity between English and Arabic consonants.

One interesting observation worth further examination is the effect of orthography on the L2 speakers' production of English consonants. The existing literature on the effect of orthography on learners' pronunciation is inconclusive. While some studies have shown it may help enhance language learners' attention to distinctive pronunciation features, others have shown that it could be detrimental to L2 pronunciation (Bassetti et al., 2015). In the current study, orthography seems to have mixed effects as well. For example, the existence of the grapheme [g] after [n] is probably why the learners produced /ŋ/ as /ŋg/ in the word *along*. On

the other hand, the existence of the graphemes [p] and [v] in English did not seem to prevent many of the participants from mispronouncing them and substituting their production with /b/ and /v/, respectively.

Table 3 below characterizes the phonological processes that have occurred in the pronunciation errors of the L2 speakers, followed by a discussion of how they may affect communication and speech intelligibility.

Table 3: Characterization of the L2 speakers' mispronounced consonants

Mispronounced consonant	Phonological process
/v/	Devoicing: no vibration of vocal folds during production
/ŋ/	/g/ insertion: inserting /g/ after /ŋ/
/p/	Voicing: some vibration of vocal folds and short voice onset time
/ɹ/	Trilling or tapping of /ɹ/

Most participants' productions of the sound /v/ showed no voicing. The speakers substituted /v/ with the voiceless phoneme /f/, which exists in their native Saudi Arabic. This is a clear case of L1 influence. The substitution of /v/ with /f/ not only contributes to the perception of a foreign accent but is potentially detrimental to speakers' intelligibility. The differentiation between the sound pair /v/ and /f/ in English is considered important according to the Functional Load Principle (Brown, 1988) and is part of the Lingua Franca Core (Jenkins, 2000). In addition, the L2 speakers substituted /b/ for /p/, though to a lesser degree. Two phonological manifestations were noticed in the participants' production of /p/: voicing and a very short to the non-existent lag between the release of the closure and the production of the next vowel, which also resulted in lack of aspiration. The conflation of /p/ and /b/ has been shown to impede intelligibility in the speech of Saudi nonnative speakers (Flege & Port, 1981), and the differentiation between the two sounds was ranked by Brown (1988) as a top priority for nonnative English speakers in his Functional Load Principle.

The mispronunciations of /ɹ/ and /ŋ/ are probably less serious for intelligibility than the substitutions of /p/ and /v/ with /b/ and /f/, respectively. Many of the L2 speakers produced a trill or a tap rhotic instead of the English post-alveolar approximant /ɹ/. This is also a clear case of L1 influence, as the phonemic inventory of Saudi Arabic has an alveolar rhotic /r/, which can be realized as either a trill or tap based on the phonological context in which it occurs. Unlike /p/ and /v/, the participants did not substitute /ɹ/ with another existing English phoneme, which is why it is not considered serious to speech intelligibility. In addition, rhotic variation is very common across native English dialects, and trill and tap rhotic sounds also exist in some varieties of English (Cruttenden, 2014). For these reasons, it is unlikely that the production of the English /ɹ/ as a trill or tap by Saudi nonnative speakers would affect their intelligibility; however, it may render their speech perceived as foreign accented. The majority of the L2 speakers added /g/ after their production of /ŋ/, which is obviously a negative effect of orthography since /ŋ/ is represented orthographically as [ng] (e.g., *along*, *making* and *sing*). This is not expected to cause any breakdown in communication, as the target sound is accurately produced, and the insertion of /g/ is unlikely to distort its perception. I should mention, at last, that one should be careful to draw any firm conclusions about intelligibility

without any empirical evidence. Therefore, further research may explore how these consonant mispronunciations on the part of the Saudi L2 speakers affect their speech intelligibility.

6. CONCLUSION

The present study's findings showed that Saudi L2 speakers with exposure to native English in an English-speaking country face challenges in authentically producing the following consonants: /v/, /ŋ/, /ɪ/ and /p/. They substituted /p/ with /b/ and /v/ with /f/ in a clear case of L1 negative influence. These two substitutions have the potential to negatively affecting speech intelligibility and can also result in communication breakdown. The mispronunciation of /ŋ/ and /ɪ/is deemed less serious and unlikely to impact speech intelligibility, but may contribute to foreign accent perception. Further studies are clearly needed to ascertain empirically the effect of these mispronunciations on speech intelligibility.

Teachers and curriculum designers must prioritize teaching /p/ and /v/ to Saudi learners of English. Learners need to establish a distinct, perceptual phonemic category for each of these sounds. They also need to notice the articulatory differences between the consonant pairs /p/-/b/ and /v/-/f/. Voicing (i.e., the vibration of the vocal folds) is fundamental for noticing the difference between these sounds. In addition to voicing, the difference between /p/ and /b/ can also be seen in the presence of aspiration for /p/ in syllable-initial positions (i.e., a brief puff of air following the release of voiceless stops) which often results in a longer voice onset time (duration between the release of stop and the production of the next vowel). Below are some suggested practical tips for language teachers to follow. These tips are used widely in pronunciation textbooks and in pedagogical research (e.g., Celce-Murcia et al., 2010; Pennington & Rogerson-Revell, 2019; Roach, 2009; Saito, 2013).

1. Introduce the learners to the different orthographic alphabets used to represent the sounds /p, /b/, /v/and /f/.

2. Play the sounds in pairs, in isolation and in word contexts, preferably in minimal pairs, and ask the learners to pay attention to the difference between each sound pair. Perception drills should be part of this exercise.

3. Present a graphic image to the learners, preferably animated, demonstrating how the sounds are articulated and illustrating the difference between them. There are now innovative ways to carry out this step using technology and online platforms (e.g., soundsofspeech.uiowa.edu). In addition, teachers can utilize some of the common ways used by phoneticians to demonstrate the differences between sounds. For example, to demonstrate the concept of voicing, ask the learners to gently place their index finger and thumb against the outside of their larynx and notice the vibrational difference between the two sounds. Another common exercise for differentiating /p/ and /b/ is to ask learners to place their palms in front of their mouths, produce the two consonants and notice the difference in aspiration between them.

4. Ask the learners to repeat the sounds, in isolation and word context, after a native model in group and individually, and provide them with various immediate types of feedback (i.e., direct, recast, etc.). In addition, during communicative activities, you can always point out directly or indirectly any occurrence of mispronunciation.

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