Arab World English Journal
INTERNATIONAL PEER REVIEWED JOURNAL ISSN: 2229-9327
مجلة اللغة الانكليزية في العالم العربي

AWEJ Volume.4 Number.4, 2013

Pp.143-166

Perception and production problems: To what extent is Sudanese English intelligible to the native British and American listeners?

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Abstract

This study addresses the pronunciation and perception problems experienced by Sudanese university learners of English. Specifically, the study examines how intelligible these learners are to British and American listeners. The whole work was done on the basis of segmental analysis of the English speech sounds, which included vowels, consonants and SPIN sentences in three different experiments. Single-item (word) stimuli were constructed on the basis of the Modified Rhyme Test (MRT) but with a few potential improvements. The target stimuli above were recorded from ten Sudanese-Arabic learners of English as foreign language (EFL). On the basis of a pilot test, one male speaker was then selected as the optimally representative Sudanese Arabic-accented English speaker. The same stimuli were recorded from a male native speaker of RP English. Results revealed that vowels are the most difficult sounds to pronounce and the English dentals produced by Sudanese speakers are strongly influenced by their L1 equivalents. Native English speakers are more intelligible to British and American listeners, while they are less intelligible to Sudanese speakers.

Key words: segmental measurement, intelligible, interference, merge

1 Introduction

Researchers need to test in a greater detail the ways in which non-native speech of English varies from that of the native speakers determining the extent to which such variation can impede or enhance intelligibility. A task such as this requires looking at the phonetic and phonological difference between L1 and L2 to find out which segmental variations are responsible for speech intelligibility problems. This is often necessary since phonemic variation between languages has negative effects on the learning of L2 speech. According to Jenkins (2000), (incorrect) habit formation is one of the major factors responsible for intelligibility problems where the muscular habits that are always operated to produce the L1 speech sounds, are automatically activated in L2 production. This process requires non-native speakers to pay more attention producing accurate speech. However, as soon as, these speakers release control to focus on the content of the message, they produce erroneous pronunciation. This situation continues until sufficient practice leads to the mastery of L2 sounds, which are phonetically different from those of L1. However, incorrect speech habits are not the underlying cause of the pronunciation problems in foreign-accented speech. The incorrect production of L2 speech sounds occur due to categorical differences between L1 and L2, where non-native speakers use incorrect perceptual representations (normally L1 sounds) for the production of L2 (Flege 1976). Many L2 speakers of English fail to distinguish between phonemic and allophonic sounds of English, or they often conflate or confuse some speech sounds as result of differences between L1 and L2. For example, Arab speakers of English conflate /b/ and /p/, because the latter has no phonological representation in Arabic (Cruttenden 2008, Flege 1976). Similar problems occur among Russian speakers who confuse clear /l/ as in *leaf*, *black* and *lose* and dark /ɫ/as in *pool*, *full* and *milk*, which form contrastive phonemes in Russian, but allophones in English.

This study attempts to investigate segmental intelligibility problems that Sudanese-Arabic EFL learners face. It reports an experimental analysis of the English speech sounds including vowels and consonants to test how intelligible Sudanese EFL learners are to British and American listeners. The study provides cognitive insights into the nature and the causes of error patterns detected.

2 Method

2.1 Intelligibility tests used

Intelligible speech is defined as speech that is understood by native speakers (Munro et al. 2006). This means that speech intelligibility is principally a hearer-based construct that depends on interaction in an appropriate context involving the comprehension of the message between the listener and the speaker. It is also possible to refer to speech intelligibility as any successful communication that involves both native and non-native speakers of English. Since the non-native listeners in this study are expected to have an incorrect conception of English speech sounds, focus will be on examining vowels and consonants. Priority is given to segmental properties, firstly because vowels and consonants form the basic sounds of the English language, the mastery of which is required for perfect learning of speech. Secondly, because the assessment of whether speech is intelligible or not is attributed to segmental factors, more than 50% of speech intelligibility is accounted for on the basis of speech sounds (Pascoe 2005, Fraser 2005). The Modified Rhyme Test (MRT) was used in the experiments. The MRT is considered to be the most accurate and reliable measure of intelligibility (Logan, Greene and Pisoni 1989) at the phoneme level. Speech intelligibility measures involve word identification tasks in a closed-set of four-items, where the listeners are asked to select the response they think the speaker intended. The score is the number of correctly responded to items. Test items normally target phonemes and words. Phonemes refer to vowels and single consonants. The formal assessments of phonemes interpret the responses as either intelligible or unintelligible; put in figures, a score of (close to) 100% is interpreted as completely intelligible performance (Lafon 1966).

Word intelligibility, on the other hand, was established by having listeners recognise 25 keywords; each word was embedded final position in a short everyday sentence taken from the SPIN test. SPIN is an abbreviation of 'Speech Perception in Noise' Test (Kalikow, Stevens and Elliott 1977, Wang and van Heuven 2003, Wang 2007). An example of SPIN-test items would be *'She wore her broken arm in sling'* (keyword underlined). Listeners write down the final word that they think they heard in each sentence. This part of the SPIN test proved to be efficient at assessing speech recognition abilities (Rhebergen and Versfeld 2005). Although the listeners' performance is primarily quantified in terms of number of whole words correctly recognized, partially correct answers are also important since they give information about the perception of phonemes in onset, nucleus and coda position.

3. Participants

3.1 Sudanese speakers of English

The study participants were ten Sudanese University students in the Department of English at Gadarif University in the Sudan. The learners involved in these experiments specialized in English language teaching (TEFL). They had finished six semesters out of eight semesters of their studies when they participated in the listening test.

3.2 Selection procedure of a model Sudanese EFL learner

A Sudanese model speaker was selected by means of a quality sound test from among a number of 11 Sudanese speakers of English. The quality sound test was operated online and candidates of different nationalities were invited to listen to the test and then assess the sound quality of the speakers by clicking on one of the grade options provided. Assessment of the speakers' sound quality depended on the computation of the total mean of the results of each speaker in the test wherein the speaker with the average mean was chosen as a representative learner.

3.3 Native speakers of English

In the control part of the study a single male native speaker of English (RP accent) was used as a model speaker of English.

3.4 Native listeners of English: British and American listeners

The group of native English listeners comprised ten British and ten American speakers of English preparing for BA or MA degrees at Leiden University. Listeners were recruited by means of online or poster invitation. The recruitments were asked to fill in short questionnaire before they started answering the perception test. In the questionnaires, they provided information about their nationalities as British or American speakers of English and their linguistic backgrounds. Moreover, the listeners did not speak Arabic, which represents the first language of the Sudanese speakers involved in the experiments. So, they were expected to be unfamiliar with English spoken with Sudanese Arabic-accent. Distribution of male/female is not considered in this study since the final objective of the tests did not set out any gender specifications involving the results to be obtained; therefore, the experiments were right to any one who speaks English as a native language.

4 Overall structure of the test battery

The experimental stimuli include three tests. These are (i) a vowel test, which is composed of minimal quartets including short and long vowels as well as diphthongs, and (ii) single consonants in either onset or coda position. These target sounds were embedded in meaningful C*VC* words (where C* stands for one to three consonants). The third test comprised 25 sentences taken from the high-predictability set included in the SPIN (Speech Perception in Noise) test (Kalikow, Stevens and Elliott 1977). These are short everyday sentences in which the sentence-final target word is made highly predictable from the earlier words in the sentence, as in *She wore her broken arm in a <u>sling</u>* (target word underlined). Word stimuli in the first three tests were embedded in a fixed carrier sentence [*Say…again*], which insured a fixed intonation with a rise-fall accent on the target word. The vowel and the single consonant tests contained items on each individual vowel or consonant phoneme in the RP inventory. Inadvertently, the vowel test did not include an item targeting the vowel /əʊ/ as in *boat*. Moreover, the consonant test targeted all the consonants in onset position and in coda position. All items in the tests were chosen such that they occurred in dense lexical neighbourhoods, i.e. there should be many words in English that differ from the test item only in the target sounds. These so-called lexical neighbours, differing from the target word in only the identity of the test sound, make up the pool of possible distracters (alternatives) in the construction of the MRT test. When selecting the three distracters needed for each test items, lexical neighbours that differ from the target in only one distinctive feature were preferably selected. For the target *pit*, we selected alternatives with vowels that differed from /ɪ/ in just one vowel feature, i.e. *pet* (differing in height), *put* (differing in backness) and *pot*. The latter alternative differs from the target in both height and backness; we preferred this to the one-feature difference in *peat* (or *Pete*) as we decided to exclude proper names and low-frequency alternatives as much as possible, which may show a larger decrement in recognition than high-frequency words. The full set of test items is included in the Appendix.

4.1 Tests materials

The stimulus sentences were typed on sheets of paper (one sheet for each test), and then read by male Sudanese and native speaker of RP English (see 3.2.2). Recordings took place in a sound-treated room. The speaker's voice was digitally recorded (44.1 KHz, 16 bits) through a high-quality swan-neck Sennheiser HSP4 microphone. The speakers were instructed to inhale before uttering the next sentence so that clear recording is achieved. The target words were excerpted from their spoken context using a high-resolution digital waveform editor Praat (Boersma and Weenink 1996). Target words were cut at zero-crossings to avoid clicks at onset and offset. Target words and SPIN sentences were then recorded onto Audio CD in seven tracks. The first track contained two practice trials for the vowel test and was followed by track 2, which contained the 19 test vowel items. Tracks 3 and 4 contained the practice and test trials for the single consonant tests. Track 5 comprised the 25 SPIN sentences with no practice items. In the single consonant test, trials targeting onsets preceded the items targeting codas. Other than that, the order of the trials within each part of the test battery was random. Trials were separated by a 5-second silent interval. After every tenth trial a short beep was recorded, to help the listeners keep track on their answer sheets.

4.2 Test procedure

The stimuli were presented over loudspeakers in a small classroom that seated ten listeners. Subjects were given standardized written instructions and received a set of answer sheets that listed four alternatives for each test item. They were instructed for each trial to decide which of the four possibilities listed on their answer sheet they had just heard on the CD. They had to tick exactly one box for each trial and were told to gamble in case of doubt. Alternatives were listed in conventional English orthography. In the final test (SPIN), subjects were instructed to write down only the last word of each sentence that was presented to them. There were short breaks between tests and between presenting the practice items and test trials. Subjects could ask for clarification during these breaks in case the written instructions were not clear to them.

5 Overall results

5.1 Vowels

This section will present the results of the test battery in four sections, one for each test. Each section will first outline the structural differences between the sounds in the source language, Sudanese Arabic (SA) and in the target language, RP English. Such comparisons may help understand why certain English sounds are difficult for Sudanese learners and others are not.

5.1.1 Vowel results

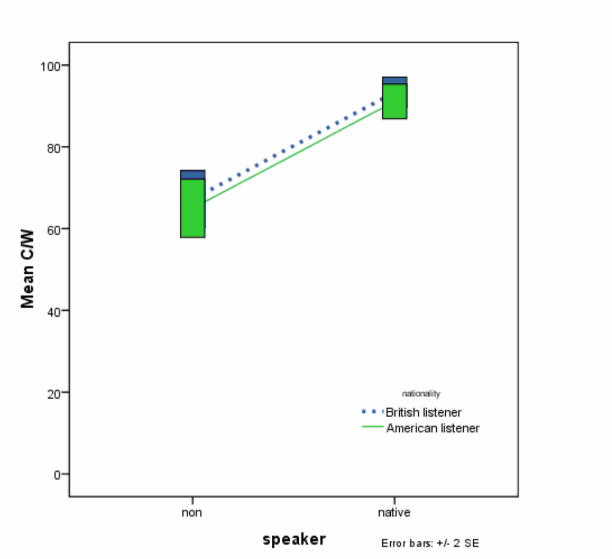


Figure 1 Mean correct responses (%) of English vowel tokens of ten British and ten American listeners. The vowels were produced by one Sudanese and one native speaker of British English.

As Figure1 shows, the perception level of the native listeners (British and American) is higher when they were exposed to English vowel tokens produced by the native speaker but low when the same vowel tokens were read by a Sudanese speaker. Overall mean correct for the British listeners is 67% and 93% against 65% and 91% for American listeners in the vowel tokens of English, respectively. A repeated measures analysis of variance (RM-ANOVA) with native language of the speaker (native, foreign) as a within-subject factor and nationality of the listener (British, American) as a between-subjects factor shows that only the effect of speaker type is significant, $F(1, 18) = 152.3$ ($p < .001$). The effect of listener and the listener × speaker interaction are insignificant, $F(1, 18) < 1$ for both main effect and interaction.

The confusion matrices in Tables 1 and 2 present details about the listeners' performance on the vowel level. The tables show that listeners found the English vowels produced by the Sudanese speakers more difficult than those read by the native speakers. In Table1, the British listeners totally misperceived the English front mid close /e/ as /ɪ/ and less often as /iː/. The English open /æ/ also proved to be difficult for the listeners. It was frequently misheard as /ʌ/ and less frequently as /ʊ/. Another type of perception error which also occurred frequently was the confusion of the English tense /iː /for its lax counterpart /ɪ/. Moreover, the English tense /iː/ was replaced by /æ/ or /e/ but less often. Important perception errors of the central and back English vowels included the replacement of the English /ɔ/ by /ʊ/ and less often by /ʌ/ or /æ/, whilst the back low /ɑː/ was substituted for /ɜː/. Other few miscellaneous errors were the misperception of /ɔ/ as /ʌ or æ/ and /ɔː /as /ɑː/. Interestingly, similar perception error patterns were made by the American listeners exposed to the same English vowel tokens, which were spoken by Sudanese speakers. More interestingly, most of these errors have to do with central and back vowels, which imply a systematic relation with the production of the English source vowels. This relation will be described later. On the other hand, no serious problems were found when the English vowels were read by the native speaker. However, the English lax- tense pairs /ʊ~uː, ɪ ~ iː/ were often substituted by both British and American listeners.

Table 1. Confusion matrix of English stimulus vowels and diphthongs produced by Sudanese EFL learners and perceived by ten British listeners. Correct responses are on the main diagonal, indicated in bold face.

Target	Perceived RP vowels																		
	ɜː	ʌ	ɑː	æ	ɑʊ	aɪ	e	eə	eɪ	ɪ	iː	ɪə	ɔ	ɔː	ɔɪ	ʊ	uː	ʊə	əu
ɜː	**6**		1								2			1					
ʌ		**9**					1												
ɑː	3		**7**																
æ		5		**3**												2			
ɑʊ					**9**														1
aɪ						**10**													
e							**0**			9	1								
eə	2							**7**	1										
eɪ						1	3		**6**										
ɪ										**10**									
iː				1			1			5	**3**								
ɪə												**10**							
ɔ		2		1									**0**			7			
ɔː			1											**9**					
ɔɪ					1	1									**8**				
ʊ							1									**9**			
uː							1									1	**8**		
ʊə														2			1	**7**	

Table 2. Confusion matrix of English stimulus vowels and diphthongs produced by Sudanese EFL learners (in the rows) and responded to by ten American listeners (in the columns). Correct responses are on the main diagonal, indicated in bold face.

	Perceived RP vowels																	
Target	ɜː	ʌ	ɑː	æ	ɑʊ	aɪ	e	eə	eɪ	ɪ	iː	ɪə	ɔ	ɔː	ɔɪ	ʊ	uː	ʊə
ɜː	**5**		1								4							
ʌ		**6**											4					
ɑː	1		**8**											1				
æ		7		**1**			1									1		
ɑʊ					**10**													
aɪ						**9**			1									
e							**1**			9								
eə								**10**										
eɪ							4		**2**	4								
ɪ										**10**								
iː							1			5	**4**							
ɪə								1			1	**8**						
ɔ		3											**1**			6		
ɔː														**10**				
ɔɪ															**10**			
ʊ																**9**	1	
uː											1					5	**4**	
ʊə														1				**9**

5.1.2 Discussion and conclusion

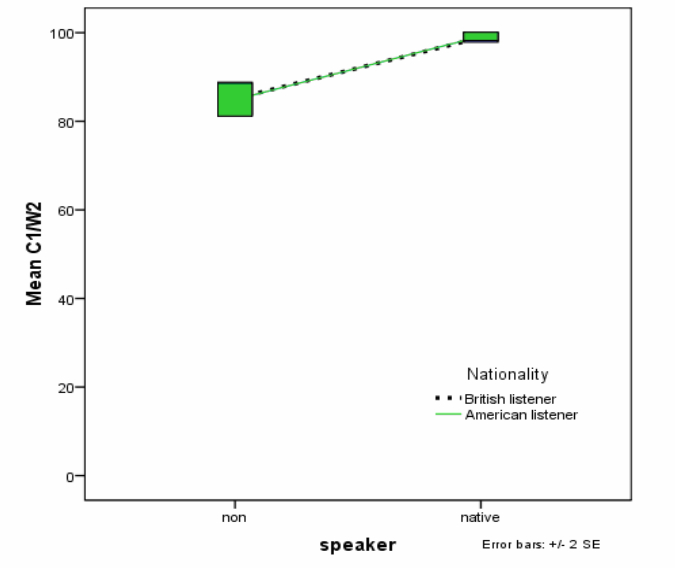
Most likely many of the errors which were made by the British and American listeners identifying English vowels produced by Sudanese speakers, resulted due to linguistic factors. In more detail, the replacement of the English /e/ by /ɪ/ can be attributed to two elements. Firstly, it is probably triggered by L1 effect which permits only vowel sounds available in the Arabic vowel repertoire such as /i, a, u/, while it blocks /e/ which is not part of the vowel system (see Kopczwski and Mellani 1993). This assumption is less probable, however, since previous studies showed that Arabic speakers developed /e/ (Munro 1993, Dickins 2007). Actually, Sudanese Arabic also developed monophthongs. These include /e/ derived historically from the diphthong /aj/ as in /ʕajn/ 'an eye', which coalesced (merged) in dialects such as Cairene and Central Sudanese. In Sanani and a number of Peninsula dialects, the diphthongs are maintained in all phonological contexts. Moreover, among some Cairene speakers the monophthongs are shortened in closed syllables to give short /e/ or /ɔ/, hence they are not considered to be separate vowels (Watson 2002). Secondly, a replacement error of this type can most probably be referred to spelling/graphical differences between English and Arabic, where the Sudanese-Arabic speakers pronounce English /e/ in the way it is spelt as a transfer of the Arabic spelling system which maintains a direct letter-sound relation. Therefore, the English vowel /e/ in words such as *enter*, *envelope*, *wet, let*, etc., are often mispronounced as /ɪ/ by the Sudanese speakers which forms the major cause of confusion in this context. It is also possible to describe this phenomenon as an interlingual error, which results from faulty or partial learning of the L2 rule.

Similarly, the misperception of /æ/ as /ʌ/ or /ʊ/ is due to an incorrect English vowel. That is, Arabic speakers almost always have problems with the pronunciation of the front open /æ/. They tend to pronounce the English /æ/ in the same way they produce their L1 vowel back open lengthened /a/; i.e., in Sudanese and Cairene Arabic /a/ is pronounced as in /bæːb/ 'door' (Kaye 1997). It is likely this is the reason that why native Arabic speakers are advised to keep the English short vowel /æ/ fully front (Cruttenden 2008). A similar conclusion was drawn by Bobda (2000) that Sudanese speakers of English fluctuate between /ʌ, ɜː, ʊ/ due to interference from their Arabic linguistic background. The confusion of lax-tense /ɪ ~ iː/ by the British and American listeners can also be attributed to an incorrect vowel production, which probably resulted from the wrong implementation of English vowel categories. It is less probable that these errors of substitution are the result of length element of the learners' L2. This is because a vowel distinction in both English and Arabic vowel systems is based on short/long contrasts.

5.2 Consonants

5.2.1 Consonant results

Figure 2 *Mean correct identification of English onset and coda consonants by 10 British and 10 American listeners of English. Stimuli were produced by one Sudanese and one native speaker of English.*



As Figure 2 shows, the perception level of the British and American listeners in English consonants is very high. The overall mean correct of such listeners is 85.0 and 84.8 % when the consonants were produced by the Sudanese speakers and 99.0% and 99.2% when they were spoken by native speakers of English. The RM-ANOVA shows that the effect of speaker type is highly significant, $F(1, 18) = 94.5$ ($p < .001$). Moreover, the British listeners showed better understanding of the English consonants read by the Sudanese speakers, but the difference is insignificant, $F(1, 18) < 1$. Furthermore, the level of performance in the consonants read by the native speakers between the two listeners is almost the same, so that the speaker × listener interaction remains insignificant, $F(1, 18) < 1$. It is probably because both listener types are native speakers of English. However, few English onset and coda consonants were misperceived (see Tables 3, 4, 5 and 6).

Table 3 *Confusion matrix of English stimulus onset consonants produced by a Sudanese EFL speaker (targets, in the rows) and responded to by ten British listeners (in the columns). Correct responses are on the main diagonal, indicated in bold face.*

Target	Perceived RP consonants																				
	b	tʃ	d	t	ð	f	g	h	j	k	l	m	n	p	r	s	ʃ	θ	v	w	z
b	**10**																				
tʃ		**10**																			
d			**2**	5										3							
t			4	**6**																	
ð					**0**																10
f						**10**															
g							**8**			2											
h	1							**8**			1										
j									**10**												
k										**10**											
l											**10**										
m												**10**									
n													**9**	1							
p		1				1								**8**							
r	1														**9**						
s																**10**					
ʃ																	**10**				
θ																5		**5**			
v	2																		**7**	1	
w																				**10**	
z																					**10**

Table 4. *Confusion matrix of English stimulus onset consonants produced by a Sudanese EFL speaker (targets, in the rows) and responded to by ten American listeners (in the columns). Correct responses are on the main diagonal, indicated in bold face.*

Target	Perceived RP consonants																				
	b	tʃ	d	t	ð	f	g	h	dʒ	k	l	m	n	p	r	s	ʃ	θ	v	w	z
b	**10**																				
tʃ		**10**																			
d			**0**	10																	
t			5	**5**																	
ð					**0**																10
f						**10**															
g							**10**														
h	1							**9**													
dʒ									**10**												
k										**10**											
l											**10**										
m												**10**									
n													**10**								
p														**10**							
r															**10**						
s																**10**					
ʃ																	**10**				
θ																7		**3**			
v																			**9**	1	
w																				**10**	
z																					**10**

Table 5. *Confusion matrix of English stimulus coda consonants produced by a Sudanese EFL speaker and responded to by ten British listeners. Correct responses are on the main diagonal, indicated in bold face.*

Target	Perceived RP consonants																		
	b	tʃ	d	dʒ	ð	f	g	k	l	m	n	ŋ	p	s	ʃ	t	θ	v	z
b	**9**							1											
tʃ		**10**																	
d			**10**																
dʒ				**10**															
ð					**7**														3
f						**10**													
g							**10**												
k								**10**											
l									**8**		1							1	
m										**10**									
n											**10**								
ŋ											3	**7**							
p								1					**9**						
s														**10**					
ʃ		1													**9**				
t																**10**			
θ														1			**5**		4
v													1					**9**	
z														6					**4**

Table 6. *Confusion matrix of English stimulus coda consonants produced by a Sudanese EFL speaker (targets, in the rows) and responded to by ten American listeners (in the columns).*

Target	Perceived RP consonants																		
	b	tʃ	d	dʒ	tʃ	f	g	k	l	m	n	ŋ	p	s	ʃ	t	θ	v	z
b	**10**																		
tʃ		**10**																	
d			**10**																
dʒ				**10**															
ð					**5**														5
f						**8**												2	
g							**10**												
k							2	**4**					4						
l									**10**										
m										**10**									
n											**10**								
ŋ											1	**9**							
p								3					**7**						
s														**10**					
ʃ		1													**9**				
t																**10**			
θ														4		1	**2**		3
v													1					**9**	
z														4					**6**

Correct responses are on the main diagonal, indicated in bold face.

On the onset consonants, both British and American listeners totally misidentified the English /ð/ as /z/, whilst frequent misperceptions of /θ/ as /s/ and /d/ as /t/ were also observed. It is worth mentioning that the American listeners totally misperceived /d/ as /t/. These are probably the most serious perception errors experienced by the listeners involving the English consonants read by Sudanese speakers. Similar error patterns of the dental fricative consonants of English were made in the coda consonants read by the Sudanese speakers. These included the replacement of /ð/ by /z/, /θ/ by /s/, /z/ was replaced by /s or θ/ whilst /θ/ was replaced /s or ð/ and /ŋ ~n/ mostly by both listeners. Other miscellaneous substitutions such as /k~g, f~v/ were made by the American listeners only.

The British and American listeners also made other miscellaneous perception errors, which included /v~p, ʃ~tʃ, p~k/ in coda position. The error frequency made in the fricative consonants is higher for onsets but lower for the coda position.

In contrast to the above, the listeners showed nearly perfect perception of English onset and coda consonants articulated by the native speakers. On the onset consonants, the British listeners misperceived /ð/ as /θ/ and /θ/ as /s/, whilst the American listeners showed perfect perception. On the coda consonants, the most prominent type of error was an interchangeable substitution of /m~n/ by British and /n/ as /ŋ/ American listeners.

5.2.2 Discussion and conclusions

The conflation of /ð/ with /z/ and /θ/ with /s/ which were read by Sudanese speakers can be attributed to incorrectly produced English consonants. This conflation resulted to due interference of (L1) Sudanese colloquial Arabic (in formal Arabic these sounds are pronounced correctly) (Mohammed 1991). In the Sudanese consonant inventory the interdental /θ, ð/ merged with the apico-dental (often labeled as alveolar or sibilant) /s, z/ (Dickins 2007, Watson 2002, Corriente 1978). Thus, Arabic words like /hæða/ 'this', are mispronounced as /hæza/, whilst /θæbit/ 'firm' is mispronounced as /sæbit/, which influenced the production of the English dental and alveolar fricatives. Actually, in a number of Arabic dialects, the line separating dental continuants from sibilant (hissing) sounds is becoming blurred (see Watson 2002, Dickins 2007, Schmidt 1987). This change, therefore, has side-effects involving the perception of L2 dental fricatives. According to Kopczwski and Mellani (1993), to avoid these types of confusions, Arabic speakers (of different colloquial dialects) of English need to rearrange the distinctive features lying between inter-dentals and alveolar from those of Arabic. Furthermore, distinction between English /θ, ð/ does not always lie in their articulation since most EFL learners can perform them correctly in isolation. However, the problem aggravates when such dentals are combined with /s/ and /z/, particularly in languages which contain no dental fricatives. All of /s, z/ and /θ, ð/ are produced nearer to the upper incisors, so that learners need to practice drills containing combinations involving such sounds (Cruttenden 2008).

In terms of international English intelligibility, the incorrect pronunciation of the English dental fricatives /θ, ð/ and /s, z/ represents a learning problem for second language learners across-language sounds. It is probably because /θ, ð/ are relatively infrequent phonemes in the sound patterns of many of the world's languages. However, the assumption does not show consistency as such substitutions were also observed among EFL/ESL speakers descending from language backgrounds with similar dental fricatives, e.g. Arabic, etc. Intelligibility problems as such probably arise in interactions involving non-native and native speech participants of English due to factors like (i) the number of the minimal pairs the distinction of which is dependent on contrasts of such phonemes and (ii) the potential frequency of such pairs in interactions. This claim motivates the prediction that in an error hierarchy, contrast between phonemes such as /θ~s, ð~z/ may imply a high functional load due to their rare occurrence in many languages which in turn leads to intelligibility problems. Thus, the intricate learning nature of these phonemes, as both rare and highly marked across-language sounds, practically plays a major role in labelling them as a prominent issue of speech intelligibility problems (see Van den Doel 2006, Seidlhofer 2005, Jenkins 2000).

Other substitution errors of English /k~g/ coda consonants which were read by the Sudanese learners are likely made due to the lack of a clear voicing feature separating voiced from voiceless stops, which occurs across very narrow (VOT) boundaries.

5.3 SPIN sentences

5.3.1 Results

Figure 4 presents the mean correct scores on the SPIN test obtained by ten British and ten American listeners. The sentences were read by one Sudanese and one British speaker of English. Error bars (± 2 standard error, SE) are also shown. The figure also shows the correct identification scores on components of the SPIN keywords. Separate scores were computed for the onsets, vocalic nuclei and codas of the SPIN keywords. Also, a composite score was computed by taking the mean of these three component scores. Note that the composite score is always higher than the word-recognition score: for a keyword to be counted as correctly recognized all components had to be identified correctly by the listener. I will present and statistically analyse only the word-recognition scores. The component scores will be analysed in a later section when I will make an attempt to predict word recognition from the component scores.

As Figure 4 shows, the perception level of the simple predictable English meaningful sentences of the British and American listeners reveals nearly perfect performance of the SPIN sentences produced by the British speaker; total mean value are 93 and 95%, respectively. However, lower rates were obtained when the same sentences were read by the Sudanese speaker of English: total mean rates 65% and 69 % for the British and American listeners, respectively. Moreover, in comparison to the British listeners, the American listeners show a higher intelligibility level of the SPIN sentences irrespective of the speaker's accent. The main effect of speaker type (Sudanese EFL versus native British) was highly significant by RM-ANOVA, $F(1, 18) = 239.9$ ($p < .001$). The effect of listener type (American versus British), however, is a trend at best, $F(1, 18) = 3.3$ ($p = .085$). The speaker × listener interaction is totally insignificant, $F(1, 18) < 1$.

Figure 4. *Mean correct recognition of keywords by ten British and ten American listeners of SPIN sentences produced by one Sudanese and one British speaker of English. Error bars are ±2 SE)*

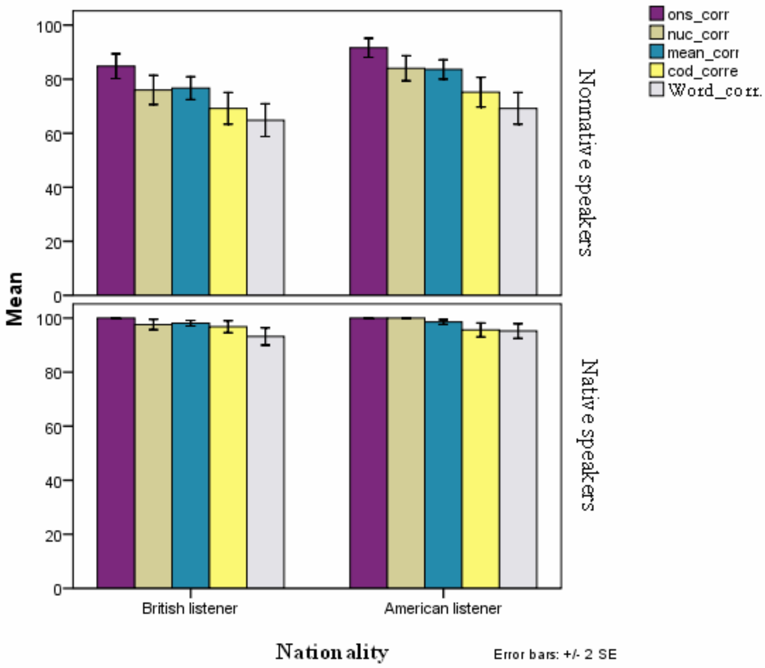


Figure 4 provides details on the listeners' performance in the perception of the SPIN keyword components produced by the Sudanese and the British speaker. The correct identification by British and American listeners of onset consonants in the keywords is 85 against 93% when the consonants were read by the Sudanese and British speaker, respectively, $F(1,18) = 90.8$ ($p < .001$). However, the listeners responded perfectly to the same consonants spoken by the British speakers; total mean correct 100% for both listener groups, $F(1, 18) = 7.5$ ($p = .013$) for both the main effect of listener group and for the speaker × listener interaction. The nucleus vowel results show a small difference of perception between the British and American listeners; total mean correct are 76 against 84% when the items were read by the designated Sudanese EFL speaker, and 97 and 100% when the items were read by the native speaker, $F (1, 18) = 136.2$ ($p < .001$) for the speaker effect and $F (1, 18) = 10.4$ ($p = .005$) for the main effect of listener nationality. However, the interaction between speaker and listener groups is a trend at best, $F (1, 18) = 3.0$ ($p = .099$). On the other hand, performance in the coda consonants proved to be the lowest of all and the British listeners had higher scores than the Americans when the sentences were read by the British speakers; total mean is 97 against 96%. However, both listener types showed a lower score when the same coda consonants were read by Sudanese speakers; total mean correct is 69 against 75%, respectively. Again, the effect of speaker type was highly significant, F (1, 18) =

191.2 (p < .001), whereas the effect of listener group was not, F (1, 18) = 1.3 (p = .271). The interaction between speaker type and listener group just fails to reach significance, F (1, 18) = 4.3 (p = .053).

5.3.2 Discussion and conclusions

Both British and American listeners had high perception of simple and predictable English sentences produced by the native speakers. However, the American listeners showed a slightly higher perception level than their British counterparts, from both Sudanese and native speakers of English; total mean evaluation of these two groups of listeners are 69 and 95% and 65 and 93%, respectively. The listeners' performance is always better when they hear native speakers. Interestingly, the American listeners tend to have better scores irrespective of speaker type. Possibly, the SPIN sentences, which were developed in the USA, refer to American rather than to British everyday situations. The coda consonants proved to be a difficult area in which the listeners showed a low performance, in comparison to the onset consonants and nucleus vowels. The correlation tables 11 and 12 may provide more insight.

6. Correlations

Tables 11 and 12 present correlation matrices for vowels, single, and the component scores on the SPIN keywords: i.e. nucleus vowels, consonants, the mean of the latter three components, and the recognition scores on the entire keyword in the SPIN sentences. The correlation coefficients were computed for the mean percent correct scores of British (upper part of tables) and American (lower part of tables) native listeners, separately for the non-native Table 11, and native speaker Table 12. The tables present linear product-moment correlation coefficients (r) between the listeners' perception scores for all tests and test components in the battery.

Table 11. *Correlation matrix for scores on vowels, single consonants, and (components of the) SPIN test read by one Sudanese speaker of English.*

Listeners		SPIN sentences				MRT	
		onset	nuc.	Coda	Mean	vowels	cons
British	Nuclei	.339					
	Codas	.375	.552				
	onC	**.655***	**.776****	**.895****			
	vowels	–.163	.000	.099	.006		
	consonants	–.151	–.111	–.386	–.312	–.104	
	Words correct	.380	.448	**.802****	**.745***	–.075	–491
American	Nuclei	**.692***					
	Codas	.445	.573				
	onC	**.815****	**.905****	**.810****			
	vowels	–.411	–.553	–.362	–.528		
	consonants	–.320	–.490	.222	–.232	.192	
	Words correct	.549	.597	**.670***	**.719***	–.097	.175

The computation of the correlation of the SPIN results provided different figures with respect to listener and speaker nationality backgrounds (for an explanation of the concept of the correlation coefficient, see chapter three). With regard to SPIN test components read by the designated Sudanese EFL learner, a correlation between the onset consonants and nucleus vowels yielded a positive significant correlation at r = .692 (p < .05) for the American listeners, whilst it shows a positive but insignificant r = .339 for the British listeners. These figures imply that the vowel nucleus is predictive of the onset correct perception, in particular, those of the American listeners. Moreover, the coda consonant components correlate with the onset and nucleus vowels positively at r = .375 and .552 for the British listeners and at r = .445 and .573 for the American listeners, respectively. These relations indicate that both British and American listeners identify the onset consonants well whenever they succeed in identifying nucleus vowels, coda consonants and vice versa. On the other hand, we find no useful correlation between vowels, consonants and their SPIN components, which we did not expect. There are weak relations exist between SPIN coda consonants and consonants at r = .222. This indicates that vowels and consonants have a negative association with the SPIN components, except the coda consonants, which have a positive relationship to consonants. Similarly, English vowels heard by American listeners showed a high positive correlation with coda consonants but not significant at r = .625.

Table 12. *Correlation matrix for scores on vowels, single consonants and SPIN test read by one British speaker of English.*

Listeners		SPIN sentences				MRT	
		onset	nuc.	Coda	Mean	vowels	cons
British	Nuclei	.[a]					
	Codas	.[a]	.068				
	on C	.[a]	**.663***	**.792****			
	Vowels	.[a]	–.583	–.181	–.493		
	consonants	.[a]	–.167	.272	.102	–.111	
	words correct	.[a]	–.089	–.582	–.491	.386	–356
American	Nuclei	.[a]	.[a]				
	Codas	.[a]	.[a]				
	onC	.[a]	.[a]	**2.000****			
	Vowels	.[a]	.[a]	.625	.625		
	consonants	.[a]	.[a]	–.218	–.218	–.307	
	words correct	.[a]	.[a]	**.667***	**.667***	**.742***	–327

Individual vowels and consonants show some kind of correlation. These figures help us predict that vowels, nucleus and coda consonants are the most decisive elements of correct scoring. They also reflect that more positive relations tend to occur more often within SPIN components than between the combination of vowels and consonants, which mean that the subjects' better performance in the nucleus vowels does not indicate that they do better in vowels.

7. Conclusions

Errors made by British and American listeners in the perception of the English front, central and back vowels produced by Sudanese speakers were largely due to fact that the learners' native language, Sudanese Arabic, distinguishes merely three vowel qualities. These English vowels are not part of the speakers' L1 inventory so they represent learning difficulty. Moreover, the paucity of knowledge of the English sound-letter correspondence on the part of the learners often leads to the misperception of English vowels. Such perception errors often take place due to partial learning or insufficient practice.

Frequent confusions were made by the British and American listeners of English in the perception of the English dental fricatives /s, θ/ and /z, ð/ read by the Sudanese speaker are probably due to interference from Sudanese –Arabic source consonant system; i.e., by the filter effect of the speaker L1 Sudanese Arabic (SA) consonant inventory.

British and American listeners showed no serious perception problem with English speech sounds which were produced by the native control speakers.

The results also reflect the effect of the linguistic backgrounds of speech participants on intelligibility. Native listeners are better equipped to interpret the speech of a native talker. On the other hand, non-native talkers may produce the L2 speech sound with a base of articulation that is typical of their L1 rather than of the target language which leads to misinterpretation of such a sound. This means that ESL/EFL listeners from the same native language background as the talkers will be more likely to access the correct phonemic category than ESL/EFL listeners and speakers who do not share the same native language.

Vowels and coda consonants rather than initial consonants of English proved to be the most problematical area of perception Sudanese Arabic-accented English for native British and American listeners.

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Appendices

Appendix 1.Vowel list: /hVd/ meaningful words in a fixed carrier phrase (*say …..again*);19 different full vowels and diphthongs read by Sudanese EFL learners and native speakers of RP English. The stimuli were used in the perception tests.

No.	Vowel
1.	Air
2.	Pet
3.	Pat
4.	Pot
5.	Nut
6.	Pit
7.	Peat
8.	Fool
9.	Full
10.	Mile
12.	Peer
13.	Poor
14.	Late
15.	Out
16.	Boy
17.	Bird
18.	Bard
19.	Board
20.	Boat

Appendix 2. Onset and coda consonants list of meaningful words in a fixed carrier (*say …..again*). The stimuli were read by Sudanese EFL learners and native speakers of RP English. The stimuli were used in the perception tests.

No	Onset consonants	Coda consonants
1	**G**ot	Sa**ck**
2	**B**ang	Ma**sh**
3	**Sh**ut	Pa**ge**
4	**P**in	Hea**th**
5	**F**it	Sa**d**
6	**Th**en	Pa**t**
7	**Th**aw	Sa**fe**
8	**Z**eal	Pu**b**
9	**D**en	Ra**ve**
10	**S**ip	Ma**tch**
11	**J**ob	Co**p**
12	**V**est	La**ce**
13	**t**ame	Ra**ze**
14	**C**old	Co**g**
15	**Ch**at	Wi**th**

Appendix (3) SPIN sentences presented part of the perception test.

4- High predictability SPIN sentences
1- Throw out all the useless junk.
2- She cooked him a hearty meal.
3- Her entry should win the first prize.
4- The stale bread was covered with mood.
5- The fireman heard her frightened scream.
6- Your knees and your elbows are joints.
7- I ate a piece of chocolate fudge.
8- Instead of a fence plant a hedge.
9- The story had a clever plot.
10- The landlord raised the rent.
11- Her hair was tied with a blue bow.
12- He's employed by a large firm.
13- To open the jar twist the lid.
14- The swimmer's leg got a bad cramp.
15- Our seats were in the second row.
16- The thread was wound on the spool.
17- They tracked the lion to his den.
18- Spread some butter on your bread.
19- A spoiled child is a brat.
20- Keep your broken arm in a sling.
21- The mouse was caught in the trap.
22- I have got a cold and a sore throat.
23- Ruth poured herself a cup of tea.
24- The house was robbed by a thief.
25- Wash the floor with a mop.