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LET'S STRESS IT! INVESTIGATIONS OF SAUDI EFL TEACHERS' LEXICAL STRESS PATTERNS

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ABSTRACT

Koffi (2019) investigated the acoustic correlates that Arabic L2 speakers of English use to encode lexical stress. This study replicates the same methodology and uses the same acoustic correlates and the same Just Noticeable Difference (JND) thresholds. Whereas Koffi (2019) focused on a general population of Arabic speakers of English, the current study investigates how 10 females Saudi L2 speakers of English who are college professors encode lexical stress. Do they encode lexical stress similarly or differently from the group that Koffi (2019) investigated? What does this entail for the acquisition of suprasegmentals in L2 English?

Keywords: Acoustic Correlates of Lexical Stress, Arabic-accented English, Just Noticeable Difference (JND), Acoustic Correlates Ranking

1.0 Introduction

This investigation is a replication study of Koffi's (2019). It aims at examining whether or not Arabic L2 speakers of English of different proficiency levels encode lexical differently. In Koffi (2019) the participants were of uneven proficiency levels, but in this study, they are more proficient because they have advanced degrees in English. In fact, they teach English in college. This replication study uses an identical design as Koffi (2019). The only independent variable is the proficiency level of the participants (Walker et al., 2019).

2.0 A Quick Literature Review

The study of the acoustic correlates of lexical stress has a 60-year-old history. It can be traced back to Fry (1955) and (1958) who found that native speakers of American English encode lexical stress by ranking F0, intensity, and duration as follows:

F0 > Duration > Intensity

Since Fry's seminal study, many studies have investigated how the acoustic correlates of lexical stress rank in dialects of English and in other languages. For dialects of English, Keyworth (2014) found that American speakers from Minnesota encode lexical stress according to the following hierarchy:

Intensity > Duration > F0

Kochanski et al. (2005) found that British speakers also rely first and foremost on intensity. Koffi (2019) replicated Fry's methodology to investigate the encoding and ranking of lexical stress in Arabic-accented English. He uncovered the following ranking:

[1] **Authorship Responsibilities:** Author 1 provided Author 2 with a preliminary version. This published version has undergone extensive revision and rewriting by Author 2. They both share equally in the rights, privileges, and responsibilities of this publication.

Intensity (57.14%) = Duration (57.14%) > F0 (42.85%)

His ranking is different from that of Bouchhioua (2008) who found that Tunisian speakers of English ranked their acoustic correlates of lexical stress as follows:

Duration > Intensity > F0

Al-Ani (1992) replicated Fry's methodology to study how Arabic speakers rank the acoustic correlates of lexical stress in their L1 as follows:

Intensity > Duration > F0

Goldsmith (1990:158) describes Arabic as a stress-timed language like English. In Arabic, primary stress falls on "super-heavy codas, otherwise on penultimate syllables." Given that Arabic and English are both accent languages, Saudi speakers should display similar behaviors as English speakers.

3.0 Participants, Data, and Methodology

As noted earlier, this study replicates Koffi (2019). The methodology and the analytical framework are the same, except for the independent variable, which is the proficiency level of the speakers. The proficiency levels of the participants in Koffi's study are unknow. However, the participants in this study have a homogeneous level of proficiency in English. They all have advanced college degrees and teach English as a Foreign Language in Saudi Arabia. Another common denominator among them is that they all learned L2 English in Saudi Arabia, and none of them had lived outside of Saudi Arabia by the time their data was collected. Table 1 provides additional sociometric information about the participants.

N0	Participants	Age	Country	City of Birth	Age of Onset	Grade Level[2]
1.	KSAF2	30	KSA	Riyadh	12	11
2.	KSAF3	27	KSA	Riyadh	7	7
3.	KSAF5	34	KSA	Riyadh	11	11
4.	KSAF7	35	KSA	Riyadh	5	11
5.	KSAF8	31	KSA	Riyadh	12	16
6.	KSAF10	29	KSA	Riyadh	6	6
7.	KSAF15	35	KSA	Riyadh	12	12
8.	KSAF18	34	KSA	Riyadh	6	12
9.	KSAF20	31	KSA	Riyadh	12	12
10.	KSAF22	25	KSA	Riyadh	13	9
	Mean	31.1	NA	NA	9.6	10.7

Table 1: Participants' Sociometric Data

The participants in this study read the same Speech Accent Archive (SAA) text that those in Koffi (2019) recorded themselves reading:

[2] **Grade Level** corresponds to the participants' first-time using English in a classroom

*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 her kids. she can scoop these things into three red bags, and we will go meet her **Wednesday** at the train **station**.*

The elicitation paragraph contains seven disyllabic words with a trochaic stress pattern, as listed in Table 2. A trochaic pattern means that primary stress falls on the penultimate syllable. The transcriptions used in this study are based on *Merriam-Webster Learner's Dictionary*. Thus, they represent the lexical stress patterns of General American English (GAE).

N0	Word	IPA Transcription
1.	Stélla	[ˈstɛlə]
2.	máybe	[ˈmebi]
3.	bróther	[ˈbrʌðər]
4.	álso	[ˈɔlso]
5.	plástic	[ˈplæstɪk]
6.	Wédnesday	[ˈwɛnzde]
7.	státion	[ˈsteʃən]

Table 2: Seven disyllabic words and their IPA representation

Each participant was recorded with a SONY ICD-UX560F voice recorder. Thereafter, the MP3 recordings were converted to WAV mono, with a sampling frequency of 44,100 Hz. A headphone with a fixed microphone was used during the recording. The microphone is a Cardioid (unidirectional) type with a frequency response between 50 Hz and 20,000 Hz. The participant samples were later annotated and analyzed in Praat. The acoustic correlates of F0, intensity and duration were extracted, as displayed in Figure 1.

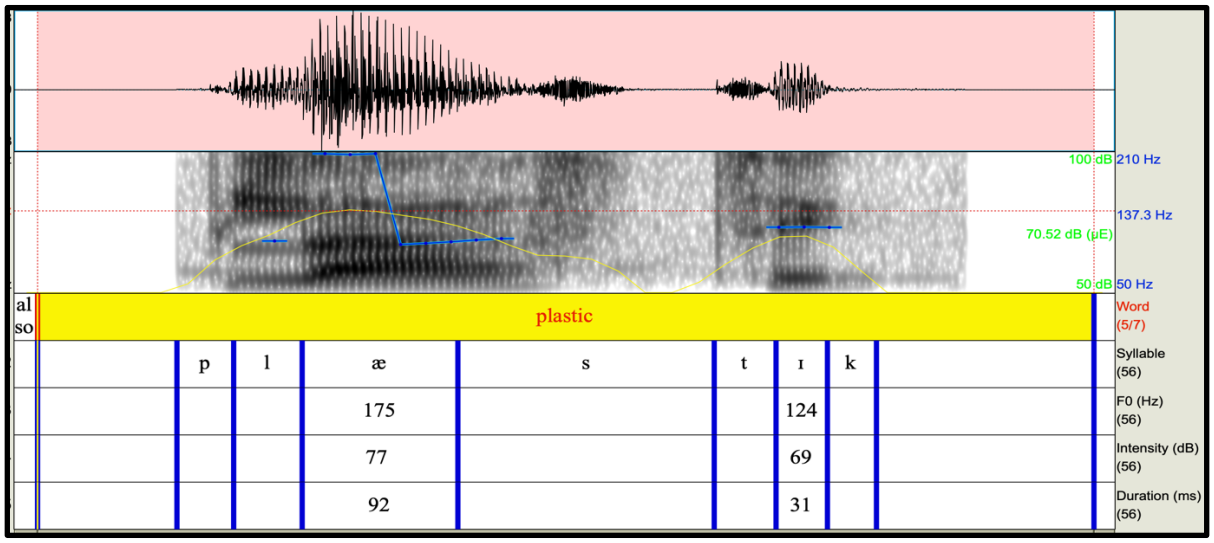

Figure 1: Annotated Spectrogram of <plastic> by KSAF3

The procedure in Figure 1 was repeated for all seven words produced by each participant. The total number of extracted tokens is 420 tokens (7 words x 2 syllables x 10 participants x 3 correlates). We note in passing that whenever Praat rendered a pitch value as "pitch undefined," a measurement of 74 Hz was used because the F0 floor in Praat is set at 75 Hz. An "undefined"

pitch value does not mean an absence of pitch, but rather that pitch was lower than 75 Hz. This is the reason why 74 Hz was used for all instances of "pitch undefined." In the example in Figure 1, the word **<plastic>**, primary stress falls on the nucleus **[æ]** of the syllable **[ˈplæs]**. The three acoustic correlates converge on **[æ]** to show that it carries primary stress. This is in keeping with Koffi's acoustic-based definition of lexical stress, which is stated as follows:

> A syllable is deemed strong (stressed/primary) if and only if the nucleus of its F0 is ≥ 1 Hz higher, its intensity is ≥ 3 dB louder, or its duration is ≥ 10 ms longer than any other nucleus or nuclei in the same word (Koffi 2021:282).

When this definition is applied to a word such as **<plastic>**, we see that the nucleus **[æ]** of the syllable **[ˈplæs]** carries primary stress because its F0 (175 Hz) has a higher pitch than the nucleus **[ɪ]** of the syllable **<tic>** (124 Hz). Since the pitch of the former is 51 Hz higher than that of the latter, we conclude that **[ˈplæs]** carries primary stress. The same goes for the intensity correlate, because **[æ]** (77 dB) is 8 dB louder than **[ɪ]** (69 dB). Lastly, we know that **[æ]** (92 msec) carries primary stress because it is longer than **[ɪ]** (31 msec) by 61 msec. When Just Noticeable Difference (JND) thresholds are used to gauge lexical stress, there is no need to rely on a statistical interpretation of the data because, for JNDs to be considered as valid, they must clear a minimum threshold of 75% of correct responses (Moore 2007).

4.0 Findings

This study is undertaken to see if highly proficient Arabic-accented English speakers such as those in Table 1 encode lexical stress in English differently from those in Koffi (2019). The 420 tokens that they produced consist of 140 pitch tokens, 140 intensity tokens, and 140 duration tokens. They are displayed in Tables 3, 4, and 5 below.

		Stélla		máybe		bróther		álso		plástic		Wédnesday			státion	
N0	**Participants**	ste	la	may	be	bro	ther	al	so	plas	tic	we	nis	day	sta	tion
1.	KSAF2	126	185	124	138	105	153	112	148	190	108	123	-	140	135	143
2.	KSAF3	116	196	129	121	206	207	120	147	175	124	111	-	197	161	110
3.	KSAF5	123	108	157	128	113	109	143	190	127	131	137	162	-	165	181
4.	KSAF7	199	166	142	115	174	207	142	149	194	74	145	144	185	153	168
5.	KSAF8	174	151	188	190	171	167	194	107	177	170	182	-	161	183	111
6.	KSAF10	200	163	161	121	197	195	117	124	105	113	114	-	128	134	132
7.	KSAF15	74	149	142	154	186	178	131	139	202	104	112	205	181	129	143
8.	KSAF18	161	181	114	113	197	138	132	143	198	104	108	-	115	128	164
9.	KSAF20	207	195	200	192	183	192	188	120	160	74	105	133	207	105	110
10.	KSAF22	103	94	117	204	185	189	119	150	113	-	108	208	150	125	145
	Mean	148	159	147	148	172	174	140	142	164	111	125	170	163	142	141

Table 4: F0 Measurements

		Stélla		máybe		bróther		álso		plástic		Wédnesday			státion	
N0	**Participants**	ste	la	may	be	bro	ther	al	so	plas	tic	we	nis	day	sta	tion
1.	KSAF2	79	73	73	69	77	70	76	72	72	62	75	-	74	75	70
2.	KSAF3	75	78	71	71	77	76	78	76	77	69	77	-	74	72	72
3.	KSAF5	76	69	70	63	79	71	80	76	80	70	72	74	-	75	-
4.	KSAF7	73	72	74	67	81	77	79	74	78	67	78	79	76	76	80
5.	KSAF8	68	63	62	64	67	63	70	58	68	54	64	-	63	64	62
6.	KSAF10	70	68	68	65	69	65	73	69	74	64	77	-	77	75	68
7.	KSAF15	73	68	71	66	71	68	74	72	73	62	74	67	71	70	71
8.	KSAF18	69	67	69	63	69	66	67	69	67	62	75	-	67	69	70
9.	KSAF20	66	69	68	67	74	68	73	61	72	54	70	67	68	69	66
10.	KSAF22	73	71	73	70	74	69	77	76	72	-	74	67	71	74	72
	Mean	72	70	70	67	74	69	75	70	73	63	74	71	71	72	70

Table 4: Intensity Measurements

		Stélla		máybe		bróther		álso		plástic		Wédnesday			státion	
N0	**Participants**	ste	la	may	be	bro	ther	al	so	plas	tic	we	nis	day	sta	tion
1.	KSAF2	90	212	120	68	72	70	72	93	103	29	82	-	147	115	60
2.	KSAF3	40	120	140	63	70	35	59	93	92	31	59	-	144	169	92
3.	KSAF5	77	143	91	84	58	40	65	37	53	30	57	36	-	68	23
4.	KSAF7	60	96	110	100	53	40	81	77	98	42	49	63	184	96	53
5.	KSAF8	71	149	75	90	70	113	106	95	105	26	47	-	218	117	61
6.	KSAF10	60	57	119	60	92	47	105	47	103	43	89	-	66	69	40
7.	KSAF15	76	76	125	156	44	47	101	86	69	37	26	40	136	56	48
8.	KSAF18	70	123	135	115	81	59	125	52	67	33	64	-	133	83	49
9.	KSAF20	36	122	131	61	77	55	99	18	87	20	69	65	82	94	39
10.	KSAF22	42	67	113	64	89	46	94	53	81	-	54	48	146	59	33
	Mean	62	117	116	86	71	55	91	65	86	32	60	50	140	93	50

Table 5: Duration Measurements

5.1 Interpretation of the Findings and Correlate ranking

With regard to pitch, we see that it was used only 28.57% of the time to encode lexical stress. This means that F0 was used to encode lexical stress in two of seven words. We note in passing that <Wednesday> was sometimes pronounced as [ˈwɛ**.nəz**.de]. This means that it was turned into three syllables instead of two. Half of the Saudi EFL teachers inserted an epenthetic syllable **[nəz]**. Similarly, Koffi (2019) notes that 50% of the participants in his study did the same. This shows clearly that the pronunciation of <Wednesday> is problematic, regardless of the level of proficiency of Arabic speakers. For the intensity correlate, we see that the participants relied on it to encode lexical stress in 5 of 7 words (71.42%). They also relied on duration to encode lexical stress in 5 of 7 words (71.42%). The overall ranking of correlates is as follows:

Intensity (71.42%) = Duration (71.42%) > F0 (28.57%)

This ranking is exactly the same as in Koffi (2019):

Intensity (57.14%) = Duration (57.14%) > F0 (42.85%)

The difference lies only in the sheer number of words. The teachers encoded lexical stress by relying on intensity and duration in 5 out of 7 words, whereas in Koffi (2019), the participants did so in 4 out 7 words. In principle, the sheer number of words does matter as much as the overall lexical strategy used to encode primary stress. The take-away from this replication study is that the speakers' level of proficiency does not seem to matter. Highly proficient speakers rank their correlates similarly as those who are less proficient. What seems to be going on here is that Arabic speakers tend to transfer the lexical encoding and ranking strategy from their native L1 into English. We draw this inference from Al-Ani's (1992) findings. Furthermore, Koffi (2019), Ani (1992), Bouchhioua (2008), and the results from this replication study converge to show that Arabic speakers do not rely on F0 to encode lexical stress. In all these studies, F0 ranks last.

6.0 Summary

This replication confirms the findings in Koffi (2019). Given that the 10 females speakers of English in this study are highly proficient (they teach English in college), we conclude that the lexical stress strategy that Arabic speakers use is not correlated with their level of proficiency. Instead, it seems to have everything to do with the transfer of suprasegmental features of their L1 Arabic into their L2 English. The ranking in Al-Ani (1992) shows that Arabic speakers rely mostly on intensity to encode lexical stress. It is therefore not surprising to see that, regardless of proficiency levels, Arabic-accented English speakers depend equally on intensity and duration to encode lexical stress. The strategy that they use does not interfere with intelligibility for two reasons. First, the three acoustic correlates of stress lexical stress are co-equal. This means that any one of them can be used to encode lexical stress. Secondly, relying on intensity to encode lexical stress does not matter because, as noted by Keyworth (2014), native speakers of American English rely primarily on intensity to encode lexical stress. Kochanski et al. (2005) found that British speakers also rank intensity first.

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Appendix A: Sociometric

Participant	Age	Country of Birth	City of Birth	Cities lived in KSA	Dialect ascription	Inner Circle life	If yes, age outside KSA	If yes, English used	Age of 1st Spoken English	Age of 1st English class	Major contribution to Fluency
KSAF2	30	KSA	Riyadh	Riyadh	Najdi	-	-	-	12	11	NS Interaction
KSAF3	27	KSA	Riyadh	Riyadh	Najdi	-	-	-	7	7	Entertainement/ NS Interaction
KSAF5	35	KSA	Riyadh	Riyadh	Najdi	-	-	-	5	11	Entertainement
KSAF7	34	KSA	Riyadh	Riyadh	Southern	-	-	-	11	11	Sibling
KSAF8	31	KSA	Riyadh	Riyadh	Najdi	-	-	-	12	16	Entertainement/ NS Interaction
KSAF10	29	KSA	Medina	Medina, Riyadh	Hijazi	-	-	-	6	6	Entertainement
KSAF15	35	KSA	Riyadh	Riyadh	Hijazi	-	-	-	12	12	Entertainement
KSAF18	34	KSA	Riyadh	Riyadh	Najdi	-	-	-	6	12	Entertainement/ NS Interaction
KSAF20	31	KSA	Riyadh	Jubail, Jeddah, Hail, Riyadh	Northern	-	-	-	12	12	School
KSAF22	25	KSA	Jeddah	Jeddah, Riyadh, Taif, Tabuk	Najdi	-	-	-	13	9	Entertainement/ NS Interaction