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Examining Phonetic Cues in English Lexical Stress: A Comparative Study of Yemeni EFL Learners and American Speakers Across Diverse Syllable Patterns, Word Lengths, and Proficiency Levels

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Abstract

Producing English lexical stress involves manipulating phonetic cues such as vowel duration, intensity, and fundamental frequency (F0). Existing literature presents diverse perspectives on how EFL learners utilize these prosodic features to realize stress (Fry, 1955; Modesto & Barbosa, 2019; Saha & Mandal, 2018; Zhang & Francis, 2010; Zuraiq & Sereno, 2021). However, inconsistencies in methodology and limited stimulus sets across previous studies hinder cross-study comparisons. Addressing this gap, the present study examines whether the use of these cues by Arab EFL learners remains consistent across disyllabic and trisyllabic words or varies according to syllabic structure and word length. A total of 65 Yemeni undergraduates at two proficiency levels and 10 American native speakers were recruited to produce 21 disyllabic and 21 trisyllabic words in which the stressed syllable was clearly marked. The analysis revealed that similar to American speakers, Yemeni EFL learners employed vowel duration, intensity, and F0 to distinguish stressed syllables from unstressed ones. Results showed significant differences in the stressed-to-unstressed vowel ratio between Yemeni learners and American speakers. American speakers exhibited a more pronounced reduction in vowel duration, intensity, and F0 for unstressed syllables compared to Yemeni EFL learners. Additionally, the study found that the use of phonetic correlates varies between disyllabic and trisyllabic words and across different proficiency levels, indicating that the production of English lexical stress is influenced by syllable pattern, proficiency level and word length. These findings highlight the complexity of stress production in EFL learners and suggest that instructional strategies should consider these variabilities to improve learners' pronunciation skills.

INTRODUCTION

The debate over how English stress patterns used by EFL learners affect speech recognition by listeners has been ongoing since 1955, as discussed by Koffi (2021). Researchers concurred

that diversity among languages' phonological and phonetic systems is the source of the debate towards the significance of the stress patterns in enhancing intelligibility while speaking English (Altmann & Kabak, 2015; Fry, 1955; Guo, 2022; Koffi, 2021; Ladefoged, 2001; Levis, 2018; Tremblay, 2009; Zhang & Francis, 2010; Zuraiq & Sereno, 2021). English stress patterns can be manifested at lexical and sentence levels. At the lexical level, stress occurs when one syllable in a word becomes more dominant than the other syllables (Zuraiq & Sereno, 2021). The stressed syllable in the word ***photo****graph* for example; illustrates the first syllable is more prominent than the other syllables. Cutler et al. (1997) state that lexical stress patterns are critical in word recognition and structure information. The same conclusion has been reached by subsequent investigations concluding that producing correct English stress patterns improves the comprehension and the intelligibility of the transmitted message and makes word recognition more accurate (Al-Thalab et al., 2018; Lee et al., 2019; Levis, 2018; Saha & Mandal, 2018; Tuan, 2018; Zuraiq & Sereno, 2021).

Producing English stress patterns is a natural process for native speakers, which involves the realization of one or multiple phonetic cues such as duration, intensity, fundamental frequency (F0) and vowel formants. However, studies reported that producing English lexical stress is challenging for English language learners, especially for those who speak a language with fixed stress patterns in all words, such as Arabic (Zuraiq & Sereno, 2021). This study aims to examine how Arab EFL undergraduates, particularly Yemeni Arab EFL undergraduates, and native American speakers use phonetic cues to produce English lexical stress. The study investigates whether proficiency levels influence the use of these cues under conditions where participants can clearly see the stressed syllable in the stimuli to avoid the familiarity effect. The goal is to understand how these phonetic features affect the accuracy and consistency of stress placement on English words, thereby contributing specific insights to the literature in phonetics, as recommended by Koffi (2021) book. The current study, therefore, aims to answer the questions;

1. How do Yemeni EFL learners use phonetic cues when producing English lexical stress in disyllabic and trisyllabic words?
2. To what extent does the level of proficiency influence the use of phonetic correlates when producing English lexical stress in disyllabic and trisyllabic words among Yemeni EFL undergraduates compared to American speakers?

LITERATURE REVIEW

Theoretical perspectives on lexical stress in English

Researchers have looked at how English lexical stress is acquired to gain a deeper knowledge of how EFL learners produce English lexical stress (Jaiprasong & Pongpairoj, 2020; Saha & Mandal, 2018; Tuan, 2018; Zuraiq & Sereno, 2021). By convention, the production of English lexical stress has been studied in contemporary linguistics through two disciplines: phonology and phonetics. Many longitudinal studies investigated the production of English lexical stress from phonological bases. That is to say, researchers from different language backgrounds attempted to examine the effect of the L1 phonological system on the production of English

lexical stress (Al-Khulaidi, 2017; Jaiprasong & Pongpairoj, 2020; Liu, 2017; Tuan, 2018). In particular, these previous studies concentrated on the differences between L1 and English stress patterns to predict EFL learners' challenges in assigning the primary stress in English words that contain two or more syllables.

Investigating the effect of mother tongue influence proposed some insightful understandings of the cross-linguistic influence on prosodic processing (Chrabaszcz et al., 2014). However, results cannot be generalized as each language has different phonological and phonetic specifics. Therefore, the previous studies reported different challenges and recorded different performances produced by learners of the English language (Koffi, 2021; Levis, 2018). Studies that used this paradigm tried to answer the issue of where EFL learners correctly locate the primary stress in English speech at the word level. Precisely, the fundamental issue examined earlier was the idea of stress being shifted to another syllable. On the other hand, little discussion surrounds the production of English lexical stress at the phonetic level.

Phonetic cues in the production of lexical stress

Over the following years, research has increasingly turned towards phonetic analysis to understand how non-native speakers use acoustic features—such as vowel duration, intensity, and fundamental frequency (F0)—to encode lexical stress. Unlike phonological analysis, which focuses on abstract rules and patterns of stress placement, phonetic studies investigate the physical, observable characteristics of speech, enabling a more objective examination of how stress is realized. This shift toward phonetic analysis allows for a more detailed understanding of stress realization and its effects on intelligibility and foreign-accentedness (Jeong et al., 2020; Jung & Rhee, 2018; Modesto & Barbosa, 2019; Saha & Mandal, 2018; Zhang & Francis, 2010; Zuraiq & Sereno, 2021).

In English, lexical stress is typically marked by three primary phonetic cues: vowel duration, intensity, and fundamental frequency (F0). These cues serve as prosodic signals that distinguish stressed from unstressed syllables in spoken words. Duration refers to the length of time a vowel is held during articulation (Koffi, 2021; Tremblay et al., 2021). In stressed syllables, vowels tend to be significantly longer than those in unstressed positions. This lengthening creates a perceptual prominence that helps listeners identify the stressed syllable. In contrast, vowels in unstressed syllables are often reduced and shortened, contributing to the characteristic rhythm of English (Mousikou et al., 2024). Intensity, often perceived as loudness, is another cue used to signal stress (Koffi, 2021). Stressed syllables are typically produced with greater vocal effort, resulting in increased amplitude or sound pressure. In phonetic analysis, intensity is measured in decibels (dB), and higher intensity values are generally associated with stressed syllables (Mousikou et al., 2024). However, intensity is considered a less reliable cue compared to duration and F0, as it can be influenced by various external factors, such as recording conditions or speaker variability (Fry, 1955). Fundamental frequency (F0) corresponds to the perceived pitch of the voice, determined by the rate of vocal fold vibration (Koffi, 2021; Tremblay et al., 2021). Stressed syllables often exhibit a noticeable pitch rise or peak, making F0 a critical cue for stress perception in English (Sung, 2025). While F0 is commonly used by native speakers to highlight prominence, its use among L2 learners varies depending on their language background and familiarity with pitch modulation as a stress cue.

Cross-linguistic insights and challenges in measuring stress production

A number of studies utilized the phonetic software PRAAT to describe stress patterns acoustically by measuring each vowel's duration, intensity, pitch and fundamental frequency of syllables and compared the production of L1 learners to American native speakers' production of English stress patterns. For example, Saha and Mandal (2018) examined the production of English lexical stress by Bengali learners. Their findings indicated that, although Bengali speakers utilized pitch, duration, and intensity, they produced significantly less native-like stress patterns. The researchers noted that Bengali learners tended to produce unstressed syllables with a full vowel, in contrast to English speakers, who significantly reduced vowel duration in unstressed syllables.

In the same year, Jung and Rhee (2018) aimed to analyze the English lexical stress produced by Korean, Japanese and Taiwanese-Chinese speakers compared to native English speakers acoustically. The findings demonstrated that both native and non-native speakers employed vowel duration as the greatest cue and F0 as the second strongest cue. The intensity was the weakest cue across all speech groups. Particularly for the Taiwanese-Chinese speakers, the intensity ratio was 1.00, suggesting that they did not distinguish between stressed and unstressed vowels. The results of Jung and Rhee (2018) supported the results of Fry (1955) on using vowel intensity as the weakest and the least reliable acoustic cue in realizing English stress. Meanwhile, Beckman and Pierrehumbert (1986) found that both duration and intensity are the most reliable acoustic cues. On the other hand, the result of Jung and Rhee (2018) showed that all group speakers have a strong tendency to show the most distinguishable difference in duration but not in F0 or intensity. A recent study conducted by Guo (2022) further investigated the phonetic cues transfer effects of first language (L1) regional dialects on the production of English stress contrasts. The study included twenty native English speakers and sixty Chinese learners from various dialect backgrounds (Beijing, Changsha, and Guangzhou). Following Fry's (1959) method, all participants delivered the minimal pair stimuli, including primary stress at the penultimate and final syllables. The results revealed that all Chinese participants produced the stressed syllable with higher F0, longer duration, and greater intensity values. Meanwhile, the native English speakers used an exquisite combination of F0 and duration and intensity. In contrast, the various dialect groups showed a tendency to transmit their native phonetic cues into their production of English lexical stress, resulting in phonetic cue deviation or irregularity.

The above mentioned studies focused on producing the English stress pattern in minimal English pairs. Levis (2018) reported that stress minimal pairs are relatively uncommon, especially when the segmental pairs are identical (Cutler et al., 1997). There are perhaps as many as 100 in English, most of which involve two-syllable words. Furthermore, incorrectly assigning stress in minimal pairs production may not significantly impact oral communication comprehension (Ghosh & Levis, 2021). When an English learner says, "She ***PRE****sents* the topic to the audience" instead of *pre****SENT***, the listener can assume the meaning as soon as all consonants and vowels are fully produced. On the other hand, when an English word has no other counterparts, the listener will become unable to recall similar segmental sounds to understand the word.

Furthermore, using stimuli that consist of words with only two syllables does not really help to understand the nature of using the phonetic cues when words get extended. Some English words can assign the primary stress at the penultimate syllable with the usage of duration and F0 as strong correlates, as reported in the investigation of Jung and Rhee (2018). The question can be raised here: will learners always assign the stressed syllable at the penultimate using vowel duration and F0, or is this not fixed when words get lengthened by extra-syllables? Accordingly, there is a need to investigate the production of English lexical stress phonetic cues in words with more than two syllables. As Koffi (2021) outlined in his book, it is advised to examine how English lexical stress is produced in phonetic measures to get a variety of information about these acoustic features produced by English learners from different language backgrounds and be able to speak about foreign-accented English scientifically. Therefore, this study focuses on examining the variability in employing vowel duration, intensity, and F0 across different syllable patterns and word lengths, with the overarching goal of understanding how these phonetic features affect the accuracy and consistency of stress placement in English words. Figure 1 shows the variables that affect the production of English lexical stress phonetic cues.

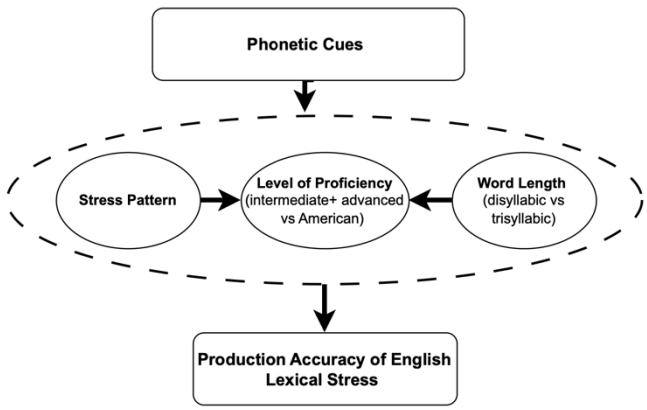

Figure 1 Variables affecting production of English lexical stress phonetic cues

Production of English lexical stress by Arab EFL learners

The production of English lexical stress by Arab speakers has been a topic of interest among researchers for nearly three decades (Youssef & Mazurkewich, 1998; Zuraiq & Sereno, 2021). Based on online published studies, about 13 studies were carried out to investigate the production of English lexical stress by Arab speakers since the 1980s (Ali & Abdalla, 2021; Al-Khulaidi, 2017; Al-Maghrabi, 2021; Almbark et al., 2014; Altmann & Kabak, 2015; Anani, 1989; Aziz, 1980; Ghaith, 1993; Helal, 2014; Younes, 1984; Youssef & Mazurkewich, 1998; Zuraiq & Sereno, 2021). The focus of these studies was the location of primary stress at the phonological level. Most of these researchers testified a profound relationship between the learners' ability to acquire English lexical stress and the Arabic language stress pattern system. The evidence for this relationship is highly regarded as Arabic-specific interference in transferring stress rules from Arabic to English lexical stress production. Yet, most of these studies focused on the effect of Arabic stress rules that examined the pattern of the syllable structure and its influence in changing the placement of the English primary stress. There has

been no reliable evidence that clarifies how Arab EFL learners produce English lexical stress acoustically using phonetic cue measurements other than the study of Zuraiq and Sereno (2021), who studied the effect of grammatical class in changing the location of the English primary stress in 8 minimal pairs. According to Zuraiq and Sereno (2021), although Arab Jordanian learners produced the stressed syllable with longer vowel duration, greater vowel intensity, and higher F0, the produced ratio of phonetic cues by Arab Jordanian learners differed from that of native speakers. These differences increased difficulties in the production of English lexical stress by Arab English learners. Thus, encoding the phonetic cues when producing English lexical stress by EFL learners requires further investigation due to the scarcity of research (Jeong et al., 2020; Jung & Rhee, 2018; Koffi, 2021; Modesto & Barbosa, 2019; Saha & Mandal, 2018; Zhang & Francis, 2010; Zuraiq & Sereno, 2021).

Within the context of Yemen, little has been mentioned about the production of English lexical stress by Yemeni learners. The latest study was carried out by Al-Khulaidi (2017), who studied the production of English lexical stress by Yemeni speakers. Through the underpinning of the Contrastive Analysis framework, Al-Khulaidi (2017) tested the pronunciation of learners who live in Ibb City. This study focused on how Yemeni speakers assign the primary stress in English words that consist of suffixes and prefixes. Al-Khulaidi (2017) stated that Yemeni learners face many challenges in producing primary English stress in English words. According to the findings of Al-Khulaidi (2017), errors in English lexical stress are related to the influence of the Arabic language on the production of Yemeni EFL learners who tend to emphasize the first syllable. Nevertheless, Al-Khulaidi (2017) used only ten participants in his study and tested the production of real English words that were familiar to the participants' knowledge. In addition, the analysis of English lexical stress was done purely based on the auditory impressions of the researcher himself. In other words, the researcher listened to the recorded data and assigned the stressed syllable accordingly, which decreased the validity and increased the researcher's bias. Thus, more research is needed to understand how Arab EFL learners utilize the phonetic correlates to produce English in multisyllabic words.

MATERIALS AND METHODS

Design

The study follows a casual comparative design based on quantitative analysis, comparing the production of Yemeni EFL undergraduates and English American speakers using phonetic acoustical measurements. It included one task to test the production of English lexical stress. The stimuli for the production task encompassed real English disyllabic and trisyllabic words containing various stress patterns and locations. However, the primary stress was consistently placed for Yemeni EFL learners, as the study focuses on the phonetic cues used to assign stress in multisyllabic words rather than investigating the assignment of primary stress in words. This approach ensures consistent results across participants.

Participants

Participants were selected using a demographic survey questionnaire that gathered information on gender, age, and prior consent. A total of 65 respondents participated in the study, comprising both male and female undergraduates aged 18 to 23. All participants were originally from Hadhramout City, Yemen, and were enrolled in the English department at Hadramout University.

These participants were further categorized based on their proficiency levels, determined through a placement test. Among them, 38 participants were classified as intermediate learners, while 28 were identified as advanced learners. This distinction allows for an analysis of how proficiency influences the use of phonetic cues in producing English lexical stress. In addition to the Yemeni participants, the study included a control group of 10 native American English speakers. This control group is crucial for establishing baseline measures of vowel duration, intensity, and fundamental frequency (F0). By comparing the production of these acoustic features between the native speakers and the Yemeni EFL learners, the study aims to assess the accuracy and consistency of stress production among the Yemeni participants.

Assessments and measures

Forty-two disyllabic and trisyllabic words, as given in Appendix 1, were selected from the study of Al-Thalab (2018), under the condition of making the primary stress marked to the participants in each test word. Twenty-one disyllabic and trisyllabic words were selected equally. The target words were randomly presented and pronounced twice by native American speakers and three times each by Yemeni EFL learners at their normal speech rate in neutral frame sentences such as “I said test word this time”, following the method of Guo (2022), Jung and Rhee (2018), and Saha and Mandal (2018); the additional repetition for the learners was to ensure sufficient data for within-speaker variability analysis and to account for possible inconsistencies in L2 pronunciation. For fluency, the speakers were instructed to read the text several times before recording and reading the material aloud. The speech was digitized at a sampling rate of 16 kHz with an accuracy of 16 bits.

Each stressed, and unstressed vowel in the test was examined for duration, average intensity, and average F0 using PRAAT acoustic analysis software (Boersma & Weenink, 2025). The intensity cue was measured using the mean of multiple intensity values extracted over a number of time points. The F0 cue was also calculated for the average value over the entire vowel. To ensure reliable results, the pitch range of the female speakers was set to 100172XDX 500 Hz and the male speakers' pitch range was set to 751D73XX 300 Hz, as explained in the study of Saha and Mandal (2018) and Zhang et al. (2008). Pairwise comparisons and post-hoc analysis of variance between-subjects level of proficiency and stress positions, mainly the antepenultimate, penultimate, or ultimate syllable of the within-subjects variable for the originally measured values of each acoustic variable. All post-hoc tests (LSD) used a critical *p*-value of 0.05.

RESULTS

Phonetic cues in disyllabic words

The measurements of the research questions depend on the differences in utilizing phonetic cues by the Yemeni EFL learners and the American speakers. In particular, when it comes to intensity, the ratio was measured by dividing the average intensity of the stressed vowel by the average intensity vowel of the unstressed vowels. The ratio of F0 was calculated using the same method of intensity. Measurements of vowel durations depend on the value number of producing the vowel within a certain time point without dividing the stressed syllable by the unstressed syllable, following the methods of Guo (2022) and Saha and Mandal (2018).

Duration

The overall results of vowel duration measurements between the stressed and the unstressed vowels showed that Yemeni EFL undergraduate and American speakers produced the stressed vowel correctly at the penultimate syllable. The mean value of vowels at the penultimate syllable scored 0.95 by the three groups. By contrast, the mean value of the vowel in the ultimate syllable scored 0.88 by the three groups. Table 1 shows the statistics of duration measurements in disyllabic words. Although there are differences between duration values among the three groups, the duration values between the stressed and unstressed vowels by the Yemeni intermediate and advanced undergraduates showed slight differences. These results indicate that the Yemeni intermediate and advanced undergraduates produced both syllables with longer duration compared to the American speakers.

Table 1

Results of vowel duration in disyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Penultimate	Duration1 (**stressed**)	Advanced	.09719	.005456
		American	.08625	.003194
		Intermediate	.10725	.00848
		Total	.09690	.009939
Ultimate	Duration2 (unstressed)	Advanced	.08769	.007199
		American	.04900	.003162
		Intermediate	.09131	.002983
		Total	.07600	.019926
Penultimate	Duration1 (unstressed)	Advanced	.09680	.002950
		American	.05780	.002280
		Intermediate	.10360	.003507
		Total	.08607	.021915
Ultimate	Duration2 (**stressed**)	Advanced	.11400	.002915
		American	.09889	.002168
		Intermediate	.11540	.002702
		Total	.10940	.008149

Table 1 also shows vowel duration values of the Yemeni intermediate and advanced EFL undergraduates and American English speakers in disyllabic words where stress falls on the ultimate syllable. It can be seen that although the three groups produced longer duration to

stress vowels at the ultimate syllable, the American English speaker reported significantly higher differences between the stressed and the unstressed vowels compared to the Yemeni intermediate and advanced EFL undergraduates. The three groups recorded the vowel duration at the penultimate in fewer milliseconds than the vowel in the ultimate stressed syllable. This result means that all three groups could produce the stressed syllable with a longer duration. American speakers scored 0.057 ms at the penultimate and 0.098 ms at the ultimate syllable. Between the two groups of the Yemeni EFL undergraduates, the advanced group produced similar results to the American group.

To ensure this result, a multivariant test was conducted to find out if there were any significant differences in the results among groups. The test revealed that there is a significant effect in the results among the three groups with [F (95.656) $p < 0.05$]. The post-hoc test (based on participants' level of proficiency) showed a significant effect of differences among Yemeni EFL intermediate undergraduates, English native speakers, and Yemeni EFL advanced undergraduates with a p-value that is smaller than 0.05. Refer to Table 2 for the post-hoc test results on the duration measurement of disyllabic words with stress placed on the penultimate syllable.

Table 2

Duration in disyllabic words at the penultimate syllable

Duration Type	Comparison Group	Mean Difference	Sig.
Duration 1 (Stressed)	Advanced vs. American	-0.01094*	.001
	Advanced vs. Intermediate	-0.01006*	.000
	American vs. Intermediate	0.02100*	.000
Duration 2 (Unstressed)	Advanced vs. American	0.03869*	.000
	Advanced vs. Intermediate	-0.00362*	.040
	American vs. Intermediate	-0.04231*	.000

Note: *The asterisk (*)* indicates significance at the 0.05 level.

Results from Table 2 show for Duration 1 (stressed syllables), there were significant differences between Advanced and American (-0.01094*, $p = .001$), Advanced and Intermediate (-0.01006*, $p = .000$), and American and Intermediate (0.02100*, $p = .000$). For Duration 2 (unstressed syllables), significant differences were also found between Advanced and American (0.03869*, $p = .000$), Advanced and Intermediate (-0.00362*, $p = .040$), and American and Intermediate (-0.04231*, $p = .000$). Another multivariate test was conducted to determine whether there were any significant differences among the variables where stress is placed on the ultimate syllable. The value for the differences in Wilks' Lambda was obtained. The test revealed a significant main effect across the dependent variables [F (93.343b), $p < 0.05$]. To explore differences among the three groups, a post-hoc test (based on participants' level of proficiency) was performed. The results showed significant differences among Yemeni EFL intermediate undergraduates, English native speakers, and Yemeni EFL advanced undergraduates, with a p-value smaller than 0.05. Refer to Table 3 for the post-hoc test results on the duration measurement of disyllabic words with stress placed on the ultimate syllable.

Table 3

Duration in disyllabic words at the ultimate syllable

Duration Type	Comparison Group	Mean Difference	Sig.
Unstressed	Advanced vs. American	0.03900*	.001
	Advanced vs. Intermediate	– 0.00680*	.000
	Intermediate vs. American	0.04580*	.000
Stressed	Advanced vs. American	0.01520*	.000
	Advanced vs. Intermediate	– 0.00140	.040
	Intermediate vs. American	0.01660*	1.000

Note: *The asterisk (*)* indicates significance at the 0.05 level.

Table 3 shows results for unstressed syllables, where the mean difference between the Advanced group and the American group was 0.039 ms (p = .001), between the Advanced and Intermediate groups it was –0.0068 ms (p < .001), and between the Intermediate and American groups it was 0.0458 ms (p < .001). For stressed syllables, the mean difference between the Advanced and American groups was 0.0152 ms (p < .001), between the Advanced and Intermediate groups it was –0.0014 ms (p = .040), and between the Intermediate and American groups it was 0.0166 ms (p = 1.000).

Intensity

The average intensity of all vowels in the disyllabic words was measured (in dB). The ratio between the stressed and unstressed vowels within the same word was obtained in this section by dividing the intensity of the stressed vowel by the intensity of the unstressed vowel, as shown in Table 4. It is observed that the Yemeni advanced EFL undergraduates produced intensity between the two syllables with 1.133 ratios and 1.128 ratios by the Yemeni intermediate EFL undergraduates. On the other hand, the ratio of intensity by the American speakers is 1.189. This means that the average intensity difference between stressed and unstressed vowels in the same word was comparatively higher in the production of American speakers compared to the Yemeni EFL undergraduates.

Table 4

Results of vowel intensity in disyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Penultimate	Intensity (**stressed**)	Advanced	1.13331	.003719
		American	1.18912	.006302
		Intermediate	1.12881	.003507
		Total	1.15042	.028099
Ultimate	Intensity (unstressed)	Advanced	1.13540	.008473
		American	1.18200	.010909
		Intermediate	1.13140	.001140
		Total	1.14960	.024902

Moreover, the scores of the average intensity show that the participants can differentiate between the stressed and the unstressed syllable. Results of the univariant test show that the

p-vlaue is [*F* (822.930), $p < 0.05$]. This result explains that there is a significant difference among the three groups. A post-hoc test was also conducted to identify which specific group means differ significantly from each other. The result of the post-hoc clarifies that there is a significant main effect of average intensity ratio among the three groups with [*F* (822.930), $p < 0.005$]. This result also implies that the three groups increased vowel intensity more when vowels were stressed than unstressed vowels. Yet, the degree of intensity increases in stressed vowels by American speakers higher than that by Yemeni EFL undergraduates. However, the advanced group performed more similarly to the American speakers. Refer to Table 5 for the differences among the three groups.

Table 5

Post-hoc results of intensity in disyllabic words at the penultimate

Comparison	Mean Difference	Sig.
Advanced vs. American	0.0558	0.000
Intermediate vs. American	0.0045	0.009
Advanced vs. Intermediate	0.0603	0.000

Note: *The asterisk (*)* indicates significance at the 0.05 level.

Table 5 presents the post-hoc comparisons of intensity (penultimate syllable) between proficiency groups. The Advanced group produced significantly lower intensity than the American group (mean difference = –0.0558, $p < .001$) and significantly lower intensity than the Intermediate group (mean difference = –0.0603, $p < .001$). The Intermediate group produced slightly higher intensity than the American group (mean difference = 0.0045, $p = .009$).

However, stressing the vowel at the ultimate syllable did not show a higher ratio than stressing vowels at the penultimate syllable. As shown in Table 4, Yemeni advanced EFL undergraduates produced intensity between the two syllables with a 1.135 ratio and 1.131 by Yemeni intermediate EFL undergraduates. On the other hand, the intensity ratio of the American speakers is 1.182. A univariant test was conducted to test the variances of the average intensity ratio among the three groups of participants where stress is located at the ultimate syllable. The results show that there is a significant difference between group levels with [*F* (61.790), $p < 0.05$]. The variations of stressing the ultimate syllable using the average intensity make it evident that English speakers recorded a wider range of deviations, with a distinct emphasis on the ultimate stress. However, the post-hoc results show no differences between the intermediate and the advanced group with a *p*-value that is bigger than 0.05, as shown in Table 6.

Table 6

Post-hoc results of intensity at the ultimate

Comparison	Mean Difference	Sig.
Advanced vs. American	-0.04660*	0.000
Advanced vs. Intermediate	0.00400	0.445
American vs. Intermediate	0.05060*	0.000

Note: *The asterisk (*)* indicates significance at the 0.05 level.

Table 6 shows post-hoc comparisons of intensity in disyllabic words (ultimate syllable). A significant difference was found between Advanced and American speakers (mean difference = –0.0466, $p < .001$) and between American and Intermediate speakers (mean difference = 0.0506, $p < .001$). No significant difference was found between Advanced and Intermediate speakers (mean difference = 0.004, $p = .445$).

Fundamental frequency (F0)

The average F0 of the stressed and unstressed vowels was measured (in Hz). The ratio between stressed and unstressed vowels within the same word for average F0 was obtained using the same method of intensity measurements. The descriptive statistics of vowel F0, where the penultimate syllable is stressed, are shown in Table 7. The results imply that vowel F0 was increased among the three groups and show differences between syllables with 1.114 ratios recorded by the advanced group, 1.762 by Americans, and 1.074 by the intermediate group.

Table 7

Results of vowel F0 in disyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Penultimate	F0 (**stressed**)	Advanced	1.11450	.065272
		American	1.76231	.122296
		Intermediate	1.07463	.055809
		Total	1.31715	.329534
Ultimate	F0 (unstressed)	Advanced	1.36140	.035997
		American	1.44040	.028815
		Intermediate	1.17120	.009445
		Total	1.32433	.119624

The findings of the univariant test analysis of the average F0, show there is a significant effect of levels using the average F0 to stress the penultimate syllable with [F (320.326), $p < 0.005$]. The post-hoc test results revealed no significant main effect of vowel F0 between the intermediate and the advanced groups, with a p-value (0.198) that is bigger than 0.05. Meanwhile, there is a significant main effect between American and advanced groups and between American and intermediate with a p-value smaller than 0.05. Table 8 shows the results of the post-hoc test.

Table 8

Post-hoc results of F0 in disyllabic words at the penultimate

Comparison	Mean Difference	Sig.
Advanced vs. American	-0.64781*	0.000
Advanced vs. Intermediate	0.03987	0.198
American vs. Intermediate	0.68769*	0.000

Note: *The asterisk (*)* indicates the mean difference is significant at the 0.05 level.

Table 8 displays post-hoc comparisons of F0 at the penultimate syllable. Significant differences were found between Advanced and American speakers (mean difference = –0.64781, p < .001)

and between American and Intermediate speakers (mean difference = 0.68769, $p < .001$). However, the difference between Advanced and Intermediate speakers was not statistically significant (mean difference = 0.03987, $p = .198$).

At the ultimate stressed syllable, both American and advanced groups recorded higher intensity than the intermediate group, with a mean 1.440 by the American, 1.361 by the advanced, and 1.171 by the intermediate, respectively. The result of the univariant test in words that have stress at the ultimate syllable shows a significant difference of levels with [F (129.650), $p < 0.05$]. The post-hoc test also shows significant differences between and among groups. Yet, the differences are not high between American and advanced groups, refer to in Table 9.

Table 9

Post-hoc results of F0 in disyllabic words at the ultimate

Comparison	Mean Difference	Sig.
Advanced vs. American	-0.07900*	0.001
Advanced vs. Intermediate	0.19020*	0.000
American vs. Intermediate	0.26920*	0.000

Note: *The asterisk (*)* indicates the mean difference is significant at the 0.05 level.

Table 9 presents post-hoc comparisons of F0 at the ultimate syllable. All group comparisons were statistically significant. Advanced speakers differed from American speakers (mean difference = –0.07900, $p = .001$) and from Intermediate speakers (mean difference = 0.19020, $p < .001$). American and Intermediate speakers also showed a significant difference (mean difference = 0.26920, $p < .001$).

Phonetic cues in trisyllabic words

Duration

The results of this section analysed only vowels at the antepenultimate and the penultimate syllables. This is due to the existence of tense vowels at ultimate in some words, which affects the vowel length that the stimuli of trisyllabic words have. Table 10 provides the descriptive analysis of vowel duration.

Table 10

Results of vowels duration in trisyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Antepenultimate	Duration1 (**stressed**)	Advanced	.09708	.002449
		American	.09367	.001414
		Intermediate	.10842	.002205
		Total	.09972	.004212
	Duration 2 (unstressed)	Advanced	.08775	.002006
		American	.07908	.002151
		Intermediate	.09675	.001865
		Total	.08786	.0077571

Location		Level	Mean (mili.sec)	Std Deviation
Penultimate	Duration1 (**stressed**)	Advanced	.09633	.00212132
		American	.09333	.00173205
		Intermediate	.10211	.00250555
		Total	.09726	.00662702
	Duration2 (unstressed)	Advanced	.0856667	.00212132
		American	.0820000	.00173205
		Intermediate	.0965556	.00250555
		Total	.0880741	.00662702

The overall results of duration measurements between the stressed and unstressed vowels showed that Yemeni EFL undergraduates and American speakers produced the vowel at the antepenultimate syllable with a longer duration compared to the vowels in the following syllable.

The total mean value of vowel duration at the antepenultimate syllable is 0.099 for the three groups. On the other hand, the mean value of vowel duration at the penultimate syllable was 0.087 for the three groups. This means that the duration of the stressed syllable is longer than the unstressed syllable. However, the difference between them is not equal, where the American speakers scored higher differences among the three groups. A multivariant test was conducted to test if there are significant differences among group levels. Results reveal that there is a significant effect of the level difference in using duration between the stressed and the unstressed among the three groups with a *p*-value [F (68.575), $p < 0.05$]. The differences between and among groups were obtained in the post-hoc results for comparison. Although results showed differences among and between all groups, with a *p*-value smaller than 0.05, the advanced group scored better than the intermediate group, as illustrated in Table 11.

Table 11

Post-hoc test results of duration at the antepenultimate in trisyllabic

Duration	Comparison	Mean Difference	Sig.
Du 1	Advanced vs. American	0.00342	0.003
	Advanced vs. Intermediate	-0.00342	0.003
	American vs. Intermediate	-0.01133	0.000
Du 2	Advanced vs. American	0.00867	0.000
	Advanced vs. Intermediate	-0.00867	0.000
	American vs. Intermediate	-0.01767	0.000

As shown in Table 11, significant differences were found among groups for both Du 1 and Du 2. The Intermediate group consistently produced longer durations than both the Advanced and American groups. The Advanced group also showed significantly longer durations than the American group in most comparisons.

At the penultimate syllable, as shown in Table 10, the duration measurements between the stressed and the unstressed vowels showed that Yemeni EFL undergraduates and native English speakers produced the vowels at the penultimate syllable with a shorter duration than the preceded vowel. The variance among each syllable is clear and explicit. The mean value of vowel duration in the antepenultimate syllable was 0.097ms for the three groups. The mean value of vowel duration in the penultimate syllable was 0.088 for the three groups. This result

indicates that stress was not cued by vowel duration. The multivariant test which was conducted to test difference among duration in words where stress is at the penultimate showed a significant difference in level among groups. The test result revealed a significant main effect on proficiency level with [F (26523), $p > 0.05$]. These findings imply that the three groups differ in using vowel duration cues at the penultimate stressed syllable. Results of the post-hoc showed no significant main effect of duration between English speakers and Yemeni advanced EFL undergraduates. See Table 12. However, there is strong evidence of significance in producing vowel duration at the penultimate between American speakers and Yemeni advanced EFL undergraduates. The significance of differences is evident in the vowel production among the three groups: Yemeni intermediate EFL undergraduates, Yemeni advanced EFL undergraduates, and native English speakers. The results show that the three groups of samples produced the vowel at the antepenultimate syllable with longer duration than the stressed vowel at the penultimate syllable. Yet, the Yemeni intermediate EFL undergraduate made the penultimate vowel syllable longer than the Yemeni advanced EFL undergraduate and the American speakers. Thus, the stress may not be cued by the long duration when lax vowels exist at the penultimate syllable as the schwa or /e/ sound in *magnetic*/mægˈnet.ɪk/.

Table 12

Result of post-hoc test of duration at the penultimate in trisyllabic

Duration	Comparison	Mean Difference	Sig.
Du 1	Advanced vs. American	0.00300*	.005
	American vs. Intermediate	–0.00578*	.000
	Intermediate vs. Advanced	0.00578*	.000
Du 2	Advanced vs. American	0.00367*	.001
	American vs. Intermediate	–0.01089*	.000
	Intermediate vs. Advanced	0.01456*	.000

Note: The mean differences marked with an asterisk (*) are significant at the 0.05 level.

For Du 1, Advanced speakers produced slightly longer durations than American speakers (0.00300 ms, $p = .005$), and Intermediate speakers produced longer durations than both American (–0.00578 ms, $p < .001$) and Advanced speakers (0.00578 ms, $p < .001$). For Du 2, Advanced durations exceeded American durations by 0.00367 ms ($p = .001$), American durations were shorter than Intermediate durations by 0.01089 ms ($p < .001$), and Intermediate durations exceeded Advanced durations by 0.01456 ms ($p < .001$).

Intensity

Despite differences in vowel intensity recorded between and among the three groups in disyllabic words, the intensity at the antepenultimate syllable showed a significant main effect among groups but not between Yemeni advanced and intermediate EFL undergraduates. Table 13 shows the descriptive results of vowel intensity ratio differences between the antepenultimate and the penultimate syllables. As shown in Table 13, the three groups made the vowel at the antepenultimate higher in intensity. However, differences in vowel intensity between both syllables are higher in the production of the American speakers, with a mean value of 1.57. On the other hand, the mean by the intermediate and the advanced EFL undergraduate recorded fewer differences with mean values of 1.163 and 1.197, respectively.

Table 13

Results vowels intensity at the antepenultimate in trisyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Antepenultimate	Intensity (**stressed**)	Advanced	1.19784606	.057924723
		American	1.57592940	.091828659
		Intermediate	1.16329979	036880513
		Total	1.31235842	.200160081
Ultimate	Intensity (unstressed)	Advanced	1.00800617	.019268519
		American	1.05357348	.024857168
		Intermediate	1.02278245	.029517014
		Total	1.02812070	.030766921

To find out differences, multivariate test was conducted. The results indicate that there are significant differences among groups with a P value [*F* (24.40), $p < 0.05$] that is smaller than 0.05. The post-hoc showed significant differences between the American and the advanced group and between the American and the intermediate group. Refer to Table 14 for the post-hoc test results.

Table 14

Post-hoc test of vowels intensity at the antepenultimate in trisyllabic

Intensity	Comparison	Mean Difference	Sig.
INT 1	Advanced vs. American	–3.83*	.000
	Advanced vs. Intermediate	11.67*	.000
	American vs. Intermediate	4.75*	.000
INT 2	Advanced vs. American	–1.08	.256
	Intermediate vs. Advanced	–11.67*	.000
	American vs. Intermediate	12.75*	.000

Note: The mean differences marked with an asterisk (*) are significant at the 0.05 level.

Table 14 shows that for INT 1, Advanced speakers had significantly lower intensity than American (–3.83, $p < .001$) and significantly higher intensity than Intermediate (11.67, $p < .001$); Americans also differed from Intermediates (4.75, $p < .001$). For INT 2, the Advanced vs. American difference was not significant (–1.08, $p = .256$), while Intermediate speakers differed significantly from both Advanced (–11.67, $p < .001$) and American (12.75, $p < .001$).

Referring to Table 13, results shows that vowel intensity is a strong and reliable cue when stress falls at the penultimate syllable in trisyllabic words, as the ratio between the unstressed and the stressed syllable counted almost 1.03 in the production of the three groups. The mean ratio of vowel intensity in the penultimate syllable was 1.00 by the advanced group, 1.05 by the American speakers, and 1.02 by the intermediate group. The intermediate group achieved closed measurements to the American speakers rather than the advanced group. Results of the multivariate test indicate significant differences among groups with a *p*-value [*F* (7.791), $p < 0.05$]. The post-hoc test shows significant differences between the American and the advanced group and between the American and the intermediate group, as shown in Table 15. In contrast, no significant differences were observed between the advanced and intermediate Yemeni undergraduates.

Table 15

Result of post-hoc test of intensity at the antepenultimate

Intensity	Comparison	Mean Difference	Sig.
INT 1	Advanced vs. American	0.67	.226
	Intermediate vs. Advanced	1.11*	.049
	Intermediate vs. American	1.78*	.003
INT 2	Advanced vs. American	4.11*	.000
	Intermediate vs. Advanced	0.22	.732
	Intermediate vs. American	3.89*	.000

Note: The mean differences marked with an asterisk (*) are significant at the 0.05 level.

The findings reveal significant differences in intensity cues between the American and intermediate groups, and between the American and advanced groups. However, no significant differences exist between the Yemeni EFL intermediate and advanced undergraduates, with a *p*-value greater than 0.05.

Fundamental frequency (F0)

The results of F0 measurements between the stressed and unstressed vowels showed that Yemeni EFL undergraduates and the American speakers produced the vowel at the antepenultimate syllable with higher F0 than the other vowels in the following syllables. The mean value of vowel F0 in the antepenultimate syllable was 1.43 for the three groups. The mean value of vowel F0 at the penultimate syllable was 1.42 for the advanced group, 1.63 for the American group, and 1.24 for the intermediate group. Table 16 shows the descriptive analysis of vowel F0 at the antepenultimate syllable.

Table 16

Results of vowel F0 at the penultimate in trisyllabic words

Location		Level	Mean (mili.sec)	Std Deviation
Antepenultimate	F0 (**stressed**)	Advanced	1.42371600	.078785665
		American	1.63381238	.059855785
		Intermediate	1.24358399	.102808541
		Total	1.43370412	.180429591
Penultimate	F0 (unstressed)	Advanced	1.28103057	.049297992
		American	1.13230922	.59330141
		Intermediate	1.25274571	.057366708
		Total	1.22202850	.084625746

The test of multivariant approved differences in utilizing vowel F0 among groups where the *p*-value [F (22.935), $p < 0.05$]. The result of post hoc showed the differences between and among the three groups. Yet, the advanced groups produced a more similar ratio of vowel F0 to the American than the intermediate group. At the antepenultimate syllable position in trisyllabic words, Table 17 presents the post-hoc results among the three groups, indicating significant differences across all groups—except between the advanced and intermediate groups, where no statistically significant difference was found.

Table 17

Result of post-hoc test of F0 at the antepenultimate in trisyllabic

F0	Comparsion	Mean Difference	Sig.
F0 1	Advanced vs. American	8.67*	0.000
	American vs. Intermediate	6.00*	0.004
	Advanced vs. Intermediate	14.67*	0.000
F02	American vs. Intermediate	2100964*	0.000
	Advanced vs. American	18013201*	0.000
	Intermediate vs. American	39022839*	0.000

Note: The mean differences marked with an asterisk (*) are significant at the 0.05 level.

Table 17 presents the post-hoc test results for F0 at the antepenultimate syllable in trisyllabic words. The findings show significant differences among the three groups. Specifically, both the advanced and intermediate Yemeni EFL learners differed significantly from the American speakers. Additionally, the advanced group also showed a significant difference compared to the intermediate group, indicating variation in how F0 was used to mark stress. The results confirm that F0 is a reliable cue, especially for distinguishing proficiency levels among Yemeni EFL learners.

Table 16 also explains the statistics of F0 cues, where stress is located at the penultimate syllable. The three groups produced the stressed vowel with a higher F0 than the unstressed vowel. The results of the mean ratio of F0 between the stressed and the unstressed vowel is 1.22 hertz by the three groups. Results show more F0 differences between stressed and unstressed vowels in the production of Yemeni EFL undergraduates compared to the American speakers. The mean ratio of vowel F0 was 1.28 by the advanced, 1.25 by the intermediate, and 1.13 by the American speakers. It can be noticed that F0 is the most reliable cue to produce the English lexical stress at the penultimate syllable by Yemeni EFL undergraduates. The multivariant test testified differences in the results of F0 of stress at the penultimate with a *p*-value that is smaller than .05. However, these differences exist in the production of vowel F0 between American speakers and the Yemeni EFL undergraduates. No significant differences were evident between the advanced and the intermediate Yemeni EFL undergraduates' production of F0, as shown in Table 18, where stress is located at the penultimate syllable.

Table 18

Result of post-hoc test of F0 at the penultimate in trisyllabic

F0	Comparsion	Mean Difference	Sig.
F01	Advanced vs. American	36.78*	0.000
	Intermediate vs. Advanced	34.89*	0.000
	Intermediate vs. American	19.00*	0.000
FO 1/2	Advanced vs. American	14.87*	0.000
	Intermediate vs. Advanced	0.0283	0.000
	Intermediate vs. American	0.1204*	0.000

Note: The mean differences marked with an asterisk (*) are significant at the 0.05 level.

Table 18 shows significant F0 differences at the penultimate syllable between Yemeni EFL learners and American speakers, with advanced learners showing more native-like stress patterns than intermediate learners.

DISCUSSION

The findings of the study suggested that stressing vowels within words consisting of two or three syllables can be based on one phonetic cue or a combination of two or three phonetic cues. Although the study does not aim to identify which type of phonetic cue Arab learners use to stress syllables in English words, it is worth saying that the results of the study lend support to some studies and contradict others. To begin with, the Yemeni EFL undergraduates produced the stressed vowels at the penultimate syllable with longer duration, higher F0, and greater intensity than the unstressed vowels at the ultimate syllable in disyllabic words. Nevertheless, differences between and among the three groups were significant in vowel duration and intensity. The American speakers recorded a wider range of differences between the stressed and the unstressed vowels. On the other hand, the intermediate group showed fewer differences between both syllables. However, the average of F0 showed no differences between the intermediate and advanced groups. This result contradicts the findings of Zuraiq and Sereno (2021), who found that Iraqi EFL learners produced the stressed vowel with a higher F0 than the native speakers. Although Zuraiq and Sereno (2021) have examined the production of Iraqi speakers who lived in an English native country, they regarded this result to mother tongue influence as Arabic manifest duration and F0 in stressing syllables. The variances of these results between Iraqi and Yemeni learners might be an effect of dialectal differences within the Arabic language. On the contrary, the same result lends support to the claim that Arab learners of English realize the English lexical stress using the three phonetic cues as explained in the studies of Koffi (2021), who examined Tunisian learners of English, yet, this result cannot be generalized because Tunisian learners are more affected by French rather than Arabic. The finding of this study proved that Yemeni EFL undergraduates could differentiate between the stressed and the unstressed vowels. However, differences in utilizing the three phonetic cues were very high, which increased the accentedness in the production of the Yemeni EFL undergraduates. The same results were obtained in the study of Jung and Rhee (2018) in the production of Korean, Japanese, and Taiwanese-Chinese EFL learners.

Results of the study further reveal that Yemeni EFL undergraduates and English native speakers used longer duration to stress the vowel at the penultimate syllable. However, Yemeni EFL undergraduates maintained a longer vowel duration in the unstressed syllable than the American speaker. The same result was reported in the study of Saha and Mandal (2018), stating that the duration of unstressed vowels was significantly shorter than their stressed counterparts in the exact disyllabic target words for both Bengali and English speakers. However, English speakers reduced vowel duration more in the unstressed vowels than Bengali speakers.

The Yemeni EFL undergraduates and the native English speakers produced stressed vowels with greater intensity and higher F0 compared to the unstressed vowels. Still, the degree of vowel intensity and F0 increase in stressed vowels by American speakers were higher than

that of Yemeni EFL undergraduates. This difference contributed significantly to non-nativeness in producing English lexical stress contrast by Yemeni EFL undergraduates. The results of the study also showed that although the Yemeni EFL advanced undergraduate performed better than the intermediates group, the variance among them was not high in using F0 at the penultimate stress and in using intensity at the ultimate stress. Thus, it can be said that the proficiency level affects the use of duration and intensity when stress is located at the penultimate syllable. Meanwhile, the ratio of vowel F0 at the ultimate shows greater differences between and among the three groups in disyllabic words entirely.

Additionally, the study shows that stressing vowels in trisyllabic words showed more variability than in disyllabic words. The stressed vowels at the antepenultimate syllable show that American speakers showed substantial differences in vowel durations among the three vowels in trisyllabic words. The advanced and the intermediate Yemeni undergraduates showed longer duration in the vowel at the antepenultimate syllable than the American speaker. However, differences among vowels in the first and second syllables can barely be recognized in duration measurements, especially by the intermediate group. It can be implied that proficiency level affects the production of English words where stress is located at the antepenultimate level. This finding lends partial support to the previous studies by Jung and Rhee (2018), Koffi (2021), Saha and Mandal (2018), and Zuraiq and Sereno (2021). With regard to vowel intensity at the antepenultimate syllable, the three groups of participants showed the most remarkable intensity in the antepenultimate syllable. Yet, the native English speakers showed notable differences among vowels at the same word level. However, previous studies showed that intensity is the weakest phonetic cue to be realized by ESL and EFL learners, as in Jung and Rhee (2018) and Zuraiq and Sereno (2021), the positions of the stress itself may affect recognition of the type of the phonetic cues, as shown in the current study.

The research findings also suggest that vowel F0 is a reliable phonetic cue to realize the stressed vowel as the antepenultimate syllable by American speakers and Yemeni EFL undergraduates. Nevertheless, the ratio produced by the American speakers differed significantly from that produced by the Yemeni EFL undergrads of both groups. The same results were also obtained by Korean English learners in Jung and Rhee's (2018) study, by Bengali in the study of Saha and Mandal (2018), and by Jordanian Arab English learners in the study of Zuraiq and Sereno (2021).

At the penultimate level, vowel duration was a reliable cue to stress vowels at the penultimate syllable by the three groups. Yet, it is worth noticing that the Yemeni intermediate EFL undergraduates showed longer duration in all vowels at the word level. Results of the advanced group showed no significant differences from the American speakers, using vowel duration to stress the penultimate syllable. These results can be interpreted through the existence of lax vowels, which did not confuse the advanced Yemeni EFL undergraduates. Vowel intensity was the least reliable cue in stressing the vowel at the penultimate syllable in trisyllabic words between and among the three groups. Therefore, as reported previously, indicating that intensity is the weakest phonetic to stress syllables, in general, is not constructive nor informative. It is essential to specify which syllable is being stressed and to identify the type of vowel used, as this finding suggests that intensity can vary in strength depending on the stressed vowel and its syllabic position.

Vowel F0 was surprisingly higher in the output of the Yemeni EFL undergraduates when stress is located at the penultimate syllable. Literature provides evidence that Arab speakers will depend on F0 and duration cues more than intensity cues when stressing the vowels, particularly at the penultimate level, as in Koffi's (2021) and Zuraiq and Sereno's (2021) studies. However, the findings of the current study emphasized the effect of syllables' position. That is because the measurement of vowel F0 showed different results in disyllabic words. The types of vowels can also be a reason for the similarity and the variances of results of the current research and the past studies by Jung and Rhee (2018), Koffi (2021), Saha and Mandal (2018) and Zuraiq and Sereno (2021) . In terms of native speaker production, the results indicate that native speakers utilized phonetic cues differently. For some words, vowel duration emerged as the strongest cue, while in others, intensity took precedence. Additionally, the effectiveness of these cues varied based on the type of vowel articulation and its position within the word. However, fundamental frequency (F0) proved to be the least reliable cue, as it is significantly influenced by the rhythm of pronunciation within carrier sentences. This variability necessitates careful and nuanced attention to obtain accurate results. This result does not support the acoustic rankings presented in Koffi's (2021) book.

In short, it can be implied that the utilization of phonetic cues to stress vowels in English words cannot be easily generalized. Factors such as word length, level of the learners' level of proficiency, and the position of stress can change the production of these phonetic cues accordingly. The findings of Flege and Bohn's (1989) study demonstrated that English lexical stress is more problematic to non-native speakers than English stress placement. Furthermore, Zhang et al. (2008) demonstrated that even if non-native speakers achieve the same level of English lexical stress as native speakers, they may still sound foreign. Nonetheless, the results of the advanced group show that English phonetic cues are achievable and can be mastered with more exposure.

CONCLUSION

The results of the study showed that cueing stressed syllables cannot be fixed based on syllable patterns. That is to say, we cannot categorise or rank which phonetic cues native speakers use to stress English words. Thus, some phonetic cues were shown to be more informative in some syllable structures and not strong in others, especially when words are longer, as in the case of trisyllabic words. The findings of the study hold some pedagogical implications for teaching English lexical stress. For instance, Field (2005) explained through his results that a rightward shift of the primary stress has a more significant impact on increasing pronunciation difficulties than a leftward shift. This conclusion provided valuable guidance to teachers about which pronunciation features they should focus on. Within the Arab EFL context, teaching English stress patterns is almost ignored by Arab EFL teachers inside the classroom, and students are not aware or motivated enough (Misfer Ahmed & Ahmed Busabaa, 2019). Several studies have examined the difficulties Arab EFL learners have when producing English stress patterns (Ali & Abdalla, 2021; Al-Khulaidi, 2017; Maghrabi, 2021; Zuraiq & Sereno, 2021). Nevertheless, results were inconsistent, and the type of phonetic correlates was not clearly defined through previous research. This inconsistency is related to investigating this issue on the basis of different theories, methods, and regional dialect differences in the Arabic language.

In terms of pedagogical direction, teachers in Arab EFL contexts should focus more explicitly on suprasegmental features, especially lexical stress, which remains underemphasised despite its significance for intelligibility. Instruction should draw students' attention to acoustic cues such as pitch (F0), duration, and intensity, and how these contribute to the perception of stress in English. Since these cues are not used in the same way in Arabic, explicit instruction is essential. Teachers should provide clear models, auditory discrimination tasks, guided pronunciation drills, and opportunities for learners to compare their speech with native-like or intelligible models. Moreover, rather than focusing exclusively on native American or British accents, teachers should adopt a more intelligibility-based approach to pronunciation. The Arab-English accent, while often viewed with stigma in some learning environments, can still be intelligible and effective for communication. Therefore, teachers should prioritise clarity and comprehensibility over native-like accent imitation. This shift would also help reduce anxiety and boost learners' confidence.

To motivate students, teachers can incorporate more engaging and communicative pronunciation activities such as mirroring, shadowing, role-plays, and pronunciation games. Integrating digital tools (e.g., speech visualisation apps or AI-based feedback) where possible can enhance learner engagement and provide immediate feedback on prosodic features. Motivation can also be fostered by raising students' awareness of the real-life value of intelligible pronunciation—for example, how it can improve their academic performance, job prospects, and ability to participate in global conversations. Finally, classroom environments that promote positive attitudes toward students' accents while also encouraging improvement can enhance learners' willingness to take risks and experiment with unfamiliar prosodic patterns. This research revealed specific features of English lexical stress that are difficult for Yemeni EFL undergraduates, mainly related to the phonetic cues that stress vowels. This area deserves more attention from linguists, language teachers, and curriculum developers, and suggestions on pedagogical materials and teaching activities should be incorporated into Yemeni EFL curricula. Yemeni and Arab EFL teachers must spend more instructional time teaching the supra-segmental features of the language, especially English stress patterns, using intelligibility-oriented, motivational, and culturally appropriate approaches to pronunciation instruction.

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CONFLICT OF INTERESTS

We declare that we have no competing interests pertaining to the subject matter discussed herein.

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Appendix 1

The stimuli of the production task

Carrier Phrases	
I say **val**ley again	I say per**o**xide again
I say **mon**ey again	I say **de**fender again
I say **rock**et again	I say re**co**rding again
I say **ni**trate again	I say by**zan**tine again
I say **da**ta again	I say mag**ne**tic again
I say **thun**der again	I say **lea**dership again
I say **nur**sing again	I say **sce**nery again
I say **ra**cing again	I say **me**rchandise again
I say **caf**feine again	I say **sig**nature again
I say **cap**tain again	I say **pes**ticide again
I say **mel**ting again	I say **val**entine again
I say **val**ance again	I say **pha**rmacy again
I say **key**board again	I say **fo**rtunate again
I say **van**guard again	I say **dig**nity again
I say **Jou**rney again	I say **mel**ody again
I say **de**fect again	I say **gal**axy again
I say sar**dine** again	I say **ben**efit again
I say suc**cess** again	I say va**nill**a again
I say cam**paign** again	I say pa**cif**ic again
I say nine**teen** again	I say con**sen**sus again
I say ma**chine** again	I say sy**nop**sis again