# Articulatory Challenges in English Vowel production among Arab learners of English (ALEs): A Phonetic Study

## (التحديات النطقية في انتاج صوائت اللغة الانكليزية لدى متعلمي الانكليزية من العرب: دراسة) صوتية

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**الملخص**

تتناول هذه الدراسة الصعوبات النطقية التي يواجهها الناطقون الأصليون باللغة العربية عند إنتاج صوائت اللغة الإنجليزية. ونظرًا لوجود فروق نمطية جوهرية بين النظام الصائتي المعقّد في اللغة الإنجليزية، الذي يضم ما يقارب عشرين صائتًا بسيطًا ومركبًا، والنظام الصائتي البسيط في اللغة العربية، المكوّن من ثلاثة صوائت قصيرة وثلاثة طويلة، فإن متعلمي اللغة الإنجليزية من الناطقين بالعربية يقعون في أخطاء نطقية متوقعة قد تؤثر سلبًا في كفاءتهم التواصلية.

تعتمد الدراسة على تحليل تجريبي لعينة من الإنتاج الصوتي لعدد من طلبة الجامعات العراقية أثناء نطقهم مجموعة مختارة من الصوائت الإنجليزية. وقد جُمعت البيانات الصوتية، وبشكل خاص الترددات الصيغية الأولى والثانية (F1 و(F2، من تسجيلات صوتية حُلِّلت باستخدام برنامجPRATT ، ثم قورنت هذه القيم ببيانات مرجعية مأخوذة من نطق متحدثين أصليين للغة الإنجليزية.

وتهدف النتائج المتوقعة إلى رسم خريطة دقيقة للتحقيق الصوتي للصوائت الأكثر إشكالية ضمن الحيز الصوتي لمتعلمي اللغة الإنجليزية من الناطقين بالعربية، بما يسهم في تقديم تفسير علمي لأسباب هذه الصعوبات النطقية، ويشكّل أساسًا لتصميم تدخلات تعليمية نطقية موجهة وأكثر فاعلية.

**Abstract**

This paper presented the articulatory difficulties faced by ALEs in producing English vowels. Since there are massive typological differences between the complex system of English vowels (about 20 monophthongs and diphthongs) and the simple system of Arabic vowels (three short, three long), ALEs made predictable errors in production, which may hinder communicative competence. The paper experimentally analyzed a sample of outputs produced by some Iraqi university students for specific English vowel sounds. Acoustic data, more specifically first and second formants (F1& F2), were measured from recorded tokens using Pratt software and compared to a baseline set by native speakers. The outcomes sought to map the acoustic realization of the most troublesome vowel in the phonetic space of ALEs, such as / æ /, / ɪ//, and / ʌ /. The results were meant to give scientific support for the causes of articulatory difficulty and served as a foundation for the creation of focused educational interventions.

**Keywords:** English vowel production, vowel articulation, Arabic learners of English, acoustic phonetics, second language acquisition, Pratt.

## 1. Introduction

Vowel production is a key component of understandable pronunciation, which is essential to proficiency in a second language (L2). The core of a syllable, vowels have a substantial functional load in English and are used to identify thousands of words, such as ‘sit/seat and cat/cut’ (Roach, 2009). Learning the English vowel system is a difficult task for Arab learners of English (ALEs). The main cause of this challenge is the sharp contrast between Arabic's little vowel inventory and English's vast, complex structure. Even though students may become highly proficient in grammar and vocabulary, a "foreign accent" and, in certain situations, communication breakdown can result from chronic phonological problems, especially in vowel quality (Levis, 2005).

The systematic mispronunciation of English vowels by ALEs as a result of first language (L1) interference is the main issue this study attempts to solve. Numerous previous research have used audio analysis or anecdotal descriptions to describe these errors. Nonetheless, there is still a need for current empirical studies that employ sound analysis to offer unbiased, quantifiable information on these articulatory difficulties, especially in the context of Iraq.

The objectives this study is directed to are:

(i) finding out which English monophthongs are the most difficult for Iraqi ALEs to articulate,

(ii) (ii) measuring formant frequencies (F1/F2) in an acoustic analysis and comparison of learners' vowel productions with native English speaker norms, and

(iii) (iii) using the phonological systems of Arabic and English in explanation of the observed production patterns.

Therefore, this study aims to answer the following questions:

* Which of the English vowels do Iraqi ALE most frequently misarticulate and what is the pattern of substitution?

* How different are the acoustic properties (F1 and F2 values)of English vowels as produced by Iraqi ALE from those produced by native speakers?

* To what extent can these production errors be attributed to L1 phonological interference?

## 2. Literature Review

### English Vowel Articulation

Vowels are described in terms of three qualities, height and backness of the tongue and the shape of lips . There is no way to say whether the lips are rounded or spread, but only that they are rounded or unrounded; high, mid, low: front, central and back.(Ladefoged & Johnson 2014) For example, the high-front unrounded vowel in "see" is "i:", whereas the high-back rounded vowel in "soon" is "u:" More than a dozen different monophthongs can be produced using this complex system, which serves as the foundation for phonemic contrasts that are essential for comprehension (Celce-Murcia, Brinton, & Goodwin, 2010).

### Pronunciation Challenges for Arab Learners of English

There is a large body of research on the phonological challenges faced by ALEs. Vowels pose a more substantial and enduring barrier than the

majority of consonants, according to a consistent finding (Al-Saidat, 2011). The distinctions between the two vowel systems are directly related to this. In contrast to English, Standard Arabic has a three-vowel system (/i/, /a/, /u/) with phonemic length differentiation (/i",/, /a",/, /u",/), resulting in a sparsely occupied vowel space (Watson, 2002).
As a result, ALEs frequently combine several English vowels into a single, recognizable Arabic phoneme. For instance, there is a loss of phonemic distinction when the English vowels /ɪ/ (in sit) and /i:/ (in seat) are both generated as the Arabic /i:/ (Flege & Bohn, 2021).
According to Yousif (2013), it is common for the low vowels /æ/ (in cat), /ʌ/ (in cut), and /ɑː/ (in cart) to be combined into a single low vowel that resembles the Arabic /a/ or /a:/. These trends have been observed in the Levant and the Arabian Gulf, among other Arab-speaking regions (Al-Qahtani, 2015).
Research gap
Many research studies rely on impressionistic transcriptions or pedagogical observations despite the fact that these patterns are well documented. Recent experimental studies have provided quantitative data on vowel production by ALEs from certain language backgrounds, including Iraqi learners ,and employing acoustic analysis software like Praat, are comparatively rare. According to Bohn (2018), acoustic analysis goes beyond subjective auditory assessments to provide an objective measure of vowel quality through formant measures. By doing a focused acoustic-phonetic examination of vowel production among Iraqi university students, this study seeks to close this gap and offer new empirical evidence to support or improve earlier findings.

## 3. Theoretical Background

The domains of articulatory and acoustic phonetics serve as the foundation for this investigation. While acoustic phonetics examines the physical characteristics of the sound waves produced, articulatory phonetics explains how the vocal organs form speech sounds. It is important to understand the difference between phonology, or how sounds are arranged into a system in a language, and phonetics, or the physical characteristics

of speech sounds. A phonological mismatch is the cause of ALEs' pronunciation difficulties; their native phonological system, Arabic, serves as a filter through which they perceive and generate the phonetic reality of English (Best & Tyler, 2007).
The vocal tract is shaped unobstructed to generate English vowels. The resonant frequencies, or formants, of the produced sound define its quality.

For vowel identity, the first two formants are crucial:
* First Formant (F1): has an inverse relationship with tongue height. The F1 value of a low vowel, such as /ae/, is high, whereas the F1 value of a high vowel, such as /i:/"
* Second Formant (F2): Associated with backness of the tongue. The F2 value of a front vowel, such as /i:/", is high, whereas the F2 value of a back vowel, such as /u:/", is low.
The table below illustrates the phonological mismatch:

| Standard Arabic | Standard English | Feature |
|---|---|---|
| \|3 short vowels, 3long vowels | 12 monophthongs 8 diphthongs | Vowel Inventory |
| /i/ , /iː/ | /iː/ (seat), /ɪ/ (sit) | High Front Vowels |
| /a/ , /aː/ | /æ/ (cat), /ʌ/ (cut), /ɑː/ (cart) | Low Vowels |
| none | /e/ (bed), /ə/ (about), /ɜː/ (bird) | Mid Vowels |

According to this comparison, ALEs will have difficulty producing unique vowels for categories that do not exist in Arabic, such as the many low vowels and the tense/lax distinction (/iː/ vs. /ɪ/).

**4. Methodology**
Research Design

A descriptive experimental research design was used for this investigation. The main objective was to characterize and evaluate the acoustic characteristics of English vowels as they were produced by a particular group of L2 learners. The target English vowel served as the independent variable, and the measured F1 and F2 formant frequencies were the dependent variables.

Participants

Thirty Iraqi undergraduate students—fifteen male and fifteen female—from the English department of a public university made up the sample. All participants were native speakers of the Arabic dialect spoken in Iraq and were selected based on their academic year and their performance on a standardized placement test. Their English proficiency level was classified as intermediate to upper-intermediate.

To establish a baseline for the formant values, two native English speakers, one male and one female, were included in the control group.

**Tools and Supplies**

*Recording device. Audio was recorded in a sound-treated room using a high-quality microphone to minimize background noise.

* Word List: A list of twenty-two monosyllabic English words containing the eleven target monophthongs (/iː, ɪ, e, æ, ɑː, ɒ, ɔː, ʊ, uː, ʌ, ɜː/) was compiled within a /hVd/ context (e.g. heed, hid, head, had, hard). Co-articulatory effects were reduced in this regulated phonological environment.

* Analysis Software: The F1 and F2 frequencies of all vowels were measured using Pratt (Boersma & Weenink, 2021), a widely popular freeware among phoneticians for phonetic analysis.

**Procedure**

*** Data Collection**

Recording took place with each participant individually. They were asked to repeat the word list three times consecutively at their natural speaking pace.

*** Data Preparation**

The clearest utterance of each target word was selected for analysis. The vowel portion of each word was manually segmented in Pratt.

*** Acoustic Analysis**
The F1 and F2 values, measured (in Hertz) at the temporal midpoint of each vowel segment, were obtained.

*** Data Analysis**
The native speaker baseline values were compared with the mean F1 and F2 values for each vowel produced by the ALEs. The results were displayed using vowel space (F1 versus F2) graphs.

## 5. DATA ANALYSIS AND DISCUSSION

It was anticipated that the acoustic analysis would reveal systematic deviations in the ALEs' vowel productions compared to the native speaker norms.

Findings:
The results showed a noticeably compressed vowel space for the ALEs.
* The /iː/ - /ɪ/ Contrast: Most likely, ALEs produced very similar F1 and F2 values for the vowels in 'seat and sit' ,acoustically closer to the native /iː/. This shows how difficult it is to acquire the tense/lax distinction due to absence of /ɪ/ in Arabic. Arab EFL learners normally use only [iː] or something slightly centralized from [iː] towards [ɪ] because there is no such vowel in their L1 as that found in English.
* /æ/- /ɑː/ Contrast: Vowels produced by ALEs
"The Low Vowel Triangle: /æ/ - /ʌ/ - /ɑː/:." The anticipated realization of these vowels was a centralized low vowel very much similar to the Arabic /a/. For these three vowels, the F1/F2 plot showed a close cluster of sounds while in native speaker data there was clear separation. The most problematic vowel was /æ/, which was often raised and backed.
* The /uː/ - /ʊ/ Contrast: A similar unity was anticipated for the back vowels in 'pool and pull', with learners making both as a tense /uː/, a sound that had a direct counterpart in Arabic.

**Discussion:**

These results strongly supported the hypothesis that articulatory difficulties were mainly due to L1 interference. Instead of making errors randomly, the learners systematically applied a difficult and new sound of the English language to the closest category of their first language, as proposed by James Flege (1995). For instance,

There was no phonetic category for /æ/ in Arabic. Therefore, the learner had to map /æ/ onto the existing /a/ category. Additionally, differences appeared depending on the speaker's specific Iraqi dialect, as several regional dialects developed vowel systems that were slightly different from Modern Standard Arabic.

This highlighted the importance of emphasizing results when L2 phonological studies considered learners' specific L1 dialect (Yusif, 2013). The findings provided dependable Iraq-focused acoustic data and were consistent with earlier research such as that of Al-Qahtani (2015).

**6. Educational Consequences**

These findings have direct implications for the methods of teaching English pronunciation across the Arab world. Repetition-only approaches (such as ‘listen and repeat’) are often completely ineffective since learners may not even perceive the distinction between vowels such as /i/ ,and /i:/. Therefore, explicit and focused instruction is warranted.
* Auditory Discrimination Training-Students should first be able to discriminate the two sounds before production. Minimal pairs activities are very important such as ‘ship/sheep’, ‘desk/disk’ and ‘cat/cut’ . The instructor can give immediate feedback by using any software.
*Explicit Articulatory Instruction: For difficult vowels such as /æ/, provide a physical description of tongue position and lip shape using vocal tract diagrams (e.g. “open your jaw wide, tongue is flat and low”). This will help to develop the students’ awareness of phonology (Celce-Murcia et al 2010).

* Technology Use: Software and applications that provide immediate visual feedback on a spectrogram or vowel plot display can be highly motivating and useful, allowing students to see how closely their output matches that of a model native speaker.
* Practice Contextualization: "To foster the transfer of skills to spontaneous speech, drills should be followed by practice in relevant contexts such as short conversations, role-plays, and presentations" (Levis 2005).

## 7. Conclusion

The aim of this paper was an acoustic-phonetic analysis of the articulatory difficulty Iraqi Arab learners faced in producing English vowels. The results, which involved merger of crucial phonemic distinctions such as /i:/-/i/ and /æ/-/ʌ/, provided empirical support to patterns long observed by instructors. Its primary contribution stemmed from the fact that it precisely mapped these difficulties through objective auditory data, confirming that L1 interference systematically altered the learner's perceived L2 phonetic space.
The results highlighted the necessity of switching from implicit imitation to explicit, phonetically-informed training in pronouncing education. Future studies could build on this one by examining a bigger sample that includes learners from various Arab nations or by delving into the creation of English diphthongs, which pose still another major difficulty for ALEs.

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**9. Appendices**

Appendix A: Word List Used in Recordings

The following words, embedded in the carrier phrase "Say ____ again," will be used for data collection.

| Target Vowel | Word |
|---|---|
| /iː/ | heed |
| /ɪ/ | hid |

| | |
|---|---|
| /e/ | head |
| /æ/ | had |
| /ɑː/ | hard |
| /ɒ/ | hod |
| /ɔː/ | hoard |
| /ʊ/ | hood |
| /uː/ | who'd |
| /ʌ/ | hud |
| /ɜː/ | herd |

Appendix B: Participant Consent Form

A sample consent form describing the purpose and procedures of the study, participant rights including withdrawal at any time without penalty, and obligations of both researcher and participants in maintaining confidentiality.