



تحليل مقارن لإقحام الصوائت: دراسة صوتية

A Cross-Linguistic Analysis of Vowel Epenthesis: A Phonetic Study

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Abstract

Epenthetic vowels, or vowel sounds added into consonant clusters to enhance the pronunciation, have significant effects on understanding spoken language. This research investigates the procedures involved in the insertion of an epenthetic vowel. It provides a phonetic analysis of vowel epenthesis in English, Kurdish, and Arabic languages. This study explains the occasional addition of extra vowel sounds to syllables. It explores how these vowels conform to the phonetic system of the language and how they contribute in speaking, particularly when combined with other consonants.

The researcher uses an acoustic analysis, using the Praat software, to determine the formants (F1 and F2) of these vowels and how these vowels are varied across the studied languages. Moreover, the goal of this study is to examine the factors that determine the insertion of these vowels. The study evaluates the acoustic properties of epenthetic vowels and their impact on speech fluency using phonetic methods.

The findings reveal that epenthetic vowels at the coda position have higher F1 values than those at the onset. Conversely, larger F2 values at the onset in all three languages indicate a more fronted articulation in that particular position. Furthermore, the study found that syllable position has a significant effect on vowel duration. Finally, the mid-central nature of these vowels shows that they serve as structural restoration assists rather than independent lexical constituents, reflecting a cross-linguistic trend toward lower default vowel quality.

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Keywords: Epenthesis,
anaptyxis, prothesis, F1, F2.

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المخلص

تُعدّ الصوائت المقحمة (Epenthetic vowels) —وهي أصوات صائتة تُضاف إلى العناقيد الصامتة لتسهيل عملية النطق— ذات تأثيرات جوهرية في استيعاب اللغة المنطوقة. يبحث هذا البحث في الآليات المتضمنة في عملية إقحام الصوائت، ويقدم تحليلاً صوتياً (phonetic analysis) لهذه الظاهرة في اللغات الإنجليزية والكردية والعربية. كما تفسر الدراسة الإضافة العرضية للأصوات الصائتة الزائدة إلى المقاطع الصوتية، وتستكشف مدى توافق هذه الصوائت مع المبادئ الصوتية الأساسية للغة، ودورها في عملية النطق، لاسيما عند اقترانها بصوامت أخرى.

اعتمد الباحث المنهج التحليلي الصوتي الفيزيائي (acoustic analysis) باستخدام برنامج (Praat)، لتحديد المكونات الطيفية (F1 و F2) لهذه الصوائت ورصد تباينها عبر اللغات محل الدراسة. بالإضافة إلى ذلك، تهدف الدراسة إلى فحص العوامل المحددة لعملية إقحام هذه الصوائت، كما تقيم الخصائص الصوتية الفيزيائية للصوائت المقحمة وأثرها على طلاقة الكلام بالاعتماد على المناهج الصوتية. وكشفت النتائج أن الصوائت المقحمة في موضع "الذيل" (coda) تمتلك قيم F1 أعلى مقارنة بتلك الموجودة في موضع "المستهل" (onset). وعلى العكس من ذلك، تشير قيم F2 المرتفعة في موضع المستهل عبر اللغات الثلاث إلى نطق أكثر تقدماً (fronted articulation) في ذلك الموضع تحديداً. كما أظهرت الدراسة أن لموقع المقطع الصوتي تأثيراً جوهرياً على مدة نطق الصائت. وختاماً، تبين الطبيعة المركزية المتوسطة (mid-central) لهذه الصوائت أنها تعمل كأدوات لترميم البنية المقطعية وليست عناصر معجمية مستقلة، مما يعكس توجهاً لغوياً عاماً نحو خفض جودة الصائت الافتراضي.

1. Introduction

In phonetics, "Epenthesis" refers to inserting an additional sound into a word. It may be further classified as a prosthesis or anaptyxis (Crystal, 2011:171). In the same respect, Hall (2011:1576) suggests that any procedure that involves the addition of a vowel to an utterance is referred to as "vowel epenthesis". Generally speaking, vowel epenthesis is used to modify syllables that fail to conform to a language's structural rules. Vowel epenthesis makes it possible for consonants that subtly occur in phonotactically erroneous contexts (ibid).

In the English language, vowel epenthesis is implemented to prevent phonotactically ill-formed sequences of sibilants that occur, for example, during plural formation (Kim& Kochetov,2011:512).

Concerning the function of epenthetic vowels, Nakhaei (2021:3) states:

"There is a variety of proposals why an epenthetic vowel is added to the input among which are the resyllabification of consonant clusters (Itô 1989), the markedness of a particular format of consonant clusters in a given language (Broselow 1992), better perception of consonants (Côte 2000), bringing a word up to a certain minimal size (e.g. in Mono spoken in Congo) (Olson 2003) and matching the prosodic features (e.g. adding an epenthetic vowel

to a word at the end of intonational phrases with a final-syllable stress in Dutch and Galician) (Kuijpers & Donselaar 1997)”

Uffmann (2012:2) tries to answer the most vital question: “Why do we have epenthesis at all? If only the well-formedness of syllables is at stake, this could also be achieved via deletion”. To clarify this, he states that vowel epenthesis has been repeatedly observed in the literature as the most common technique for meeting syllable structural requirements. The opposite strategy, deletion, is significantly less common but might still help produce syllables that are acceptable in the borrowed language.

Hamid (2016), in his dissertation “*The Prosodic Phonology of Central Kurdish*”, introduces the usage of vowel epenthesis in central Kurdish and states that Kurdish has a strict intolerance for consonant clusters at syllable boundaries. Due to sonority requirements and the particular limitations of the syllable structure, sequences of consonants in Central Kurdish (CK) that lack underlying vowels are systematically modified by epenthesis. The language guarantees that all phonological sequences adhere to well-formed syllable types by introducing vowels to break up these strings.

Despite significant studies on vowel epenthesis in individual languages, there is a lack of thorough cross-linguistic studies that investigate this phenomenon across several typologically varied languages using a consistent analytical approach. In particular, no previous research has explored vowel epenthesis in English, Kurdish, and Arabic collectively, leaving an unanswered question about whether shared phonetic principles drive epenthetic processes across languages.

Therefore, This study examines the role of epenthetic vowels within phonetic systems, notably the epenthetic vowel sounds that occasionally find their way into words, making speech smoother and more fluent. It investigates the specific role that these vowels play in the language's phonetic system. The study analyzes the distribution and frequency of epenthetic vowels to see how they help people comply with internal phonetic standards within languages.

2. The Phonetic Characteristics of Epenthetic Vowels

The phonetic properties of epenthetic vowels may differ across languages; nonetheless, specific common patterns and qualities are observed. According to McCarthy (2008:209), epenthesis is not a literal segmental insertion but syllabic overparsing. Syllables are generated with unoccupied structural positions during overparsing. The phonetic content of these vacant positions becomes apparent after the phonological grammar has been accomplished. Epenthetic vowels are often shorter than other vowels within the word. They provide an exclusively phonological role and lack emphasis or considerable prosodic weight. In Japanese, an epenthetic vowel such as /u/ is often inserted to separate n consonant clusters, for instance, "desu" as [desu]; however, it is not stressed (Goldsmith et al., 1995:252).

Moreover, epenthetic vowel placement varies depending on the syllable structure and directionality of syllabification within a language. There are various rules controlling epenthesis in different languages. For example, due to the distinct phonological rules of each language, the location of the epenthetic vowel utilised might differ significantly. For instance, in Arabic, initial consonant clusters are often split up by an epenthetic vowel (e.g., [iclass] for class), yet in Korean, high front vowels (i) are frequently introduced in clusters containing certain consonants (Hall,2011:1580). Epenthetic vowels usually have a neutral or "default" quality. The schwa [ə] is the most frequent epenthetic vowel across many languages, as it is central and unstressed. For instance, in Lebanese Arabic, [i] is always used

as an epenthetic, while in some dialects of English, a schwa is inserted within the consonants of words such as "film" [film] → [filəm] (ibid:1581).

Browman and Goldstein (1990) proposed that epenthetic vowels are inherently 'targetless', having no articulatory (or acoustic) specification and resulting from sliding of articulatory gestures. In the absence of target specification, the quality of such vowels is entirely determined by the physical properties of preceding and following articulatory gestures. This presumed 'targetlessness' of an epenthetic schwa sets it apart from lexical schwa (in English). Last but not least, epenthetic vowels are influenced by adjacent consonants or acquire the quality of neighboring vowels. In Shona, for instance, the default epenthetic vowel is [i], while the epenthetic vowel after labials is [u], and after velars (commonly) a copy of the preceding vowel, like in the following example: (Kim & Kochetove, 2011:512)

English *cork* [kɔ:k] — [koko]

3. Methodology

The study includes a comparative phonetic approach to explore vowel epenthesis in three different languages: English, Kurdish, and Arabic (Iraqi dialect). It adopts both a qualitative analysis and quantitative acoustic measurements by the use of PRAAT to clarify the phonetic features of epenthetic vowels and to achieve a clear distinction throughout the languages under study.

3.1 Data collection

The data consists of words with phonetic environment when vowel epenthesis occurs frequently in the languages under study. They include lexical items recorded from native speakers of each language. The native speakers were selected according to their native proficiency in the target languages, with no obvious pronunciation disorders, and with nearly similar ages to reduce sociophonetic differences.

The researcher employed three different native speakers for each language, recording 20 different words, 10 of them include epenthetic vowel in the onset and the other 10 words include the epenthetic vowel in the coda.

The recordings were analysed by using PRAAT, a widely used application for acoustic analysis, to investigate the F1, F2, and the duration of epenthetic vowels in each language separately. This analysis helps determine the quality and phonetic realization of the epenthetic vowels.

4. Results

The results encompass the measurement of F1, F2, and the duration of epenthetic vowels inserted in the three languages under study to identify the location of each epenthetic vowel in the vowel space, to highlight the typological differences of epenthetic vowels, and to focus on the length of epenthetic vowels in contrast to lexical vowels.

4.1 Results of F1

The F1 (first formant), which refers to the vowel height, i.e., the vertical line of the vowel space. The relation between the value of F1 and the position of the tongue is inverse; the higher F1 value, the lower the tongue is.

F1 value is counted to show the variety of vowel epenthesis and how it is different according to syllable position (onset or coda) within the languages under study. For each language, F1 was analyzed according to the position the vowel holds. The analysis of English data indicates that the average of F1 of the epenthetic vowel inserted in the onset of English words is (393.005 Hz) in comparison to the vowel that is inserted in the coda, which records an average of about (407.3Hz) as shown in the figure below:

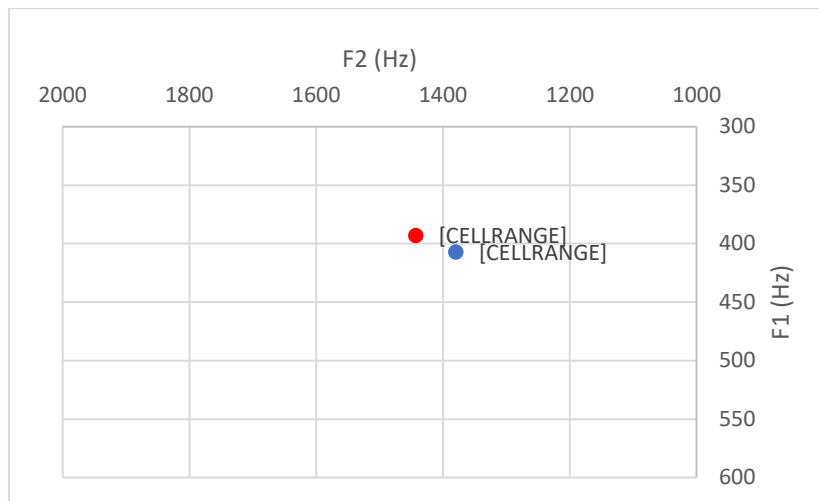


Figure 1: Vowel Epenthesis in English Onset and Coda

For the Arabic language, the average of F1 in onset vowel epenthesis is (531.09 Hz), and the average of F1 in coda is (541.05 Hz), which shows a higher value than those of English and Kurdish languages. The epenthetic vowel in coda position shows a higher value of F1, which suggests a lower position in the vowel space.

Moreover, the F1 value of the epenthetic vowel that is pronounced by Arabic speakers is higher than that of other languages. The analysis of Arabic data is presented in the following figure:

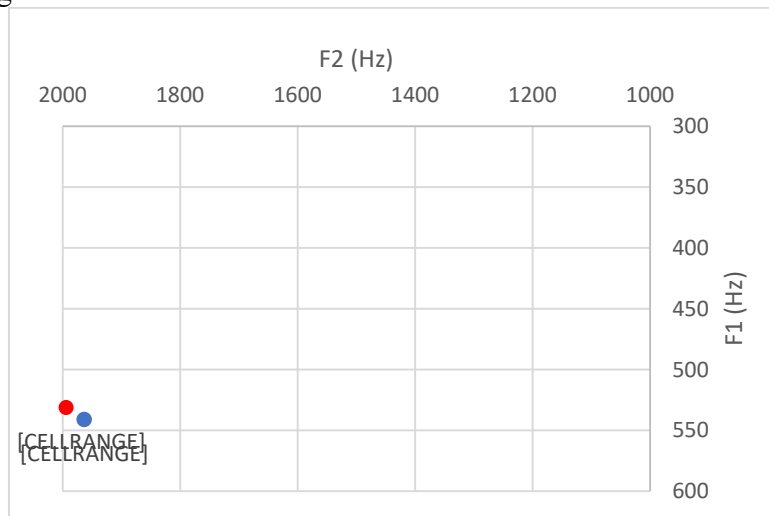


Figure 2: Epenthetic vowel in Arabic Onset and Coda

As for the Kurdish language, the average of F1 in the onset position is (425.51 Hz), indicating that the epenthetic vowel in the onset position is higher than in the coda position, which records an F1 average of (541.66 Hz).

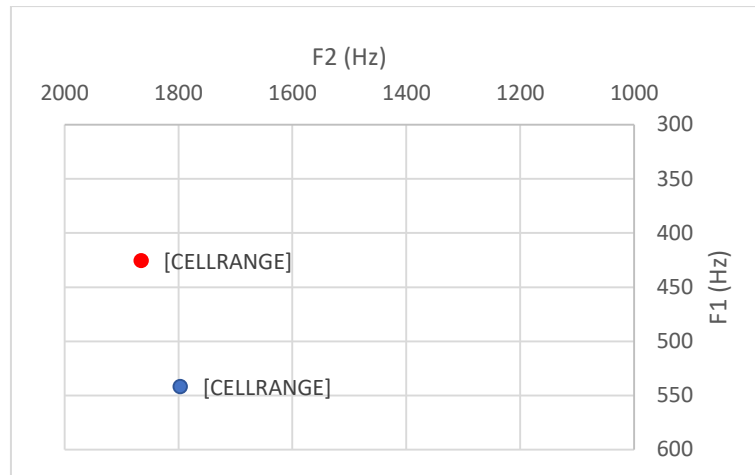


Figure 3: Epenthetic Vowel in Kurdish Onset and Coda

The results of the three languages reveal that epenthetic vowels in coda position show a higher F1 value compared to those in the onset position, in the three languages, especially in Kurdish language, when the F1 value increased from (425.4 Hz) in the onset position to (541.6 Hz) in the coda position. The same is true in both English and Arabic languages, although they recorded slight differences between F1 in onset and coda. Generally speaking, in English and Arabic, the values of F1 (in onset vs. coda) are close whereas in Kurdish there is a gap of F1 value in Onset and Coda.

4.2 Results of F2

The F2 (second formant), i.e., the horizontal line in the vowel space, refers to the tongue position (front or back) while producing the epenthetic vowel. The higher the F2 value, the more the epenthetic vowel is located at the front of the mouth. The F2 value is analysed in both the onset and coda position in all three languages to show the differences between them.

In English language, as shown in the table in (the table in duration section), the F2 value decreased from 1443.033 in the onset to 1379.467 in the coda. The same is true in both Kurdish and Arabic languages, where the value of F2 decreased from (1865.633 and 1994.167) in onset to (1796.833 and 1962.867) in coda, respectively.

Arabic language records the highest F2 value in both onset position, that is (1994.167 Hz), and coda position, that is (1962.867 Hz), followed by Kurdish language that recorded (1865.633 Hz in onset) and (1796.833 Hz in coda). The English language tends to have the lowest F2 value in both onset (1443.033 Hz) and coda (1379.467 Hz).

Moreover, the results reveal that the F2 in the onset position of the three languages always tends to be a little higher than in the coda position.

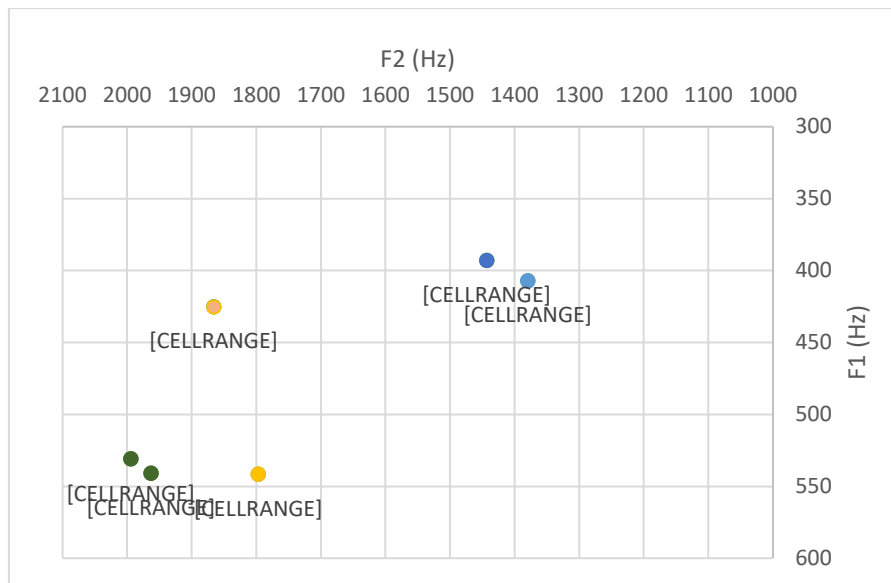


Figure 4: Vowel Space of Epenthetic Vowels in English, Kurdish, Arabic
 English= blue/ Kurdish= yellow/ Arabic= green

4.3 Results of Duration of Epenthetic Vowels

The duration (the length) of the epenthetic vowels was analysed to investigate variations in the time of production of the epenthetic vowels in Arabic, Kurdish, and English, according to syllable position (onset vs. coda). The average duration values of all epenthetic vowels were measured in milliseconds. The findings show that across the three languages, epenthetic vowels in coda position are longer than those in onset position, although the difference varies by language.

In Arabic, the average length of epenthetic vowels in coda position was 0.1043 ms, whereas onset epenthetic vowels averaged a duration of 0.0695 ms. Kurdish followed a similar pattern, with greater vowel lengths in coda positions (0.1043 ms) compared to (0.0466 ms) in onset positions. English exhibited an extended length in coda epenthesis as well, although to a lesser extent than that noted in Arabic and Kurdish, with an average of (0.0853 ms) in coda and (0.0679 ms) in onset position.

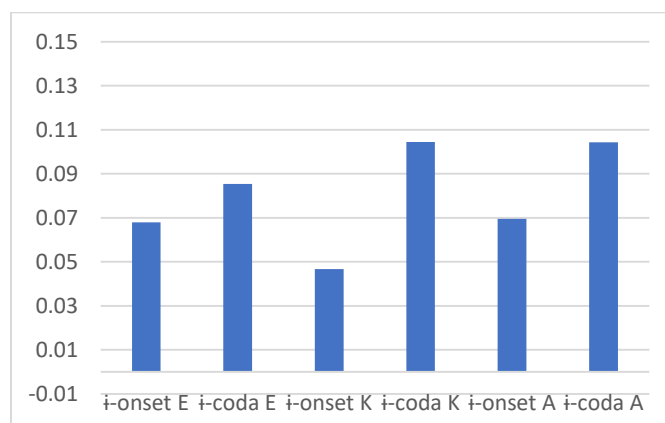


Figure 5: Duration of Epenthetic vowels in English, Kurdish, and Arabic languages

Table 1: The Average of Analysis of the Three Languages

language	position	F1	F2	Duration
English	onset	393.005	1443.033	0.067906
English	coda	407.3133	1379.467	0.085362
Kurdish	onset	425.41	1865.633	0.046636
Kurdish	coda	541.6633	1796.833	0.104399
Arabic	onset	531.09	1994.167	0.069502
Arabic	coda	541.0567	1962.867	0.1043

Finally, and based on the typical vowel space that is presented in the work of Peterson and Barney (1952), the following figure shows the position of the epenthetic vowels in relation to the classic vowels in the vowel space:

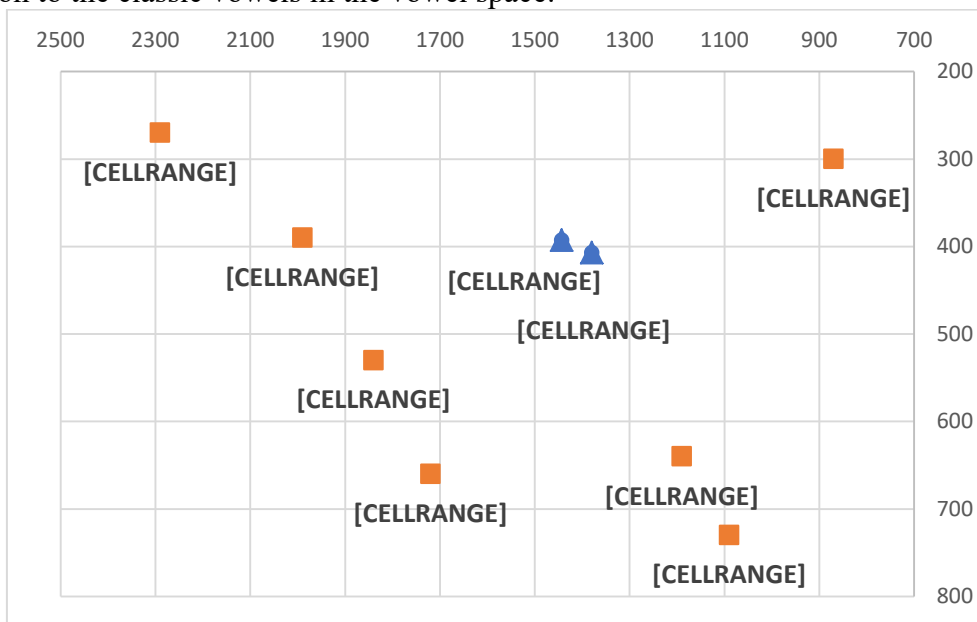


Figure 6: English Epenthetic Vowels in Relation to Lexical Vowels

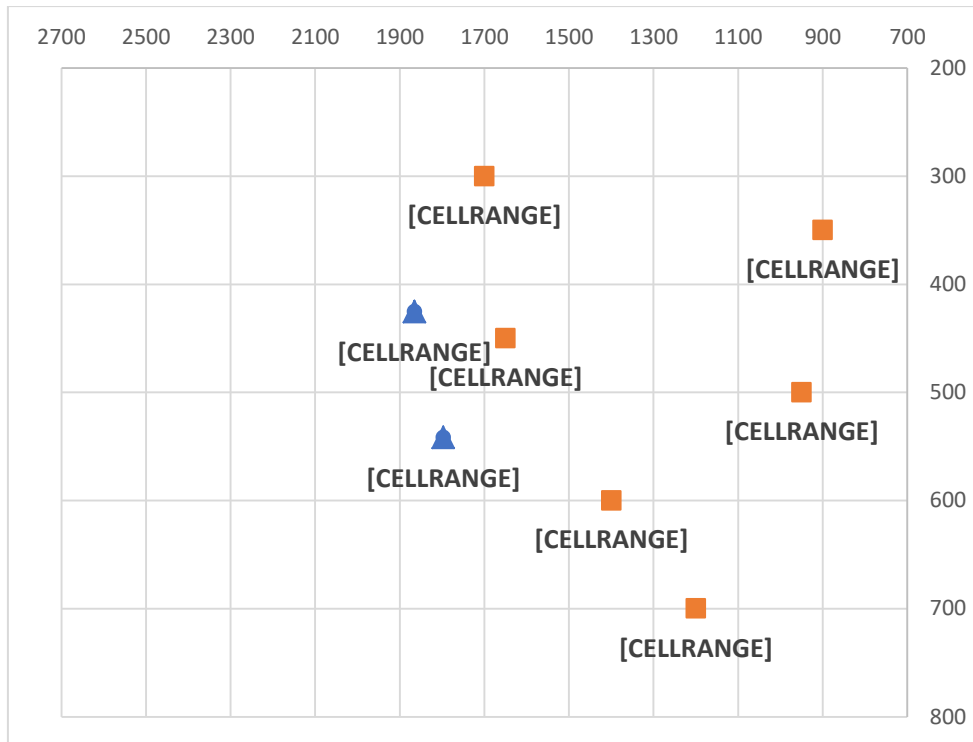


Figure 7: Kurdish Epenthetic Vowels in Relation to Lexical Vowels

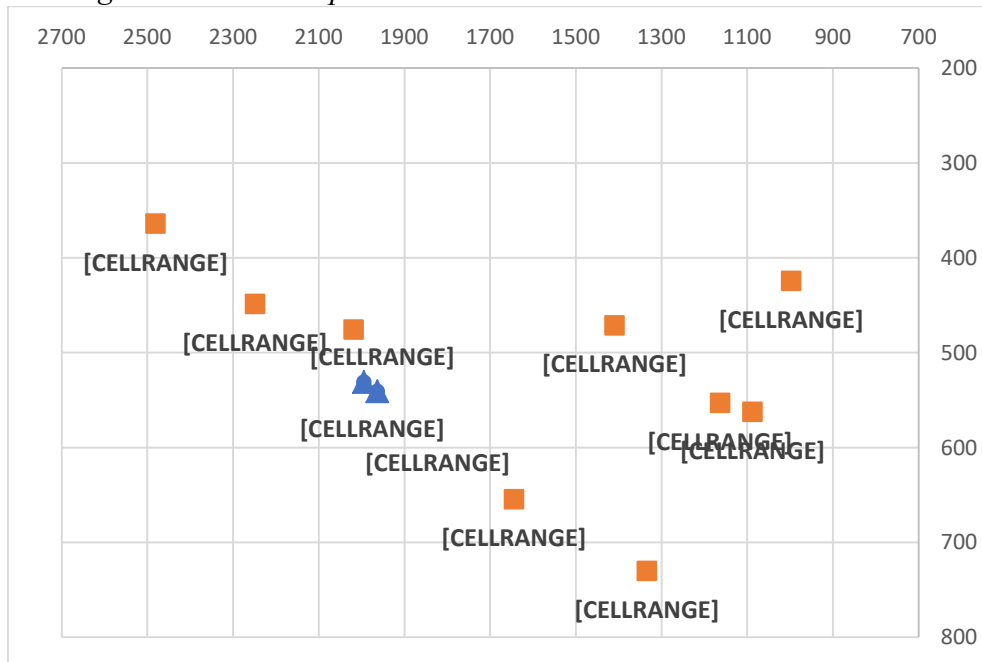


Figure 8: Arabic Epenthetic Vowels in Relation to Lexical Vowels

5. Discussion

The results of this study indicate slight phonetic, phonological, and acoustic differences, as well as, differences in F1, F2, and the length of epenthetic vowels in the languages under study, i.e., English, Kurdish, and Arabic.

The measurement of F1 in all three languages (English, Kurdish, and Arabic) indicates that the epenthetic vowels in coda position record a higher value than in onset

position, which indicates that the tongue position is lower in coda than in onset, thus, the tongue is more relaxed when inserting an epenthetic vowel in coda position. Moreover, according to the results, the difference between the tongue height in onset and coda position is small in English and Arabic languages, almost (10-15 Hz), while in Kurdish language there is a relatively big difference between the F1 of onset and of Coda (almost 116 Hz) which makes the tongue much lower when pronouncing the epenthetic vowel in coda position in relation to that in onset position of Kurdish syllables.

The results suggest that English language exhibits the lowest F1 value (in both onset and coda position), thus, the highest tongue position, followed by Kurdish and then Arabic, which records the highest F1 value and the lowest tongue position in the mouth.

These results imply that the acoustic realisation of epenthetic vowels is significantly shaped by syllable position. The higher F1 results in the coda position could indicate articulatory relaxation or less coarticulatory limitations at the final part of the syllable (the coda).

Concerning the F2 value (the frontness-backness of the tongue), the results show relative differences between the items of the analysis. The results of English data record the lowest F2 mean value, which indicates that the tongue is relatively back, more than in Kurdish and Arabic languages. Arabic language records the highest F2 value which is an indication that the tongue is in its front position while pronouncing the epenthetic vowel in both onset and coda of Arabic syllables.

In all the three languages under study, the F2 value of epenthetic vowels in onset position is higher than in coda position with very close differences between the values (≈ 64 Hz in English, ≈ 69 Hz in Kurdish, and ≈ 32 Hz in Arabic). This suggests that the epenthetic vowels inserted to onsets tend to be more fronted compared to those that are inserted to the coda in all the three languages.

These results are consistent with the acoustic patterns found in “*Acoustic Analysis of pharyngealization and vowel duration in L2 Arabic*” by Adam (2025), where it is demonstrated that formant frequencies accurately reflect articulatory configurations. However, the current data clearly reveal cross-linguistic variation: Arabic exhibits a relatively constricted vowel space, especially in pharyngealized settings, whereas English exhibits a larger vowel space with greater dispersion of F2 values. Kurdish, on the other hand, has an intermediate position, indicating that the acoustic realization of epenthetic vowels is strongly influenced by language-specific phonological systems.

Speaking about the duration of the epenthetic vowels, the epenthetic vowels in coda position of Arabic and Kurdish syllables show the longest duration compared to the duration in the coda of English syllables. This can suggest that Kurdish and Arabic speakers tend to extend the epenthetic vowel when inserted at the end of the syllable. On the other hand, English and Arabic speakers extend the epenthetic vowels added to the onset of the syllable more than Kurdish speakers.

Overall, the data demonstrate that syllable position significantly influences vowel duration, with epenthetic vowels generally exhibiting greater temporal length in coda position compared to onset position. Moreover, the short duration of the epenthetic vowels in all the languages under study supports the distinction made by Ladefoged and Johnson (2015) that suggests that they are more transitional elements rather than full phonetic segments.

The above finding supports the findings of the work of Maiteq (2020) “*A Phonetic Study of Vowel Epenthesis in the Dialect of Misurata*”, which demonstrate the prosodic

reduction of epenthetic segments. However, different languages have different levels of temporal reduction. Kurdish data reveal a smaller temporal contrast, which may indicate a higher degree of integration of epenthetic vowels into the syllable structure, while English data show a clearer differentiation between epenthetic and lexical vowel duration. This implies that duration reflects the phonological status of the vowel in each language in addition to being a sound correlation.

In general, the results state that the epenthetic vowels in all the languages under study tend to be mid-central in relation to the peer lexical vowels of the languages. This suggests a cross-linguistic tendency for a greater reduction of the default vowel quality and indicates epenthetic vowels function as a strategy or a tool for structure repair rather than separate lexical segments.

This study shows that the acoustic signatures and measurements of inserted (epenthetic) vowels in Arabic, Kurdish, and English are distinct. While these findings are broadly consistent with earlier studies, they also indicate various ways in which these vowels are molded across languages.

6. Conclusion

This study attempts to provide insight into the interesting area of vowels, specifically the epenthetic vowel sounds that sometimes find their way into words and make speech smoother and more fluent. It explores the specific function these vowels serve within the phonetic system of the language. The findings of the three languages show that epenthetic vowels in coda position have a larger F1 value than those in onset position, particularly in Kurdish. The same is true for English and Arabic, albeit there are slight differences between F1 in onset and coda.

On the other hand, the results reveal that the F2 in the onset position of the three languages always tends to be a little higher than in the coda position which suggests a more fronted position in the onset, i.e., the results indicate that the acoustic realisation of F2 is measurably influenced by syllable position, with onset epenthetic vowels exhibiting greater tongue advancement than coda epenthetic vowels. The data analysis also shows that syllable position has a considerable influence on vowel duration, with epenthetic vowels having longer temporal length in coda position than in onset position.

To sum up, the research findings indicate that, as compared to the peer lexical vowels of the languages under investigation, the epenthetic vowels in all of the languages are typically mid-central. This shows that epenthetic vowels serve as a tactic or instrument for structure restoration rather than as independent lexical segments and demonstrates a cross-linguistic tendency for a higher reduction of the default vowel quality.

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