

تحليل مقارن لإقحام الصوائت: دراسة فونولوجية

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

زينب هاشم مجيد

Zainab Hashim Majeed

جامعة السليمانية \ كلية اللغات \ قسم اللغة الانكليزية

University of Al-Sulaimania/ College of languages /

Department of English

zainab.hashim@garmian.edu.krd

ا.م.د. توانا سعدي حامد

Assist Prof. Dr. Twana Hamid Saadi

جامعة السليمانية \ كلية اللغات \ قسم اللغة الانكليزية

University of Al-Sulaimania/ College of languages /

Department of English

Twana.hamid@univsul.edu.iq

الكلمات المفتاحية: إقحام الصوائت، فك العناقيد ، الاجتلاب ، SSP ، MSD.

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المخلص

تؤثر ظاهرة إقحام الصوائت، (Vowel Epenthesis) وهي أصوات علة تُضاف إلى العناقيد الساكنة لتسهيل النطق، تأثيراً جوهرياً على استيعاب اللغة المنطوقة. تبحث هذه الدراسة في الإجراءات المتبعة في تحديد موضع المصوت المُقحم، كما تتناول التحليل الفونولوجي لهذه الظاهرة في لغات الإنجليزية، والكردية، والعربية، والفارسية. وتوضح الدراسة أسباب إدراج أصوات علة إضافية في المقطع اللفظي أحياناً، مستقصيةً السلوك الفونولوجي للعناقيد الساكنة ضمن إطار سلم الجهورية (Sonority Scale)، ومبدأً تتابع الجهورية (SSP)، وعتبة الجهورية (Sonority Threshold)، والحد الأدنى للمسافة بين مستويات الجهورية (MSD).

وبالاستناد إلى نماذج "دراغا زيك" (Draga Zec)، تحلل الدراسة بيانات لعناقيد ساكنة متنوعة من اللغات المختارة، وتتقصى مدى التزام هذه اللغات بمتطلبات الحد الأدنى للمسافة بين مستويات الجهورية (MSD)، وكيفية تفعيل العمليات الفونولوجية نتيجة انتهاكات مبدأ تتابع الجهورية وعتبة الجهورية.

تُظهر نتائج الدراسة أن التنوع المقطعي عبر اللغات يتأثر بمجموعة من معايير عتبات الجهورية والحد الأدنى للمسافة بين مستويات الجهورية (MSD). وتكشف النتائج الرئيسية عن وجود عدم تماثل كوني بين مطلع المقطع (Onset) وخاتمته (Coda)؛ حيث إن إلزامية وجود المطلع في الكردية والعربية والفارسية تستوجب إقحام المصوت كآلية "ترميم" هيكلية، بينما تبدو الإنجليزية أكثر مرونة، إذ تسمح بالمصوتات المقطعية (Syllabic Consonants) ومسافات أوسع بين عناصر العنقود الساكن. وأخيراً، تبين الدراسة أن الأنظمة الفونولوجية تتميز بالتفاعل بين القيود الكونية وتقنيات الترميم الخاصة بكل لغة، مؤكدةً على دور الأنماط اللغوية العامة واللهجات الإقليمية (مثل العربية العراقية) في تعميق فهمنا للنظرية اللسانية.

تخلص الدراسة إلى أنه بينما يوفر إطار "الحد الأدنى للمسافة بين مستويات الجهورية" وعتبة الجهورية تفسيراً قوياً لفهم مدى سلامة تكوين العناقيد الساكنة عبر اللغات، فإن تطبيقها يتباين من لغة إلى أخرى ويتفاعل مع الأنظمة الفونولوجية الأشمل. وتساهم هذه النتائج في إثراء الفونولوجيا النمطية (Typological Phonology) عبر تسليط الضوء على كيفية تطبيق المبادئ الكونية بشكل مختلف عبر لغات متباينة نمطياً.



Abstract

Vowel epenthesis, or vowel sounds that are added to consonant clusters to fix illicit clusters, has a substantial impact on understanding spoken language. This study looks into the procedures involved in the insertion of an epenthetic vowel. It looks into the phonological analysis of vowel epenthesis in English, Kurdish, Arabic, and Farsi languages. This study explains why extra vowel sounds, which are absent underlyingly, can sometimes be inserted to the surface structure of the syllable. It investigates the phonological behavior of consonant clusters within the framework of the sonority scale, sonority sequencing principle (SSP), sonority threshold, and minimal sonority distance (MSD).

Based on the modals of Zec (2007), the study analyses data of different clusters from the selected languages. It investigates how these languages adhere to the requirements of MSD, and how phonological processes are triggered by violations of SSP and sonority threshold.

The findings of the study show that cross-linguistic syllable diversity is influenced by a set of sonority thresholds and Minimal Sonority Distance (MSD) criteria. Key findings reveal a universal onset-coda asymmetry, with required onsets in Kurdish, Arabic, and Farsi necessitating vowel epenthesis as a structural repair, but English is more flexible, allowing syllabic consonants and larger cluster spacing. Finally, the study shows that phonological systems are characterized by the interaction of universal restrictions and language-specific repair techniques, emphasizing how broad typologies and regional dialects (such as Iraqi Arabic) improve the comprehension of linguistic theory.

The study concludes that while MSD and sonority threshold offer a strong explanatory framework for comprehending cluster well-formedness across languages, their application varies depending on the language and interacts with more general phonological systems. The findings contribute to the typological phonology by highlighting how universal principles are applied differently across typologically distinct languages.

1. Introduction

"Epenthesis" refers to inserting an additional sound into a word. It may be further classified as a prosthesis or anaptyxis (Crystal, 2011). In the same respect, Hall (2011) 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).

Concerning the function of epenthetic vowels, Nakhaei (2021) 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) 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 reported 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 is an attempt to shed light on the fascinating world of vowels, 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 find out how they help people comply with internal phonetic standards within languages.

2. The Phonological Characteristics of Epenthetic Vowels

The epenthetic vowel is a famous example of the difference between underlying representation (the conceptual lexicon) and surface representation (phonetic output). They are distinguished by their absence from the underlying structure; they are not included in the speaker's mental dictionary since they do not contribute to the meaning of the word. Instead, they are "inserted" into the surface structure to meet prosodic or phonotactic needs. This process can be considered a repair technique. The phonological system inserts a vowel to resolve disagreement when an

underlying form comprises a sequence that is "illegal" or unpronounceable according to the grammar of a particular language, such as a consonant cluster that contradicts the Sonority Sequencing Generalization (Goldsmith et al., 2011).

The underlying phonological structure of a word does not include the epenthetic vowels; instead, they are added to the surface form. Phonological rules transform the underlying form into the surface form, resulting in the epenthesis. For instance, in Dutch, the insertion rule might cause words like *melk ('milk') to sound like [mələk] when spoken, even if the underlying form does not include that vowel (Féry & van de Vijver, 2003). Phonological structure is like a bridge between the abstract underlying representations and the surface phonetic representations, as illustrated through the following modal:

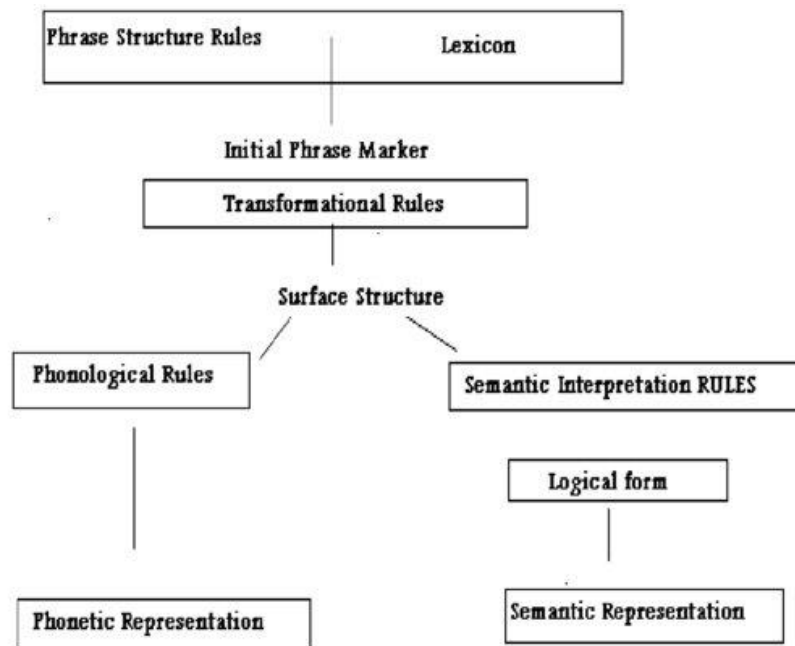


Figure 1: A Generative Grammar Model of Language (McCarthy, 2007)

This model provides a clear explanation of how disallowed consonant clusters are repaired in languages to prevent violations of its constraints.



The process of vowel epenthesis depends mainly on the context; it often appears in certain settings to avoid consonant clusters or to promote easier transitions between sounds. Morphological borders may have an impact on epenthetic vowels. Epenthesis is distinctive to various morphophonological contexts in languages, such as the joining of roots or the addition of affixes. For instance, in Sanskrit, some suffixes that would usually result in improper consonant clusters might also produce epenthetic vowels, called anaptyxis (Halle & Mohanan, 1985).

Epenthetic vowels, within the Optimality Theory framework, violate faithfulness requirements (which demand the absence of additional sounds), although they fulfil markedness constraints (that penalize linguistic structures that are difficult to produce, difficult to comprehend, or complex in their phonetic nature). This illustrates how languages satisfy the need to prevent marked structures while accommodating epenthesis as a repair method. For example, the insertion of [ə] in some English dialects (e.g., between [l] and [m] in “film”) constitutes a violation of faithfulness. However, it addresses syllabic markedness constraints (Féry & van de Vijver, 2003).

Moreover, epenthetic vowels harmonize with neighboring vowels or consonants in certain circumstances. In languages that have vowel harmony, this is a regular occurrence. In these languages, the vowel inserted must correspond to the phonetic or phonological characteristics of the vowels around it. For example, when an epenthetic vowel is placed into a Turkish word, it often complies with the preceding or the following vowel (Ladefoged and Maddieson, 1996). They are also used to repair the syllables of a language so that they follow the conventions of the language's syllable structure, which is called syllabification. A CV (consonant-vowel) pattern, favoured by many languages, may be preserved this way.

One example is the Central Kurdish term /kurt/ "short," which preserves the underlying form [kurt] because it fits the authorized CVCC structure. In complex strings, such as the verb root for "to see" /b-n-m/, the surface form is [bi.nim]. The consonants [b] and [n] can only fit within the acceptable syllable structure by inserting the epenthetic [i]. Without this vowel, the word would be impossible to pronounce as one syllable (*[bnm]) or would have an illegal vowelless onset (Hamid, 2016).

The epenthetic vowels are not stressed and do not represent any lexical or prosodic emphasis. The purpose of these sounds is not to communicate meaning but rather to preserve phonological structure. In some languages, such as Japanese, epenthetic vowels, such as [u], are assigned to consonant clusters, but they are not subject to stress; they are not stressed (Koger, 2004). However, in other languages, the epenthetic vowel may attract stress: For example: akə'l-na 'our meal'. This point is variable in Baghdadi Arabic and other Palestinian dialects; penult emphasis is one possibility. For instance, "he hits him" yuḍurba ~yuḍúrbu.

Furthermore, epenthetic vowels often constitute a component of a wide variety of phonological rules implemented systematically, like assimilation, deletion, metathesis, and epenthesis, indicating a systematic phonological pattern. For instance, in Spanish, a vowel may be put between a consonant cluster in loanwords, according to the syllable pattern of the language (e.g., "estudio" for *studio) (ibid).

A final phonologically important aspect of vowel epenthesis is its surface featural quality. Thus, it has been noted that epenthetic vowels tend to be unmarked—the 'neutral', mid central [ə], or high unrounded vowels [i], [i], or u. (Kim & Kochetove, 2011)



3. Methodology

The study includes a comparative phonological approach to explore vowel epenthesis in four different languages: English, Kurdish, Arabic (Iraqi dialect), and Farsi. It adopts a qualitative analysis based on the framework of SSP, MSD, and sonority threshold that are proposed by Zec (2007).

The study's data consist of lexical items that include both well-formed and marked consonant sequences. The English data were taken from conventional dictionaries and phonological references. The researcher relied on her intuition as a native speaker of Arabic in collecting both Standard Arabic and Iraqi Arabic data. Kurdish (Central Kurdish) and Farsi data were gathered from linguistic descriptions, literature review, and enhanced with native speaker evaluations.

4. Results

In linguistic typology, syllable structures are not random configurations but rather follow universal patterns. Every known language inventory has the CV syllable, which is regarded as the "least marked" or most fundamental structure. It consists of a single onset followed by a nucleus. The only non-negotiable condition for any syllable in all languages is the existence of a nucleus, even though different languages allow different combinations, from a single nucleus (V) to a complete CVC structure.

The way language systems control these boundaries, especially the onset, is frequently used to classify them. Certain languages, like Arabic, Kurdish, and Farsi, require an onset, which means that each syllable must start with a consonant (CV), like in (/ka.ta.ba/ in Arabic 'he wrote', /bir.jar/ in Kurdish 'decision', /pa.ran.de/ in Farsi 'bird'), and if a word appears to start with a vowel, it is actually preceded by a glottal stop /ʔ/, like in the Arabic word /ʔisim/ "name" and the Kurdish word /ʔa.za.di/ "freedom".

Other languages, such as English, allow both CV (like /ka:/ “car”) and V (like /a:/ “are”) structures since onsets are optional. These differences serve as the foundation for syllable inventories, that helps linguists in categorizing different language types based on their unique phonological limitations and regulations. Furthermore, there is no direct relationship between these two edges; a language's ability to ban, allow, or require a coda is independent of its requirement for an onset. The following table shows the typology of syllable structures of the languages under study. It identifies the probability of the presence of onsets, codas, and onset and coda clusters cross-linguistically:

Table 1: Typology of syllable structures

language	onset	coda	Onset cluster	Coda cluster	inventory
English	O	O	O	O	(C)(C)(C)V(C)(C)(C)(C)
Kurdish	R	O	X	O	CV(C)(C)
Standard Arabic	R	O	X	O	CV(C)(C)
Iraqi Arabic	R	O	O	O	(C)CV(C)(C)
Farsi	R	O	X	O	CV(C)(C)

Note: R=required, O=optional, X=banned

The above table shows that English is the only language among the selected languages that can bear syllables that start with a vowel, since the onset in the English language is optional. For example, syllables like:

- /old/ “old”,
- /eim/ “aim”
- /a:t/ “art”

Other languages of the study prohibit any zero-onset syllable, i.e., there is no syllable in the mentioned languages that starts with a vowel, and if it happened, it will immediately be preceded by the glottal stop /ʔ/, like in:

- /ʔib.ra:hi:m/ “Ibrahim/ proper noun.”



- /ʔus.ta:ð/ “teacher” Arabic
- /ʔaħ.la:m/ “dreams” Arabic
- /mei.mu:n/ “monkey” Kurdish
- /si:r/ “garlic” Farsi
- /piʃt/ “behind” Farsi
- /roz/ “day” Kurdish
- /zerd/ “yellow” Kurdish

Codas and coda clusters are always optional in all the languages under study. In English for example, syllables like /ka:/ “car”, /dra:.ma/ “drama”, with no coda, are very common. And at the same time, syllables can end with coda or coda cluster, like /bak/ “back”, /bank/ “bank”, /mʌnθs/ “months”. This is true for all the languages under study:

- /na “no”, /sag/ “dog”, /dast/ “hand” Kurdish.
- /fi:/ “in”, /dub/ “bear”, /nafs/ “soul” Standard Arabic.
- /mu/ “not”, /na:m/ “he slept”, /ħaarr/ “hot” Iraqi Arabic.
- /bâ/ “with”, /sær/ “head”, /særd/ “cold” Farsi.

Furthermore, Kurdish, standard Arabic and Farsi disallow any consonant clusters in the onset position. Syllables in these two languages usually start with only one consonant, like:

- /ka.ta.ba/ “he wrote” Standard Arabic
- /da:.neʃ.ga:h/ “university” Farsi

Controversially, English, and Iraqi Arabic are considered to be more flexible by allowing consonant clusters in the onset, like the English words:

- /traɪ/ “try”
- /laɪkt/ “liked”

And the Iraqi Arabic words:

- /qra.ja/ “reading”

- /tra:b/ “soil”

A sonority hierarchy of syllable peaks of the languages under study can be drawn as follows:

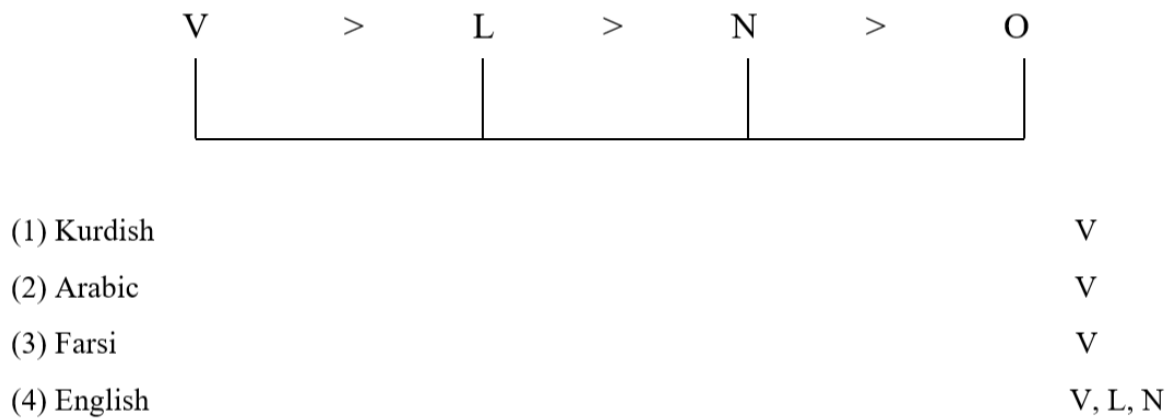


Figure1: Hierarchy of syllable peaks

As shown previously, Kurdish, Arabic, and Farsi languages share the same feature that allows only vowels to occupy the nucleus position of the syllable. On the other hand, English language has a lower threshold, allowing vowels, liquids, and nasals to serve as a syllable's peak. This approach is based on a set of principles called markedness constraints that, in theory, limit any sound from forming the peak of a syllable. These regulations, however, are not consistently applied: they are quite liberal toward vowels but extremely strict against low-sonority sounds like obstruents (like "p" or "t"). Because vowels are the most sonorous sounds, they are always chosen for a syllable's nucleus due to this set ranking, whereas less sonorous sounds are always moved to the margins.

Language thresholds will be decided through constraint interaction. Each language has constraints that limit the number of segments above the sonority threshold based on their rank as follows:

- | | |
|--------------------|-------------------|
| (1) Kurdish | O > N > L > © > V |
| (2) Arabic (S & I) | O > N > L > © > V |
| (3) Farsi | O > N > L > © > V |



(4) English O > © > N > L > V

Note: O= Obstruents, N= Nasals, L= Liquids, V= Vowels.

The Sonority Sequencing Generalization (SSG), which was mentioned earlier, largely controls syllable arrangement in the languages being studied: English, Kurdish, Arabic, and Farsi. The increase in sound intensity from the syllable's low-sonority margins toward the highly sonorous nucleus (vowel) is necessary for this concept. There is a cross-linguistic desire for onsets to start with the lowest probable sonority to maximize sound clarity at the syllable boundary. Liquids (L) are the most marked, unusual, or undesirable onsets, whereas obstruents (O) are the most preferred, according to Prince and Smolensky's (2004) markedness hierarchy. So, the English sequence (pl-) in words like 'play' and (kr-) in words like 'cry' are more preferred as an onset because they consist of an obstruent + a liquid.

On the other hand, the SSG failed to explain why English language does not allow sequences like (pn-, ml-) although the second sounds are more sonorous than the first ones. Here comes the role of MSD (Minimal Sonority Distance) to clarify this. Each language sets a threshold for how big the sonority distance should be, and what the suitable sonority sequence is according to its syllable structure. And when a cluster violates the MSD of that language, it is often repaired by the insertion of an epenthetic vowel.

Table 2: MSD in onset position

MSD	English	Kurdish	Arabic		Farsi
			standard	Iraqi	
MSD 0 OO, NN, LL (e.g.: *pp-, *kk-, *rr-, etc.)	Disallowed	Disallowed	Disallowed	Disallowed	Disallowed
MSD 1 ON, NL (e.g.: *bn-, *nl-, *mr-, etc.)	Disallowed	Restricted (Repaired)	Disallowed	Disallowed	Disallowed
MSD 2 OL (pl-, tr-, kl-, etc.)	Allowed	Disallowed	Disallowed	Allowed	Disallowed

English strongly prefers MSD 2, i.e., a large rise of two intervals. Yet there is an exception to this rule in the case of the sound 's'. The English language allows clusters such as [st] (star), [sp] (sport), and [sk] (sky). This breaks the sonority requirements since both sounds belong to the same level (obstruents), i.e., MSD0. In English, /s/ is referred to as an "extra-syllabic" sound that deviates from the normal rules. /s/ is also considered an appendix when it is followed by two consonants, even if it violates SSP.

Kurdish language is very similar to English language, but with a few more restrictions. When an MSD 1 in Kurdish language is found, it is often repaired by the addition of an epenthetic vowel like the word 'bnar, bīnar'.

As for the Standard Arabic Language, onset clusters are not permitted at all. All the clusters are eliminated structurally. For that reason, the research focuses on the Iraqi Arabic variety which allows some initial clusters like MSD2, while disallows both MSD 1 and MSD 0. Finally, Farsi bans all kinds of initial clusters. MSD is enforced by vowel epenthesis.



The purpose for these distances is that the two constituents of an onset cluster are moving in different directions. The first sound of a cluster has a "markedness" tendency for the lowest sonority (such as the voiceless stops p or k). Conversely, the second sound prefers the highest sonority (such as the liquids /r/ or /l/). The distance between them is the result of these two opposing criteria collaborating to produce a distinct, recognizable sound pattern. Briefly stated, a language's MSD level is its individual threshold for how much opposition is required at the beginning of a syllable. Once the sequence is too "blurry" due to the similarity in the sound's sonority, the grammar either rejects the sequence or adds an epenthetic vowel to restore the structure (Zec,2007).

According to Coda, and since all the languages permit consonant clusters in coda position, the MSD framework is applicable and considered to be the mirror of the onset. The preferred pattern of sonority in the coda is the opposite. It is a falling sonority sequence that starts with the more sonorous consonants immediately after the vowel, followed by the less sonorous consonants, like the clusters:

- /-mp/ ex: /dʒʌmp/
- /-nt/ ex: /bɜːnt/

The above clusters satisfy MSD since the sonority is falling. In clusters that violate MDS such as when the distance is small, or the sonority rises, like in:

- /-kr/ (rising sonority)
- /-ln/ (small MSD)

Then, such clusters are either being avoided or repaired by the insertion of an epenthetic vowel:

- /bakɪr/
- /bokɪs/

- /ganim/

5. Discussion

Applying Zec's (2007) typological concept to the phonological system of the languages under study (i.e. English, Kurdish, Standard/ Iraqi Arabic, and Farsi) reveals that structural variations in syllable margins and nuclei is systematic rather than arbitrary. This cross-linguistic analysis reveals that the distinct structure of these segments is a functional result of certain sonority thresholds and Minimal Sonority Distance (MSD) factors inherent in each language's grammar.

According to the results, onsets, codas, and the clusters in both of them are all optional in English language, so there is a minimal need for vowel epenthesis except in cases of loanwords or the violation of sonority that is mentioned later on.

In Kurdish language, the onset is required, so if a syllable starts with a vowel sound, a glottal stop or an epenthetic vowel is inserted to achieve onset satisfaction.

As for Standard Arabic, the onset is required as well, yet it highlights structural simplicity and bans clusters in onsets; hence the vowel epenthesis emerges only in the cases of loanwords, while Iraqi Arabic, which is significantly different, allows the onset clusters that make it possible to insert an epenthetic vowel when needed to ease the pronunciation. Finally, vowel epenthesis is not very common in Farsi. It appears in loanwords since the language bans clusters in the onset.

As a result, vowel epenthesis is related directly to the restrictions of the syllable structure. If the syllable does not meet the requirements of the syllable structure of the language, especially in loanwords, an epenthetic vowel is needed to fix the issue. Furthermore, the study highlights the universal onset-coda asymmetry. It shows that in the languages under



study, the coda is more flexible than the onset, being always optional, while the onset is required in some of the languages (Kurdish, Arabic, and Farsi).

The parity/ disparity among the languages under study is also obvious when applying the concept of sonority threshold. All the aforementioned languages permit vowels only to hold the center position in the syllable (the peak), except English, which is considered to be more permissive by allowing vowels, liquids, and nasals in this position. As a result, each language tries to follow the restrictions of its specific constraints. Moreover, the sonority threshold confirms the concept of SSG (Sonority Sequencing Generalization), which indicates that the sonority is raised towards the peak of the syllable and lowered towards the margins. So, when the SSG is violated and the sonority sequence is broken, the repair mechanism is needed, and an epenthetic vowel is triggered to meet the well-formedness constraint.

The cross-linguistic syllable structures are further explained by the Minimal Sonority Distance (MSD) framework. According to MSD, each language shows a different acceptable space between the segments of the cluster, i.e., how far two adjacent consonants should be, in terms of sonority. According to the results, English language allows a rise of not less than two intervals (MSD2), any other type of sonority distance is considered to be an ill-formed structure in English. In order to resolve the ill-formedness, languages activate the repair strategies, including vowel epenthesis.

Standard Arabic disallows all kinds of MSDs, since it prohibits any consonant clusters; as a result, epenthetic vowels are inserted to hold the position of the peak of the cluster. On the other hand, Iraqi Arabic shares the English language's feature of allowing at least two intervals. For this reason, an epenthetic vowel is utilized to repair ill-formed sequences.

As for Kurdish language, when MSD1 is found, a need for an epenthetic vowel emerges, along with Farsi, since it bans all kinds of MSDs.

These differences in epenthetic vowel insertion show that while all languages follow universal principles, they choose different processes either by tolerating complexity or by actively reshaping it.

In conclusion, the interaction between sonority rules and the typological orientations results in the various syllable layouts observed in these four languages. A phonological framework develops not just by its intrinsic features but also by the repair techniques it employs to resolve illegal sequences, as can be illustrated by investigating vowel insertion. In the end, these results support Zec's (2007) theoretical framework, demonstrating the critical role that both local dialectal variants and universal language classifications play in advancing phonological studies.

6. Conclusions

In conclusion, the study demonstrates the critical function of vowel epenthesis in shaping the comprehension and structural integrity of spoken languages. The study examines the phonological behavior of English, Kurdish, Arabic, and Farsi and reveals that the addition of epenthetic vowels is a systematic "repair" strategy triggered by specific violations of the Sonority Sequencing Principle (SSP) and language-specific sonority thresholds. Based on Zec's (2007) typological framework, the research shows that, while universal rules regulate syllable well-formedness, their implementation is heavily reliant on the Minimal Sonority Distance (MSD) parameters that are unique to each language.

The findings state a basic cross-linguistic asymmetry: while the coda is generally flexible, the required onset criteria in Kurdish, Arabic, and Farsi need epenthesis to resolve illegal clusters. In contrast, English's



relative permissiveness, which allows for syllabic consonants and wider cluster spacing, demonstrates a greater tolerance for structural complexity.

Finally, the study proposes that phonological systems are determined by a dynamic interaction between universal restrictions and localized correction techniques. This work develops a more detailed knowledge of typological phonology and the various ways in which languages retain syllabic well-formedness by documenting these changes across varied typologies and dialects, such as Iraqi Arabic.

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