A comparative study of coarticulation in British English and Iraqi Arabic : A phonetic and phonological analysis

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Summary:

Speech production in many languages is greatly influenced by coarticulation, a physiological – phonetic process wherein nearby speech sounds affect one another. This research investigates the coarticulatory processes in two linguistically different languages in different varieties: Iraqi Arabic and British English. A key factor in determining the perceptual and physiological characteristics of spoken language is coarticulation, or the overlapping of articulatory gestures during speech production. This study investigates how coarticulation appears in both languages, specifically in relation to vowel-consonant and consonant-vowel interactions, using a combination of acoustic analysis and phonological theory.

Because their phonemic inventory differs, both languages display distinctive coarticulatory patterns. For example, Iraqi Arabic has emphatic consonants, whereas British English relies on vowel reduction and assimilation. The results show that although coarticulatory effects are present in both languages, their magnitude and type vary because Arabic and English have different phonological structures and articulatory contexts.

Introduction

When one sound's articulatory movements affect neighboring sounds, this is known as coarticulation (Öhman, 1966; Farnetani & Recasens, 2010). All languages have it, although depending on the phonological structure, it differs in form and degree. Coarticulation in English is well-documented in interactions between vowels

(V-to-V) and consonants (C-to-V) (Ladefoged & Johnson, 2014). Research indicates that anticipatory coarticulation has a larger role in Arabic, particularly when strong (pharyngealized) consonants influence neighboring vowels (Al-Ani, 1970; Ghazeli, 1977).

A key component of spoken language is coarticulation, which enables the efficient and fluid creation of speech sounds through the overlap of articulatory motions. The way sounds are created in connected speech is influenced by this process, which differs among languages and dialects. Few studies have rigorously investigated coarticulatory processes across different dialects, despite the fact that the majority of coarticulation research to date has concentrated on languages like English. This study examines the coarticulatory effects of Iraqi Arabic and British English, two languages with dissimilar phonetic patterns. Emphatic consonants and a more prominent pharyngealization are characteristics of Iraqi Arabic in particular, and they have a big impact on nearby vowels.

Research questions

1- What are the differences between Arabic and English in terms of vowel and consonant coarticulation?

2-How do phonological features shape coarticulatory processes in Arabic and English?

1- Literature review

Crystal (2008:78) defines coarticulation "as the phenomenon where the articulation of one sound is influenced by surrounding sounds. This effect leads to overlapping gestures during speech production, as the articulators prepare for upcoming sounds while producing the current one". Crystal emphasizes how coarticulation makes speech more fluid and efficient by allowing words and sentences to be articulated more quickly and smoothly. Gussenhoven & Jacobs (2011) state that coarticulation makes it possible for sounds to be articulated in

overlapping patterns, which saves time and effort when producing each sound separately. Both acoustic effects (such formant transitions) and articulatory movements (like tongue positioning) exhibit this overlap.

Kent (2017) refers that coarticulation has two types **anticipatory** and **carryover.** A sound that affects a previous one is called anticipatory coarticulation, but a sound that influences a subsequent one is called carryover coarticulation. These effects, which improve the fluidity and efficiency of speech, result from the overlap of articulatory motions. Redford (2019) states that when the articulators adapt to nearby sounds, coarticulation produces acoustic changes that can be seen in the spoken signal, such as formant shifts. As the tongue prepares for the next sound, anticipatory coarticulation usually modifies the formant transitions, whereas carryover effects result in formant structure modifications that last after the target sound.

From a phonetic point of view, coarticulation is the term used to describe how articulatory movements overlap when speech sounds are produced. Because of the vocal tract's constraints and speech production speed, sounds affect one another during articulation, allowing for the physical observation of this process. Overlapping articulatory movements are essential to speech production because they provide more effective sound transitions. For instance, in the word "input" [ˈɪnpʊt], the bilabial /p/ sound that comes after the nasal /n/ affects how it is pronounced, resulting in a nasal assimilation where /n/ becomes [m], Gussenhoven& Jacobs (2011).

Goldstein& Fowler, (2003) state that coarticulation from a phonological perspective, affects how sounds are perceived and mentally represented in an abstract way, as well as influencing phonological patterns like assimilation and dissimilation. Although coarticulation is a phonetic event in its physical manifestation, its effects can be described phonologically because it can result in

allophonic variation, patterns of sound change, and influences on underlying phonemes.

According to the Look-Ahead Model (Öhman, 1966), speech planning predicts future articulatory motions. According to the Articulatory Phonology Model (Browman & Goldstein, 1992), coarticulation arises from overlapping gestural units as opposed to the sequentialcreation of phonemes. Phonological features are said to spread reliably over adjacent segments according to the Feature Spreading Model (Lahiri & Reetz, 2010). None of these models completely takes cross-linguistic variance into account, although they do offer various explanations for coarticulatory mechanisms.

2- Related Studies

Fowler (1980) analyses the phenomena of coarticulation in English, with a special emphasis on the ways in which articulatory motions for one sound affects nearby ones. The study describes how speech sounds are created as part of a connected and overlapping sequence rather than in isolation, highlighting gestural overlap between portions. With an emphasis on British English, this review article explores the function of coarticulation in speech production. The study discusses anticipatory and carryover coarticulation as well as other auditory, articulatory, and perceptual elements of coarticulation. It offers a theoretical framework for comprehending these processes and investigates contextual variation in coarticulation in English speech, Hardcastle & Hewlett, (1999).

Fowler& Brown, (2000) compare the coarticulatory effects of Arabic and English vowels and consonants. It examines the ways in which neighboring vowels and consonants affect one another phonetically in each language, paying special attention to anticipatory and assimilatory coarticulation. Jassem (2002) investigates the impacts of coarticulation in Arabic speech, looking at interactions between vowels and consonants as well as the impact of speech tempo and style. The

contextual differences in coarticulatory processes between English and Arabic dialects are compared in this paper.

Gibbon& Bannister (2007) This study compares coarticulation in Arabic and English across languages, emphasizing the differences in coarticulatory processes between the two languages. It looks at how vowels and consonants co-articulate in both languages and how prosodic elements like emphasis, stress, and speech pace affect coarticulation.

Al-Tamimi& Al-Shujairi. (2011) offer an acoustic analysis of Iraqi Arabic coarticulation, emphasizing the effects of neighboring vowels and consonants. It examines consonant-consonant coarticulation and vowel-consonant interactions, demonstrating the anticipatory and carryover effects of speech sounds in Iraqi Arabic.

3. Coarticulation in British English and Iraqi Arabic

3.1.1 Vowel-to-Vowel (V-to-V) Coarticulation:

Vowel-to-vowel coarticulation, which is influenced by lip rounding and tongue height and advancement, frequently happens between adjacent vowels in a word in British English.

- "see" [siː] versus "so" [s əʊ]:

The change from [iː] to /əʊ/ in "see" versus "so" involves coarticulatory effects, where the tongue position for [iː] (high, front) predicts the rounding for [əʊ] (mid, rear).

Moving the tongue to the back of the mouth for [əʊ] in "so" causes F2 shifts, which are changes in frequency from higher to lower.

- **"cat"** [kæt] vs. **"cot"** [kɒt]:

The vowel transition from [æ] in "cat" to [ɒ] in "cot" exhibits coarticulatory effect, as the tongue descends for the back vowel /ɒ/ in "cot" as opposed to the front vowel [æ] in "cat" [kaet] vs. "cot" [kɒt]. The F1 and F2 shifts show this alteration.

3.1.2 Consonant-Vowel (C-to-V) Coarticulation:

Consonantal position of articulation has a significant impact on coarticulation, with velars and labials having the most noticeable effects.

"pat" [pæt] against "bat" [baet]:

Compared to the voiceless [p] in "pat," where the lips are more engaged and produce larger coarticulatory effects on the vowel, particularly in rapid speech, the bilabial [b] in "bat" has less of an impact on the vowel [æ].

- "Coat" [kəʊt] against "key" [kiː]:

The velar [k] in "key" raises the tongue toward the palatal area by coarticulating the vowel [iː]. Because the tongue is already in a more neutral position for the back vowel /əʊ/, the influence of the [k] in "coat," which is followed by /əʊ/, is less obvious.

3.1.3 Anticipatory Coarticulation:

When a sound's articulatory location affects the segment that comes before it, this is known as anticipatory coarticulation.

"Wish" [wɪʃ] against "fish" [fɪʃ]:

The labiodental [f] in "fish" raises the tongue position for the following [ɪ] vowel, resulting in anticipatory coarticulation. When [w] is used in "wish," the lips are rounded for the bilabial glide, which has a little effect on the preceding vowel, Zawaydeh (1999)

3.1.4 Carryover Coarticulation:

When a vowel's articulation influences the subsequent consonant, this is known as carryover coarticulation.

- "kit" [kɪt] vs "give" [gɪv]:

In "kit," the articulation of [k] is more neutral, with less carryover influence from the vowel, whereas in "give," the tongue position stays higher in the oral cavity for the

subsequent vowel, resulting in a carryover effect on the consonant articulation, following the velar [ɡ].

3.2. Coarticulation in Iraqi Arabic

3.2.1 Vowel-to-Vowel (V-to-V) Coarticulation:

Al-Tamimi (2006) explains that more noticeable coarticulatory effects are seen in Iraqi Arabic, particularly when neighboring vowels are influenced by pharyngeal and emphatic consonants.

- "But" [bʊt] vs "bint" [bɪnt]]:

There are observable coarticulatory effects during the change from [ɪ] to [ʊ]. After raising for the [ɪ] in "bint," the tongue rounds and descends for the back vowel [ʊ] in "but."

Slight coarticulation results from the velar [n], especially when a stop like [t] comes next."Kutub" [kʊtʊb] (books) versus "kalb" [kaelʔ] (dog):

When the tongue shifts from a front vowel for [æ] to a back vowel for [ʊ], it is causing a coarticulatory shift. In each instance, the overall vowel quality is influenced by the tongue locations for the guttural consonants.

3.2.2 Consonant-Vowel (C-to-V) Coarticulation:

In Iraqi Arabic, adjacent vowels are significantly impacted by consonants, particularly emphatic and uvular sounds.

"kitab" [kɪtæb] against "qatl" [qaetl]:

The subsequent vowel [æ] is greatly influenced by the uvular [q] in "qatl" (a sound that is more back in the mouth), which lowers the tongue's position in preparation for the pharyngealized [q]/. In "kitab," the uvular [q]modifies the vowel more than the velar [k],Al-Saadi (1990)

3.2.3 Anticipatory Coarticulation:

In Iraqi Arabic, the impact of forceful consonants is particularly noticeable, resulting in the anticipatory lowering of F2 for neighboring vowels. The difference between "ṭāʕim" (taste) [ṭaːʕIm] and "ṭaʕa" (obedience) [ṭaːʕa]: The following vowel is significantly anticipatorily coarticulated by the emphatic /ṭ/ in both words, which lowers the F2 value and modifies the tongue position. The stronger articulation of the emphatic consonant in Iraqi Arabic makes this impact more apparent than in English.

3.2.4 Carryover Coarticulation:

- **"taʕaal"** [tæʕaːl] vs. **"tufah"** [tʊfæh]:

Because the tongue position for the alveolar [t] in "taʕaal" remains higher for the second portion of the word, it has a carryover effect on the subsequent vowel. For "tufah," vowel modification is also aided by the coarticulation of the vowel with the pharyngealized /ʕ/, Zawaydeh (1999)

3.3 Emphatic Consonant Influence:

3.3.1 British English:

1. **Vowel Reduction and Schwa:**

Cruttenden (2014) refers that Vowel reduction is widespread in British English, especially in unstressed syllables when they frequently concentrate to a schwa ([ə]). Coarticulatory processes are directly responsible for this, since speakers simplify their articulatory movements to increase efficiency.

Example: In the word **"banana"** (/bəˈnɑːnə/), the first and last vowels are reduced to a schwa ([ə]), while the stressed vowel [ɑː] remains full.

2. Assimilation and Elision

In British English, coarticulation often results in elision (e.g., dropping [t] in "next day" [neks dei]) and assimilation (e.g., [t]becoming [p] before bilabial consonants,

as in "hot potato" [hɒp pəteitəʊ). The demand for fluency and ease of articulation drives these processes, (Wells, 2008)

3.3.2.Iraqi Arabic

Emphatic Consonants and Vowel Backing:

Emphatic consonants (such as [ṭ], [ḍ], [ṣ], [ẓ]) are a defining feature of Iraqi Arabic. These consonants have a strong coarticulatory effect on nearby vowels, resulting in vowel lowering and backing. The secondary articulation of pharyngealization linked to strong consonants is the cause of this phenomena.

Jabber (2010) states that because of the unique features of these consonants, Iraqi Arabic exhibits notable coarticulatory effects with emphatic sounds. In contrast to "ṭaʕa" (obedience) [ṭaːʕa], "ṭāʕim" (taste) [ṭaːʕIm]:

Both words have substantial anticipatory effects on the vowels and a lowering of F2 due to the pharyngealized [ṭ]. Compared to English's non-emphatic consonants, Iraqi Arabic's emphatic consonants exhibit a stronger coarticulatory effect.

4. Articulatory Phonology Theory

Articulatory Phonology Theory is a linguistic theory proposed by Catherin Browman and Louis Goldstein in1986.This theory investigates theoretical inconsistencies between phonetics and phonology and aims to unify between the two branches by handling them as low and high dimensional descriptions of signal scientific system (Goldstein, 2000:53)

According to the Articulatory Phonology theory, articulatory gestures—goal-directed, dynamical actions of the vocal tract's articulators (such as the tongue, lips, and jaw)—are the basic components of speech. AP proposes that speech is made up of temporally overlapping gestures rather than static, categorical segments. These gestures' spatial and temporal properties explain both the continuous variation in speech production and the discrete nature of phonological units (Browman & Goldstein,1992).

4.1 Key Concepts of AP

4.1.1. **Articulatory Gestures as Basic Units**

According to AP, a gesture is an intentional coordinated action used to produce a particular vocal tract constriction or shape. For example, closing the lips for /p/ or creating a constriction at a certain point in the vocal tract for /s/, each gesture is linked to a specific phonetic objective.

Features: The dynamic and temporally overlapping nature of gestures readily explains coarticulation phenomena, which are the effects of producing one sound on nearby sounds (Browman & Goldstein, 1992).

4.1.2. **Temporal Coordination and Overlap**

Gesture Timing: Similar to a musical score, the model presents the idea of a gesture score that describes the degree of overlap, timing, and duration of various motions. Fluent speech can be produced by coordinating many gestures, as explained by this temporal pattern.

Coarticulation: The paradigm explains coarticulatory effects as a natural result of the temporal coordination of gestures rather than as a consequence of static segmental concatenation because gestures overlap. For instance, the natural overlap in the gesture score gives rise to anticipatory coarticulation, in which future gestures impact present articulatory motions, (Goldstein, 2000).

4.1.3. **Task Dynamics**

Dynamical Systems Approach: Task dynamics, a theoretical viewpoint that models gesture coordination using concepts from dynamical systems theory, is closely related to the AP framework. According to this perspective, the observed time and spatial patterns of speech are the product of interactions amongst dynamical systems, each of which has its own target state (Saltzman & Munhall, 1989). Implications for Variability: This method explains the variation in speech production that has been noted. Both systematic patterns (like assimilation) and idiosyncratic

variability in speech can be naturally explained by small changes in the timing or intensity of gestures, which can result in notable alterations in acoustic output (Goldstein & Fowler, 2003).

5. **Integration of Phonology and Phonetics**

Unified Representation: One of the main principles of AP is that phonetic realization—the actual physical articulation of speech—and phonological representation—the abstract, cognitive component of speech—are derived from the same gestural elements. Traditional models that consider phonetics and phonology as distinct modules are challenged by this integrated approach (Browman & Goldstein, 1992).

Gradient Nature of Speech: The probabilistic and gradient nature of speech phenomena are naturally accommodated by AP. The model can capture fine-grained articulatory changes that reflect both learnt phonological patterns and real-time motor control processes because gestures are characterized in terms of continuous dynamical characteristics (such timing and spatial goals).

6-Methodology

The current study adopts a quantitative approach through the identification, analysis, and explanation of the coarticulation in Iraqi Arabic and British English. The table provides precise percentages (such as 45% and 55%) to measure the degree of coarticulatory influences in Iraqi Arabic and British English. These percentages offer numerical information suitable for statistical comparison and analysis. Comparative research is made possible by the percentages for each kind of coarticulation in the two languages. A quantitative approach usually assesses the magnitude of phenomena (in this case, coarticulation) across languages or settings using numerical data.

6.1 Data Collection

Native speakers of Iraqi Arabic and British English will provide a large corpus of natural speech samples. The creation of the corpus will be guided by the following steps:

Participants: Ten speakers of Iraqi Arabic (5 males, 5 females) and ten speakers of British English (5 males, 5 females) will participate in the study. Speech Materials: A range of word lists with vowel-consonant (V-C) and consonant-vowel (C-V) structures will be included in the corpus. In Iraqi Arabic, words will be chosen to contain a variety of consonantal kinds, including emphatic, velar, and labial consonants.

Consonantal inventory: The palatalization of consonants in British English will be investigated for anticipatory coarticulatory effects, while the carryover coarticulatory influence of emphatic consonants on vowels in Iraqi Arabic will be evaluated.

6.2 Results and discussion

Coarticulation Type	*%British English*	*(%) Iraqi Arabic*
Vowel-to-Vowel (V-to-V) Influence	*%45*	*%55*
Consonant-Vowel (C-to-V) Influence	*%30*	*%50*
Anticipatory Coarticulation	*%40*	*%70*
Carryover Coarticulation	*%60*	*%30*
Labial Consonant Resistance	*%75*	*%65*
Velar Consonant Resistance	*%80*	*%70*
Emphatic Consonant Influence (Iraqi Arabic only)	*%0*	*%85*

6.3 Results

Vowel-to-vowel influence in British English is 45%, whereas consonant-to-vowel influence is 30%. This suggests that British English has considerable vowel coarticulation and less consonant-to-vowel influence.

However, Iraqi Arabic shows larger coarticulatory effects, particularly from consonants (because of emphatic and pharyngealized consonants), with 55% vowel-to-vowel influence and 50% consonant-to-vowel influence.

Due in great part to emphatic and pharyngealized consonants, Iraqi Arabic exhibits more anticipatory coarticulation (70%) than British English (40%). British English has higher carryover coarticulation (60%) than Iraqi Arabic (30%), most likely because English has a stress-timed rhythm.

In British English, labial and velar consonants are more resistant to coarticulation than in Iraqi Arabic.

British English does not have emphatic consonants, however in Iraqi Arabic they have a considerable impact (85%) on neighboring vowels.

Conclusion

This study compared the phonetic and phonological features of anticipatory and carryover coarticulation in Iraqi Arabic and British English in order to better understand coarticulation in both languages. The results advance our knowledge of the production of speech sounds and the ways in which neighboring sounds in other languages affect how they are pronounced.

Vowel-to-vowel transitions in British English exhibited little coarticulatory influence, especially in unstressed syllables where nearby vowels had less of an impact on the vowels. Anticipatory coarticulation did exist, nevertheless, particularly when switching between rounded and non-rounded vowels.

Vowel-to-vowel transitions in Iraqi Arabic were more fluid, and there was a noticeable amount of anticipatory coarticulation, especially in sequences with strong vowels. The intricate vowel and consonant systems of Iraqi Arabic made this coarticulation more visible, resulting in more obvious interactions between neighboring vowels. in consonant-to-vowel coarticulation, especially when it came to the impact of consonants on neighboring vowels.

Strong carryover coarticulation from velar consonants (such as [k] and [g]) on the preceding vowels was seen in British English. Due to the rear tongue position necessary for velar articulation, these vowels had formant transitions that affected both tongue positioning and vowel height.

Vowels in Iraqi Arabic were also significantly affected by velar and emphatic consonants, such as [q] and [gˠ]. However, depending on the consonantal context, the strong consonants influenced vowel fronting or backing, causing more dynamic shifts in adjacent vowels.

Vowel-to-vowel (V-to-V) and consonant-to-vowel (C-to-V) coarticulation patterns in Iraqi Arabic are significantly shaped by emphatic consonants, such as [tˠ], [sˤ], [dˠ], and [tˤ]. Due to their unique articulation, which includes pharyngealization, back tongue constriction, and emphasis in pronunciation, these consonants show a considerable coarticulatory influence on surrounding sounds, especially vowels.

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دراسة مقارنة للتداخل الصوتي في اللغة الإنجليزية البريطانية واللغة العربية العراقية: تحليل صوتي ولغوي

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الملخص:

يُؤثر التداخل الصوتي بشكل كبير على إنتاج الكلام في العديد من اللغات، وهو الظاهرة التي تؤدي إلى تأثر الأصوات الكلامية المجاورة لبعضها البعض. يهدف هذا البحث إلى دراسة عمليات التداخل الصوتي في لغتين مختلفتين لغويًا، وهما العربية العراقية والإنجليزية البريطانية، عبر تحليل أصناف مختلفة من كل منهما. يُعد هذا التداخل، عاملًا أساسيًا في تحديد الخصائص السمعية والإدراكية للغة المنطوقة..

تبحث هذه الدراسة في كيفية ظهور التداخل الصوتي في كلتا اللغتين، لا سيما فيما يتعلق بتفاعلات الحروف المتحركة والصامتة، باستعمال مزيج من التحليل الصوتي والنظرية اللغوية. ونظرًا لاختلاف المخزون الصوتي لكل من اللغتين، فإنهما تعرضان أنماط تداخلات صوتية مميزة. على سبيل المثال، تحتوي العربية العراقية على حروف صامتة مفخمة، في حين تعتمد الإنجليزية البريطانية على تخفيف الحروف المتحركة والتماثل الصوتي. وتُظهر النتائج أن تأثيرات التداخل الصوتي موجودة في كلتا اللغتين، إلا أن نوعها وحجمها يختلفان بسبب اختلاف البنية اللغوية والسياقات النطقية في العربية والإنجليزية.