Phonological Variation of /r/ in Selected Arabic Dialects

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الملخص

تُركِّز هذه الدراسة على تحليل الصوت العربي /ر/، والذي يتميز بتعقيدات وتنوعات خاصة ضمن النظام الصوتي للغة العربية. وتستهدف استقصاء المتغيرات الصوتية لهذا الصوت في مجموعة من اللهجات العربية، مع التأكيد على طريقة نطقه في مواضع مختلفة داخل الكلمات: في بداية ووسط ونهاية الكلمة. ونسعى من خلال هذا العمل البحثي للإسهام في فهم طبيعة الصوت العربي /ر/، والذي يُظهِر تعددية وتنوعاً داخل الأنظمة الصوتية العربية. ويستند البحث إلى تحليلات مُركَّزة للخصائص الصوتية المُميِّزة للصوت /ر/ في عدة لهجات ومناطق عربية. وسوف يساعد هذا العمل في تسهيل فهم العمليات الصوتية في اللغة العربية. وشملت عينة البث مجموعة مُختارة عشوائيا من الناطقين باللغة العربية، تراوحت أعمارهم من 18 عامًا فما فوق، وتنوعت أصولهم الجغرافية وكانوا من كلا الجنسين. وأُجريت الدراسة وفقًا لمنهجية وصفية تحليلية، استخدمت فيها مصفوفة الأوصاف الصوتية وبرنامج أودوستيتي لتسجيل وتحليل البيانات الصوتية. وسوف تُسهِم النتائج المُستنبَطة من هذا البحث في فهم التباينات الصوتية التي تُميِّز الصوت /ر/في اللغة العربية، وأدلة حول تنوعه في سياقات ومواقع جغرافية متعددة. وتُعزِّز هذه النتائج من أهمية البحث في ميادين تعليم واكتساب اللغة، مع الأخذ بعين الاعتبار استخدام تقنيات دقيقة لضمان موثوقية البيانات المجمعة.

Abstract

The present study offers a descriptive examination of the Arabic phoneme /r/, renowned for its intricate and diverse nature within the Arabic phonological system. This research investigates the varied manifestations of the phoneme /r/ in different regional dialects, with a specific emphasis on its pronunciation in the initial, middle, and final positions of words. The paper's significance is rooted in its contribution to the comprehension of the Arabic /r/ phoneme, a multifaceted and diverse sound within Arabic phonological systems. The paper illuminates the phonetic variability of the /r/ by analyzing its distinct manifestations across diverse Arabic dialects and regions. This can potentially facilitate language acquisition and instruction. The investigation conducted by the authors pertains to the marked and unmarked characteristics of the phonological /r/ in Arabic. The population under investigation comprises a randomly selected group of Arabic-speaking individuals aged 18 years and older, encompassing both genders and hailing from diverse countries and regions. The study employs a descriptive-analytical methodology, utilizing a unique features matrix and the Audacity Sound Recording and Analysis Application to examine the gathered data. The findings of the research enhance the comprehension of the phonetic variability that typifies the Arabic /r/ phoneme and elucidate its manifestation in diverse contexts and geographical locations. Furthermore, the outcomes of this investigation hold significance for the domain of language education and acquisition, and the techniques utilized were designed to guarantee the precision and dependability of the gathered information.

Keywords: *alveolar tap, audacity, phonemic distinction, retroflex flap, spectral analysis, trill*

Introduction

Speech sounds are diverse and vary greatly in their articulation and distribution in different languages. One such sound that has been of great interest to linguists is the /r/ phoneme, which is present in almost all languages. Despite its widespread occurrence, the articulation of /r/ varies greatly across languages and has been described as "elusive in nature" (Tawfiq, 2010, p. 31). While /r/ is classified as a rhotic sound, it encompasses a wide range of variations in terms of place and manner of articulation. Rhotics can involve dental/alveolar, postalveolar-retroflex, and uvular places of articulation, and may be realized as trills, fricatives, approximants, taps/flaps, or even vowels (Wiese, 2001).

Arabic, the official language of seventeen countries, provides an interesting case study for investigating the articulation of /r/. In classical Arabic, /r/ is trilled by repeatedly moving the tongue against the coronal passive articulator (Saleh et al., 2000), or "/r/ will be a tap/flap in intervocalic position; a single rhotic can occur as a tap/flap," as claimed by Mahyoob (2021, p. 11). However, the realization of /r/ varies from one Arabic dialect to another.

This paper aims to provide a descriptive analysis of the Arabic /r/ from different regions and answer the following questions:
1) What are the most salient realizations of some Arabic r's in word-initial, medial, and final positions?
2) What are the marked and unmarked features of /r/ in Arabic phonology?

By investigating the production of Arabic /r/ in different dialects and regions, this study will contribute to our understanding of the phonetic diversity that characterizes this important sound in Arabic and shed light on the ways in which it is realized across different contexts and regions.

Literature Review

The rhotic /r/ phoneme is a consonant that appears in a wide range of manners and places of articulation in world languages, ranging from the alveolar trill /r/ to a variety of configurations in the oral cavity. These variations create challenges for linguists in terms of classification and identification. Despite the differences, all rhotics share similar phonological behavior and tend to appear in the nucleus of the syllable next to vowels (Wiese, 2011).

Rhotic /r/

Rhotic sounds, also known as the /r/ phoneme, represent an intricate and multifaceted phonetic phenomenon. These sounds are observed to be highly variable across the languages of the world, demonstrating an expansive range of manners and places of articulation (Hamann, 2003; Ladefoged & Maddieson, 1998; Velde & Hout, 2002). Ladefoged and Maddieson (1998) describe them as covering a wide range, extending from typical alveolar trills to different fricatives, and they may be articulated from positions as diverse as the uvular to the lips. This vast array creates a multitude of possible configurations in the oral cavity, leading to, as claimed by Velde and Hout (2002) "a dispersed set of sounds: trills, taps, flaps, fricatives, and approximants, with varying places of articulation" (p. 1).

Among the examples of these myriad realizations are the post-alveolar retroflex /r/ phoneme, which may manifest as flaps [ɽ], central approximants [ɻ], or even fricative trills [r̝] (Hall, 1997; Hamann, 2003). Furthermore, rhotics can occur in multiple places of articulation, resulting in various realizations such as the labiodental approximant [ʋ], bilabial trill [ʙ], and the uvular trill [ʀ], a complexity that Hall (1997) describes as captivating and challenging. However, the studies by Anselme et al. (2023), Wiese (2001), and Ignatova et al. (2018) collectively referred to the idea that trills are less frequent compared to taps in the realization of the /r/ phoneme. This observation may suggest variations in the phonetic realization of /r/ across different languages and dialects or in different contexts within a single language.

The multifaceted nature of rhotic sounds extends beyond simple phonetic classification. As Wells (1982) notes, they may also encompass non-rhotic dialects and phenomena like r-sandhi, intrusive-r, and linking-r. The diverse manifestations and idiosyncrasies of /r/ realizations make them a subject of rich academic exploration, but not without challenges. Specific issues arise in the classification and identification of these sounds, such as the historical debate surrounding the differentiation between flaps and taps, a topic that Catford (1988) described as an "alternation" between the "complete closure of a stop and the openness" of a vowel (p. 65).

The task of finding a unifying feature among all r-phonemes can further compound this complexity. Ladefoged and Maddieson (1998) insightfully observed that the only evident connection between these variations might be the historical links they share as "the family of rhotics" (p. 232). Yet, amidst this remarkable diversity, there exists a commonality in the phonological behavior of the /r/ phoneme. Hall (1997) points out that they commonly occur within the core of a syllable, adjacent to vowels, a trait that transcends the otherwise perplexing diversity of this sound category. In summary, rhotic sounds, with their wide-ranging manners and places of articulation, intricate relationships with dialects, and the challenges posed in their classification and identification, remain an area of continuous fascination and inquiry in the field of linguistics. Their elusive nature continues to inspire further research and exploration.

English /r/ and its variations have received much attention and analysis in the literature. It is mainly referred to as a voiced post-alveolar approximant [ɹ] and shows great variability across dialects and accents (Wells, 1982). In American English, [ɹ] is used prevocalically, while an r-colored vowel like 'molar' [ɚ] appears elsewhere. However, variations exist within and between states, depending on location. For example, a labiodental approximant [ʋ] can be found in Brooklynese English (Wells, 1982). In Canadian English, /r/ is a coronal approximant, with its syllabic counterpart being [ɝ]. South African English has a strengthened /r/, realized as a tap [ɾ] in intervocalic positions or before a velar plosive or /θ/; or as a post-alveolar fricative [ɹ̝] in word-initial positions (Wells, 1982). A labiodental approximant [ʋ] is also found in British English but is viewed as affected and infantile speech (Foulkes & Docherty, 2001). This has labeled [ʋ] as a pretentious form of speech adopted by the upper class. Thus, it cannot be linked to a particular regional accent but rather to social status. In the present day, however, this is no longer the case, as Foulkes and Docherty (2001) found that the variant is used in Derby among young speakers of both the middle and working classes, unlike the second Newcastle group.

Australian English is considered a non-rhotic language, meaning that the /r/ is not pronounced at the end of a syllable or before a consonant. However, in intervocalic positions, the /r/ is sometimes pronounced as a voiced alveolar stop [d] or as a voiceless alveolar stop with a raised diacritic [d̥] (Cox, 2012). This variation in the pronunciation of /r/ is believed to be influenced by social factors, such as education, age, and region (Harrington et al., 2000). It has also been suggested that this variation may be linked to the influence of Australian Aboriginal languages, some of which have a similar sound in their phonetic inventory (Butcher & Williams, 2012). Despite the variation, the non-rhotic nature of Australian English is a defining feature of the dialect and is often associated with the broader cultural identity of Australians.

In addition to the mentioned instances of English /r/, multifaceted phonological processes, such as r-sandhi, intrusive-r, and linking-r, among others, shape the intricate variability of /r/ in English phonology. Each of these processes, though manifesting differently, shares certain underlying similarities that collectively contribute to the elaborate nature of /r/ within the language system. Milroy (1983) elucidates these phenomena, offering an all-encompassing illustration that unravels their nuanced interrelationships and interconnectedness.

R-sandhi embodies a process involving the modification of /r/ in connected discourse, specifically the insertion of /r/ in syntagmatic structures where a word terminating with a vowel precedes a word initiating with a vowel. This can be exemplified by the pronunciation of the phrase "law and order" as "law-r-and-order" in select English dialects (Barras, 2010; Wells, 1982). Distinct from r-sandhi, yet parallel in concept, intrusive-r represents a phonological occurrence in particular English varieties wherein an /r/ is interpolated between two sequentially placed words, both of which are either vowel-ending or vowel-starting, such as in the pronunciation of "idea of it" as "idea-r-of it" (Barras, 2010; Wells, 1982).

Linking-r, a further complexity within this phonological domain, signifies a scenario where an /r/ is enunciated in contexts where its pronunciation is typically absent, like in the rendering of "saw a film" as "saw-r-a film" (Wells, 1982). The convergence of these processes constructs a multifarious phonological landscape, encapsulating the /r/ in English. Milroy (1983) accentuates the intricate nature of this landscape, illustrating how one phoneme can engender multiple rules and contextual variations. These rules help us understand the complexity of language better, and even though they seem to be very different, they reveal underlying structural patterns and shared characteristics that fit with the spoken language system's natural flexibility and ability to change its morphology.

Continuing from the discussion of English phonology, efforts aimed at characterizing Arabic rhotics have been scattered and show contradictory results. This is mainly due to the dialectic situation of Arabic and the multitude of regional variations. According to Mahyoob (2021) and Saleh et al. (2015), the phoneme /r/ has two allophones in Standard Arabic: trill [r] and flap [ɾ]. Each occurs in certain environments; the trill [r] always occurs in single, geminated, and intervocalic positions, while the flap [ɾ] occurs in an unstressed syllable. Mahyoob (2021) concluded that these realizations can change when emphatic sounds precede the two allophones. Based on contemporary experimental studies in Arabic phonetics, Jameel (2009) concluded that the tap [ɾ] is restricted to certain positions and some speakers. Youssef's

(2019) study investigated the allophonic variation of Arabic /r/ in multiple Arabic dialects. The phoneme displayed dialect-specific behavior that varies from allophonic to phonemic variations.

To capture this variability, dialects were sorted into four different categories. The split-R category, appearing in Maghrebi, Tunisian, Libyan, and Egyptian Cairene Arabic, recognizes plain /r/ and an emphatic /rˤ/ as two distinct phonemes. They appear in minimal pairs in parallel phonological environments. The second category hosts dialects that contain one /r/ phoneme, that is, the emphatic-R. The Arabic dialects of Lebanon, Jordan, Syria, and Palestine have an emphatic /rˤ/ with emphatic [rˤ] and plain de-emphaticized [r] allophones. The third type is the plain-R dialect. In this group, the phoneme is plain /r/ with two emphatic and non-emphatic allophones. The last group is the uvular-R dialects, with both uvular [ʁ] and a trill [r] (Watson, 2002).

In the Egyptian dialect, Harrell (1957) reported a trill /r/, whereas Omar (1973) described Egyptian [r] as a flap and geminated [r] as a trill. Saleh et al. (2015) did a more recent spectral analysis of Egyptian Cairene /r/. They found that every participant used both allophones, though taps were used more often than trills. Dyson and Amayreh (2000) discovered that Jordanian Arabic /r/ manifests as two allophones: the tap and the trill. Different Sudanese dialects were reported to have a trill /r/ in almost all positions.

Najdi and Hijazi Arabic did receive a separate treatment from Alrasheedi (2022), who studied the distribution of rhotic allophones in Najdi (Hail) and Hijazi (Mecca) Arabic. He found that in Najdi Arabic, the voiceless alveolar flap /ɾ/ is realized as a trill [r] following the stop sounds /b,g,k/, and in geminate and intervocalic positions. On the other hand, Hijazi Arabic has only one rhotic allophone, which is the emphatic /rˤ/. However, Hijazi /rˤ/ has two variants: a pharyngealized and an epiglottalized version, which vary based on the preceding and following consonantal context. In both Najdi and Hijazi Arabic, the trill and flap allophones are not attested.

Overall, the characterization of Arabic rhotic is complex and varies considerably across dialects. Further research is needed to better understand the phonological and phonetic properties of Arabic rhotic in different dialects, as well as the factors that may account for the observed variations.

Markedness

To express the idea that not all sounds and sound combinations in language have equal status, Trubetzkoy (1939) first introduced the concept of markedness. The concept of markedness plays a prominent role in phonology as it seeks to understand the ease and difficulty of pronouncing certain sounds or sound combinations. According to this theory, sounds and sound combinations that are common, expected, and frequent are called 'unmarked', while those that are unusual, less common, and hard to articulate are 'marked'. For instance, coronal sounds like /t/ and /d/ are unmarked with regards to the place of articulation because they are more frequent in languages, while velar sounds like /k/ and /g/ are marked because they are less common.

Furthermore, vowel height is an example of markedness in vowel systems. High and low vowels like /i/ and /a/ are unmarked with respect to mid vowels like /e/ and /o/, as they are more common in vowel inventories and are often the result of neutralization and epenthesis in various languages (Rice, 2007). The concept of markedness has been used in various fields, including linguistics, psychology, and anthropology, to explain why some linguistic structures are more common and easier to produce than others. Additionally, it has been applied to areas such as second language acquisition, speech therapy, and natural language processing. Markedness is a fundamental concept in linguistics that helps to explain the patterns observed in sound and sound combination systems across different languages. It has numerous implications in both theoretical and applied linguistics, and its study has greatly contributed to our understanding of the nature of language.

In Arabic, the phoneme /r/ can be considered a marked sound (Watson, 2002). This is because in standard Arabic, the pronunciation of /r/ involves a trill or tap sound, which is relatively difficult to produce for speakers of some languages. In some dialects of Arabic, such as those spoken in Egypt and parts of the Levant, the sound /r/ is realized as a voiced uvular fricative [ʁ], which is also considered marked due to its less common occurrence in the world's languages. The markedness of the Arabic /r/ has been studied in phonological research. For example, Inkelas and Orgun (1995) examined how the markedness of the Arabic trill is reflected in the morphological and phonological patterns of the language. They argue that the markedness of the trill affects the distribution and behavior of adjacent sounds, as well as the behavior of the trill itself in certain environments. Overall, the markedness of the Arabic /r/ is an interesting aspect of the phonology of the language, and its study can help shed light on the broader topic of markedness in phonology.

Methodology

The study's main objective is to investigate the Arabic /r/ phoneme in different linguistic environments and regional differences. The researchers used a descriptive-analytic approach, reviewed relevant literature, and developed a list of 29 Arabic words with the /r/ phoneme. The study population consisted of random samples of Arabic speakers from Bahrain, Qatar, Kuwait, Saudi Arabia, Jordan, Lebanon, Egypt, Sudan, Tunisia, and Morocco, and the instruments included a distinctive features matrix and the Audacity Sound Recording and Analysis App. A team of qualified arbitrators validated the study's instruments, and the data analysis used particular phonological processing and procedures. This analysis involved the examination of particular sounds (or phonemes) used in the language, as well as the rules governing their organization and their distribution patterns. The methodology was carefully designed to ensure both accuracy and reliability in the collection and interpretation of data. In this context, 'accuracy' refers to the closeness of the measurements to the true value, while 'reliability' denotes the consistency of the measurement process (see Ladefoged & Johnson, 2014).

Study Approach

To align with the study's objectives, questions, and the nature of the problem, the researchers embraced a descriptive-analytic approach. They diligently reviewed phonology literature, encompassing basic phonological principles and Arabic-specific studies, to foster a comprehensive comprehension of Arabic phonology. This comprehensive review aimed to

unravel the nuances of the Arabic /r/ phoneme in diverse settings and assess regional disparities. By adopting this approach, the researchers aspired to delve deeper into the production and pronunciation of the /r/ in Arabic, thereby yielding pedagogical implications for language instruction and acquisition.

Population

The study population comprised random samples of Arabic speakers from nine Arab countries, aged eighteen and above, with both male and female participants. Gender and age were not considered variants in this study. While age and gender are typically influential in language acquisition and use, the primary focus of this study was on regional variations of the /r/ across Arabic dialects. Age and gender might have introduced complexities that could detract from this central focus. Therefore, these factors were controlled to maintain a targeted examination of the phonological characteristics of interest, aligning with the study's specific goals. The aim was to collect data from four participants from each region. A total of 67 recordings were obtained, as shown in Table 1. However, the vowel position within Arabic words can significantly impact the results of the study, potentially leading to incorrect or misleading conclusions. Therefore, the researchers meticulously filtered the pronunciations to exclude those that did not conform to the rules of vowel status and Arabic diacritics. Specifically, any recordings that demonstrated discrepancies in vowel sound quality were omitted from the analysis. This precaution was necessary as some recordings exhibited differences in stress placement, insertions, misreading, or exaggerated and artificial pronunciation of words. Such inconsistencies could compromise the vowel position and pronunciation, thereby jeopardizing the integrity of the research findings.

Table 1

Distribution of the Recordings According to Countries

Countries and Regions	Participants	
	Intended	**Received**
Bahrain	4	4
Qatar	4	2
Kuwait	4	1
Saudi Arabia	4	34
Jordan	4	4
Lebanon	4	4
Egypt	4	8
Sudan	4	3
Tunisia	4	3
Morocco	4	4
Total	40	67

Study Instruments

A collection of 29 Arabic words that contain the /r/ phoneme in various contexts, a matrix of distinguishing traits, and the Audacity Sound Recording and Analysis App were the three main study tools the researchers chose. A team of knowledgeable arbitrators carefully selected and approved the list of words by evaluating each item's appropriateness, clarity, and suitability, as well as its applicability to the subject matter. The arbitrators assessed the words to make sure they were relevant to the study of Arabic phonology, especially with respect to the /r/ phoneme. Any words that did not meet this criterion could have introduced unnecessary variables or noise into the study, potentially skewing the results. The chosen words were selected for clarity, unambiguity, and relevance to both the regional dialects and the study's specific phonological focus. This ensured consistent pronunciation among participants and alignment with the study's objectives, contributing to the accuracy and reliability of the results.

The phonetic characteristics of the /r/ phoneme in various contexts were also examined by the researchers using a distinguishing features matrix. The most famous of which is the one developed by the most famous distinctive features matrix is likely associated with the theory of distinctive features developed by Roman Jakobson, Gunnar Fant, and Morris Halle (1951). They were able to discern the distinctive characteristics of the /r/ in various circumstances thanks to this matrix, which also served as a methodical framework for data analysis and interpretation. The Audacity Sound Recording and Analysis App was used by the researchers in addition to these tools to record and analyze the research's primary data. By enabling the researchers to properly measure and examine the acoustic characteristics of the /r/ phoneme, this app contributed to the precision and dependability of the data that was gathered. This way, the researchers were able to provide a thorough and in-depth analysis of the /r/ phoneme in Arabic thanks to the methodical use of these tools, which also served to ensure the validity and trustworthiness of the data acquired. Here is a list of the words provided to the participants, excluding the transcriptions and English words:

Table 2
Study Word List

Initial	Broad Transcription	Medial	Broad Transcription	Final	Broad Transcription
رمال	/rɪˈmæl/	حارس	/ˈhæˌrɪs/	حارّ	/ˈhɑːr/
رحال	/rɪˈħæl/	بارد	/ˈbæˌrɪd/	جارّ	/ˈʒɑːr/
رجال	/rɪˈʒæl/	سارع	/ˈsæˌrəʕ/	سار	/ˈsɑːr/
رَأس	/ˈraʔs/	كَرَم	/ˈkərəm/	طَير	/ˈtˤeɪr/
رَد	/ˈrʌd/	حَرَم	/ˈħərəm/	خَير	/ˈxeɪr/
رَف	/ˈrʌf/	بَرَم	/ˈbərəm/	سَير	/ˈseɪr/
رُكَب	/ˈrʊkəb/	قُرب	/ˈqʊrb/	حُور	/ˈħuːr/
رُبع	/ˈrʊbʔʕ/	شُرب	/ˈʃʊrb/	نُور	/ˈnuːr/
رُكن	/ˈrʊkn/	ذُرَة	/ˈðʊrəh/	سُور	/ˈsuːr/
		ذَرَّة	/ˈðərˌrəh/	فَرّﹶﹶ	/ˈfərˌrə/

Validity of the instruments

To ensure the validity of the study instruments, the researchers engaged a group of specialized arbitrators to review the items contained in the list. The arbitrators assessed the clarity and suitability of the linguistic and phonological formulation of the items and their relevance to the field. Based on their observations, some items were deleted, and some items were re-drafted. The researchers obtained the consent of 90% of the arbitrators, confirming the validity of the study instruments. The words were picked based on their clarity, absence of ambiguity, and pertinence to the regional dialects and the phonological aspects under investigation. By meeting these criteria, the selected words facilitated uniform pronunciation across participants and aligned with the research objectives, enhancing the precision and trustworthiness of the findings. The final list consisted of 29 items distributed in three main categories: the first contained /r/ in the initial position, the second in the medial position, and the last in the final position. Each category included items with front and back vowels to take into account the variation of the Arabic /r/ phoneme in different environments.

Procedures

The process started with conducting an extensive review of relevant literature on phonology, focusing on Arabic phonology and previous studies on Arabic sounds, with a focus on the Arabic trill and its variation. This literature review provided the foundation for understanding the research topic and identifying the key factors related to the Arabic /r/ phoneme in different linguistic environments and regional variations.

Next, based on the literature review, the researchers developed a list of 29 Arabic words that contained /r/ in various contexts. These contexts included word-initial, medial, and word-final positions with front and back vowels. The word list aimed to capture the different environments in which /r/ occurs and facilitate the investigation of its characteristics. The researcher consulted a group of specialized arbitrators to evaluate the appropriateness, clarity, and relevance of each item in the word list. The arbitrators provided feedback, and based on their observations, some items underwent either deletion or re-drafting. The final word list consisted of 29 items distributed into three categories. Each category included items with front and back vowels, accounting for the variation of the Arabic trill.

For the purpose of the study, the participants were instructed to pronounce and record a list of 29 validated Arabic words using their WhatsApp application and then send the recordings to the researchers. The researchers carefully checked each recording to ensure adherence to proper vowel sound quality and Arabic diacritics. Following this verification, the recordings were imported into the Audacity Sound Recording and Analysis App, where they were subsequently analyzed.

The researchers conducted a systematic instrumental analysis of the recorded data. The first step involved extracting individual words from the recordings and assembling them into one recording for all speakers from all regions. This compilation facilitated the assessment of commonalities, unmarked pronunciations, and variations across regions. Then, the researchers inspected visually and audibly the waveform and recording of each individual word. The waveform analysis focused on the quality and quantity of trill cycles, while the auditory inspection focused on tongue position and place of articulation. This inspection process aimed

to identify commonalities, marked and unmarked pronunciations, and variations in the /r/ phoneme across different linguistic environments.

All instances of the same word were combined into one recording, allowing for a cross-check of the distribution of commonalities and irregularities in a single-word environment across regions. This cross-checking process enabled the researchers to identify and describe the behavior of the Arabic /r/ in different environments, taking regional differences into account. The next step was the interpretation and discussion of the findings in the context of the research objectives, literature review, and relevant theoretical frameworks. The researchers examined the characteristics of the Arabic /r/ in different contexts and discussed the regional variations observed. The implications of the findings for language teaching and learning were also considered.

Finally, the researchers concluded the study by summarizing the main findings and their significance. They emphasized the contributions of the research to the understanding of the Arabic /r/ and its variations in different environments and regions. The study's methodology, including the systematic instrumental analysis, balanced sample, and detailed description of materials and methods, was reported to ensure transparency and replicability.

Results and Analysis

For Arabic speakers, the unmarked Arabic trill is typically produced with the tongue flat, relaxed, and slightly touching the alveolar ridge, with no pressure and forcing air from above the tongue. While this is generally the case in Modern Standard Arabic, different regions and accents exhibit variations in the pronunciation of the Arabic /r/.

Word-Final Position

The researchers carefully examined the 29 recordings from every target country and discovered a number of intriguing patterns and tendencies. They were able to pinpoint particular qualities and elements of the /r/ phoneme in various contexts by carefully listening and analyzing. As seen in Figure 1, in word-final position, such as in /ħɑːr/ (hot), /ʒɑːr/ (neighbor), and /sɑːr/ (walked), where the /r/ is preceded by /ɑː/, the trilling amounts and turbulence degrees differ among regions. Most participants start with a trill and end with some friction or turbulence, but the spectral analysis shows varying amounts of trill and turbulence, ranging from a geminate trill to the smallest trill with the most turbulence. The differences in the trilling amount and turbulence degree suggest that there are variations in the way the Arabic trill /r/ is produced in different regions and accents. For example, some speakers may produce a more pronounced trill, while others may produce a simpler trill. The spectral analysis also shows that there are variations in the amount of turbulence produced at the release stage, which can affect the quality of the sound. It is worth mentioning that spectral analysis B is the dominant type. The data provides insights into the behavior of the Arabic /r/ sound in different linguistic environments and regional differences.

Figure 1

Word-Final Position A, B, C, D


A   B   C   D
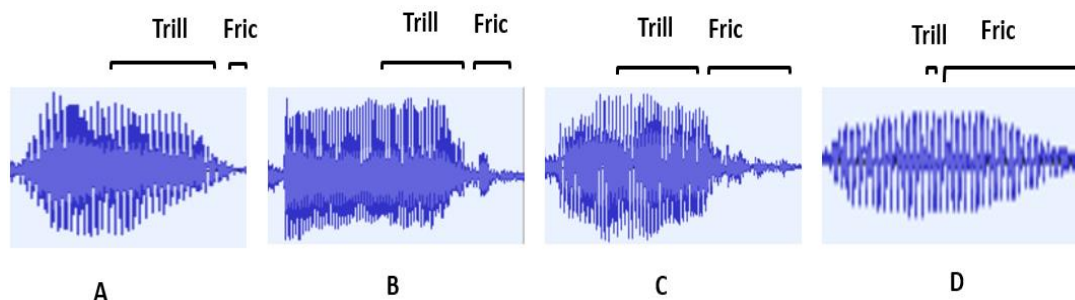
The spectral representations of the words /ʒɑːr/ (neighbor) and /sɑːr/ (walked) are similar to those of the word /ħɑːr/ (hot), showing a range of trill amounts from the biggest to the smallest, and a range of friction degrees from the least to the most.

Similar turbulence variations have been observed in the final position of /r/ when it is preceded by the diphthong /eɪ/ (Figure 2). In words such as /xeɪr/ (goodness), /tˤeɪr/ (bird), and /seɪr/ (walking), the final /r/ typically appears as a trill, with analysis showing that it is often followed by turbulence in most dialects. However, there is some variation in the duration of turbulence relative to the trills. Two main variations have been observed in relation to the initial closure. In E and F, the final /r/ is preceded by a brief period of silence, followed by a trill, and ends with some friction at the release stage. However, the silence period is relatively longer in E compared to F. In the second variation, there is no initial closure, and the trilling cycles take place immediately after the vowel, as shown in G.

Figure 2

Word-Final Position E, F, G

E   F   G
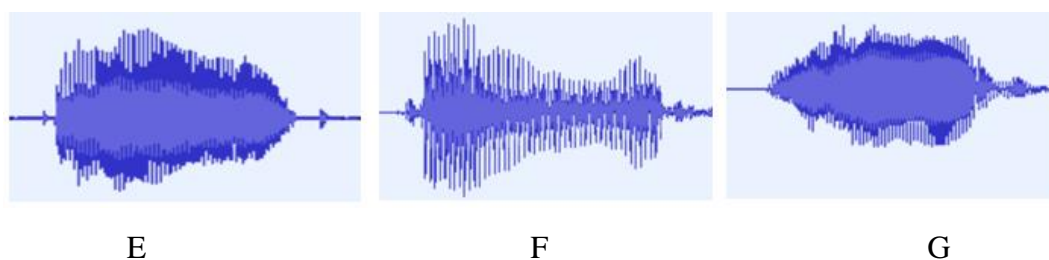
In a similar manner, the pronunciation of /r/ in the word-final position preceded by the back, close-rounded vowel /uː/ also exhibits variation. The words /ħuːr/ (an Arabic girl's name) and /nuːr/ (light) may be pronounced with either closure followed by turbulence or immediate trilling cycles after the vowel.

Medial Position

In the medial position (Figure 3), such as in the word /bærɪd/ (cold), the pronunciation of the Arabic /r/ varies across different regions. In Bahrain, the medial /r/ is typically

pronounced as a voiced retroflex flap [ɽ], while in Egypt, it sounds more like a voiced retroflex approximant [ɻ]. In most other Arab regions, the medial /r/ is perceived as a medium trill.

Figure 3

Word-Medial Position

| H	I	J
Voiced retroflex flap/ɽ/	Medial Trill	Voiced retroflex approximant /ɻ/
Bahrain	General	Egypt
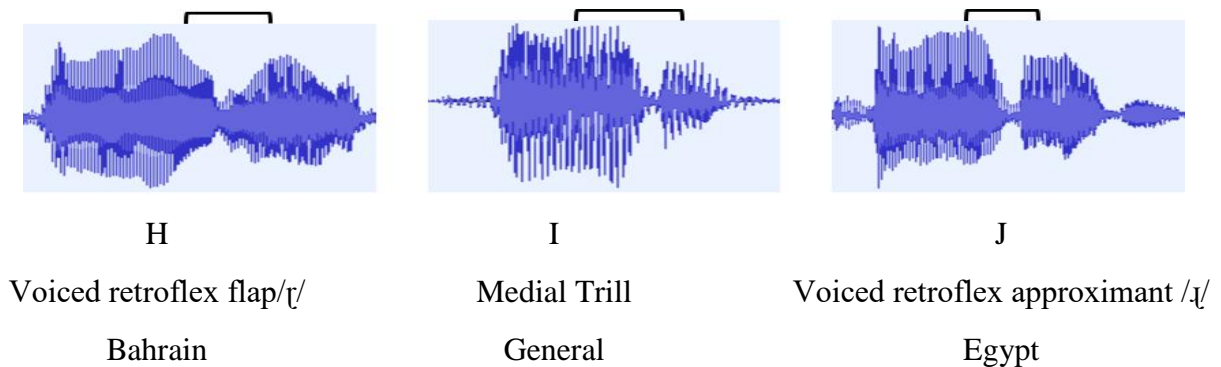
Gemination

Gemination is the process of doubling a consonant sound, resulting in a longer duration of the sound. In Modern Standard Arabic, the geminated trill is typically followed by a vowel. The /r/ in the words /fərˌrə/ (fled) and /ðərˌrəh/ (atom) is intervocalic, creating an environment conducive to gemination. The representations below (Figure 4) show different degrees of geminated trill. Representation M depicts a non-standard pronunciation (colloquial or very informal) of the words where the geminated trill is reduced to a minimum, followed by some turbulence. In most Arab regions, representation N appears to be the dominant pronunciation, with around three contacts of the trill. However, in Sudanese accents, representation O, the trill appears to vibrate for around five contacts. In most Egyptian accents, representation P, there is some sort of gemination of the retroflex approximant [ɻ], but no audible trill is observed. In all cases, the geminated trill is followed by a vowel and some turbulence. The differences in the degree of gemination can vary between regions and accents.

Figure 4

Germination

M	N	O	P
General Informal	General	Sudan	Egypt
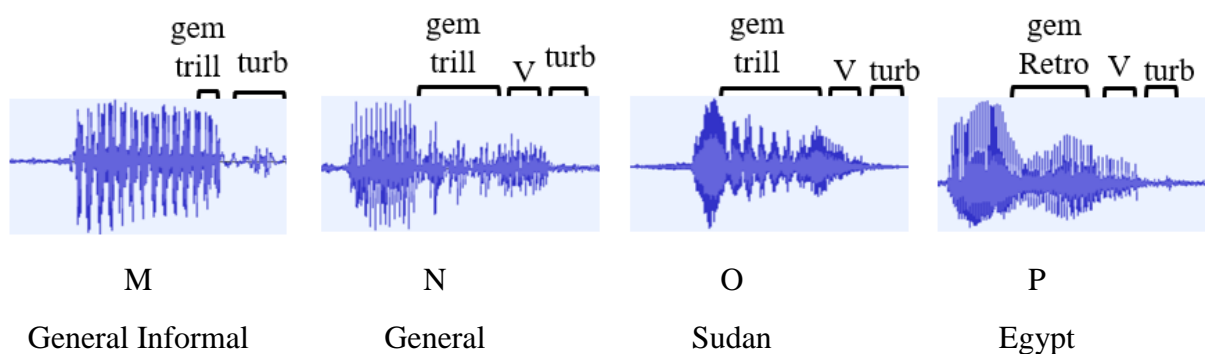
We can summarize the differences between these productions as follows:

1. Degree of Gemination: This aspect highlights the range of gemination that can be heard in the trill sound, from minimal or subdued gemination that is common in colloquial or very informal speech patterns (like in representation M) to more pronounced or extended gemination that can be heard in different accents and regional dialects.

2. Number of Contacts within the Trill: The intricacy of the trill's articulation is manifested in the fluctuating number of contacts. Most Arab regions have about three contacts (shown in N), while Sudanese accents have about five contacts (shown in O).

3. The Audible Nature of the Trill: Some Egyptian accents (as in representation P) exhibit a nuanced phenomenon where gemination seems to involve the retroflex approximant [ɻ], deviating from the conventional audible trill. This deviation introduces a layer of complexity in understanding the phonetic realization of the sound.

4. Regional Variations and Specificities: Across the Arabic-speaking world, the gemination of the trill unveils distinct regional idiosyncrasies and variations. These localized characteristics not only enrich the tapestry of Arabic phonology but also pose challenges in categorizing and standardizing the pronunciation of the trill sound.

5. Sequential Articulatory Features: The following articulation of a vowel and turbulence after the geminated trill are traits that can be seen in all of these variations. This consistency sheds light on the underlying patterns and structures that govern the sound's production, regardless of other variables.

Word Initial Position

In Arabic, the initial /r/ must be followed by a vowel and cannot be followed by a consonant. Spectral representations reveal that in most countries under investigation, the initial /r/ is not trilled but rather produced as a quick alveolar tap, as seen in representation Q (Figure 5). In some regional accents, it is realized as a retroflex tap, as shown in representation R. The examples provided, such as /rɪˈmæl/ (sand), /rɪˈʒæl/ (men), and /rɪˈħæl/ (luggage), all contain an initial /r/ followed by a short front vowel. Most speakers consistently produce a quick alveolar tap in this position, while in some cases, the initial /r/ may sound like a retroflex flap.

Figure 5

Word-Initial Position Q and R

Q

General

R

Egypt

14
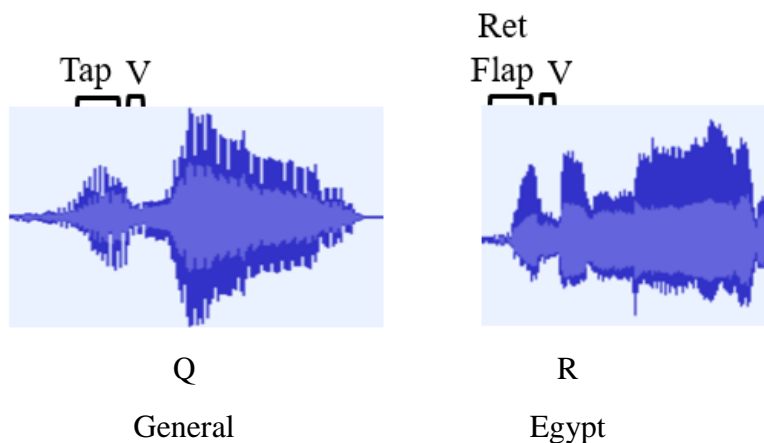
Similarly, the list also included words with the /r/ followed by a back vowel, such as /rʊbʕ/ (quarter) and /rʊkn/ (corner). The analysis of the representation below reveals that in most Arab regions, an initial /r/ is not trilled. Rather, it is a quick alveolar tap, as seen in representation S below (Figure 6). However, in some regional accents, the initial /r/ is realized as a retroflex tap, as shown in representation T.

Figure 6

Word-Initial Position S, T

S

General

T

Egypt
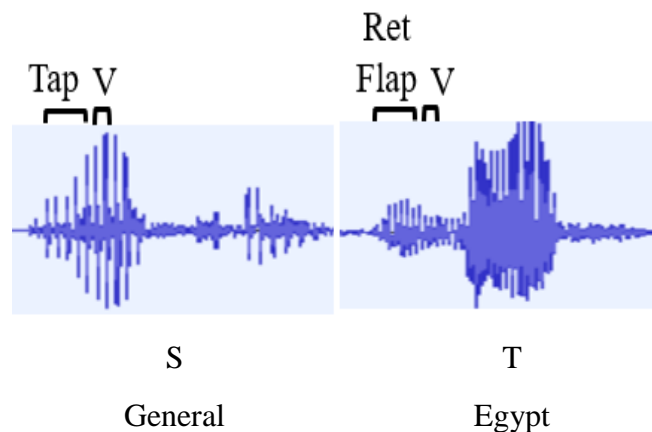
Discussion

The goal of this study was to find out how Arabic /r/ sounds at the beginning, middle, and end of words and what its phonological status is in terms of how marked it is. The results showed that an initial /r/ is typically realized as a rapid alveolar tap [ɾ/] that sometimes manifests as a retroflex tap [ɽ], regardless of the following vowel. This finding is consistent with previous studies by Saleh et al. (2015) and Alrasheedi (2022).

In the medial position, /r/ is mostly realized as a trill, with the exception of Bahrain and Egypt, where it is produced as a retroflex flap and retroflex approximant, respectively. The latter variant of /r/ as a retroflex approximant also holds true for geminated /r/. This realization was not reported in previous studies on Egyptian Arabic, which reported /r/ as a tap, trill, and flap. In cases of gemination, /r/ surfaced as an alveolar trill in all Arab regions except for Egypt (Mahyoob, 2021). In the word-final position, the phoneme /r/ is generally realized as a trill, with the exception of some Saudi Arabic, where it is trilled only when preceded by [-coronal, +voiced]. Consonants appear to have a greater role in the variation of the /r/ realization than vowels.

Regarding the phonological status of /r/, this study found that the Arabic /r/at the beginning of a word is pronounced as an unmarked alveolar tap, while the retroflex flap is a marked sound that is only made by a small number of people, mostly Egyptians. This finding is consistent with previous studies that reported trill as less frequent compared to taps /r/ (See Anselme et al., 2023; Ignatova et al., 2018 and Wiese, 2001). The present study also distinguished itself by categorizing /r/ according to the different environments that influence its pronunciation while taking into account the vowel type and markedness.

The present study contributes to the understanding of the realizations and phonological status of Arabic /r/ in different positions and environments. The findings showed that the

Arabic /r/ is commonly realized as an alveolar tap in the word-initial position, and as a trill in the word-final position, with variation in the medial position depending on the region. The markedness of /r/ was also found to be dependent on the specific realization of the sound in different environments.

Conclusion

In conclusion, this study sheds light on the diverse realizations and phonological status of the Arabic /r/ in various positions and environments. The results showed that the most common realization of initial /r/ is an alveolar tap, while medial /r/ is mostly realized as a trill, with variations in some regions. Word-final /r/ is generally pronounced as a trill, except in some Saudi Arabic. Additionally, this study found that the unmarked feature of /r/ in Arabic is its realization as an alveolar tap, while the retroflex flap is a marked feature that appears in only a few pronunciations. The study's contribution to our understanding of Arabic phonology is important, as it provides insights into the complexity of this sound and its diverse realizations in different regions. These findings have implications for language teaching and learning, as well as for further research in Arabic phonology.

Implications

The outcomes of this investigation substantially augment the field of Arabic phonology research, specifically targeting the multifaceted manifestations of the /r/ phoneme. By elucidating the nuanced variations in the pronunciation of /r/ across disparate locational contexts and regional dialectical variations, this scholarly endeavor enriches the collective comprehension of the phonological intricacies inherent to the Arabic-speaking diaspora. Through the employment of a distinctive features matrix, in conjunction with a rigorous analysis conducted via the Audacity Sound Recording and Analysis App, the study promulgates an innovative methodological framework. This can be instrumental in shaping subsequent inquiries within the domain of Arabic phonology. Such an avant-garde methodology not only fills an identifiable lacuna in extant literature but also furnishes pivotal insights. These insights may catalyze continued scholarly exploration into the multifarious and labyrinthine phonological terrain that characterizes the Arabic linguistic landscape.

Suggestions

Based on the empirical findings emanating from the current research endeavor, an array of nuanced recommendations for subsequent scholarly inquiries can be posited:

1. Augmented explorations are requisite to elucidate the multifaceted determinants influencing the nuanced variation of /r/ articulations in the medial phonological context within disparate Arab locales, encompassing Bahrain and Egypt. Such inquiries should concurrently scrutinize the dissemination of retroflex approximant manifestations of /r/ within divergent Arabic linguistic variants.
2. Prospective studies ought to concentrate on the acoustic characteristics inherent in the manifold /r/ articulations and the subsequent perception thereof by native Arabic interlocutors. This examination will furnish a deeper comprehension regarding the

auditory discernment and cognitive processing of these variances by the listeners, in addition to their impact on the comprehensibility of Arabic speech.

3. Research endeavors probing into the phonetic and phonological attributes of additional Arabic phonemic constructs, including but not limited to the emphatic consonants and the pharyngealized consonants, might facilitate an enriched understanding of the phonological framework of Arabic, as well as the inherent variations that traverse its multifarious dialects.

4. A probing inquiry into the confluence of sociolinguistic and demographic elements, encompassing age, gender, educational attainment, and linguistic intersections, may unveil novel insights pertaining to the shaping of the /r/ articulatory variations within diverse Arab regions.

In conclusion, the present study accentuates the imperative of meticulous consideration of the idiosyncratic milieu and contextual nuances in which phonetic phenomena are generated and perceptually interpreted. This is pivotal in order to ascertain their phonological positioning and markedness within the linguistic spectrum. Henceforth, ensuing research endeavors ought to persistently traverse the intricate nexus binding the phonological, phonetic, and sociolinguistic constituents that delineate the phonetic divergence of Arabic auditory symbols.

References

Alrasheedi, E. S. (2022). Flaps and trills in Najdi and Hijazi Arabic. *International Journal of Linguistics, 14*(6). https://doi.org/10.5296/ijl.v14i6.20592

Anselme, R., Pellegrino, F., & Dediu, D. (2023). What's in the r? A review of the usage of the r symbol in the Illustrations of the IPA. *Journal of the International Phonetic Association*, 1-30.

Barras, W. (2010). *English Phonetics and Phonology.* John Wiley & Sons.

Butcher, A., & Williams, L. (2012). Investigating the origins of a regional Australian English accent feature. *Journal of the International Phonetic Association, 42*(1), 1-19.

Catford, J. C. (1988). *A practical introduction to phonetics.* Oxford University Press.

Cox, F. (2012). *Australian English Pronunciation and Transcription.* Cambridge University Press.

de Velde, H. V., & van Hout, R. (2001). Patterns of /r/ variation. In H. V. de Velde & R. van Hout (Eds.), *'r-atics. Sociolinguistic, phonetic and phonological characteristics of /r/* (pp. 1-9). Etudes &Travaux.

Dickins, J. (2007). *Sudanese Arabic: Phonematics and syllable structure* (Vol. 38). Otto Harrassowitz Verlag.

Dyson, A. T., & Amayreh, M. M. (2000). Phonological errors and sound changes in Arabic-English. [Doctoral dissertation, University of Edinburgh]. Edinburgh Research Archive.

Foulkes, P., & Docherty, G. (2001). *Urban voices: accent studies in the British Isles.* Routledge.

Freeman, A. (2017). Acoustic correlates of rhotic emphasis in Fessi spoken Arabic. In *Studies on Arabic dialectology and sociolinguistics: Proceedings of the 12th International Conference of AIDA held in Marseille from May 30th to June 2nd.*

Freeman, A. M. (2019). *Rhotic Emphasis and Uvularization in Moroccan Arabic* (Doctoral dissertation, University of Pennsylvania).

Hall, T. A. (1997). The phonology of coronals (Vol. 149). John Benjamins Publishing Company.

Hamann, S. R. (2003). *The phonetics and phonology of retroflexes* (Doctoral dissertation).

Harrell, R. S. (1957). *The phonology of colloquial Egyptian Arabic.* American Council of Learned Societies. New York.

Harrington, J., Palethorpe, S., & Watson, C. (2000). Monophthongal vowel changes in Received Pronunciation: an acoustic analysis of the Queen's Christmas broadcasts. *Journal of the International Phonetic Association, 30*(1), 63-78. https://doi.org/10.1075/cilt.149

Ignatova, D., Bernhardt, B. M., Marinova-Todd, S., & Stemberger, J. P. (2018). Word-initial trill clusters in children with typical versus protracted phonological development: Bulgarian. *Clinical Linguistics & Phonetics, 32*(5-6), 506-522.

Inkelas, S. (2014). *The interplay of morphology and phonology* (Vol. 8). Oxford University Press.

Jakobson, R., Fant, C. G., & Halle, M. (1951). *Preliminaries to speech analysis: The distinctive features and their correlates.* THE M.I.T PRESS.

Jameel, A., & H, R. (2009). The pronunciation of /r/ in contemporary standard Arabic: An experimental study. *Poznań Studies in Contemporary Linguistics, 45*(3), 417-436.

Ladefoged, P., & Maddieson, I. (1998). *The sounds of the world's languages.* Wiley-Blackwell.

Ladefoged, P., & Johnson, K. (2014). *A Course in Phonetics* (7th ed.). Boston, MA: Cengage Learning.

Mahyoob, M. (2021). The influence of stress on allophonic alteration in Standard Arabic: An Optimality theoretic perspective. *The Asian EFL Journal, 28*(1.1).

Omar, M. (1973). *The Acquisition of Egyptian Arabic as a Native Language.* Berlin, Boston: De Gruyter Mouton.

Oueslati, A. (2017). *The phonology and morphology of Tunisian Arabic: A Government Phonology Approach.* John Benjamins Publishing.

Rice, K. (2007). Markedness in phonology. *The Cambridge handbook of phonology*, 79-97.

Saleh, M., Hegazi, M., Makram, R., Shoeib, R., Sayed, A., & Taher, S. (2015). Spectrographic speaking children. *Clinical Linguistics & Phonetics*, *14*(2), 79-109.

Tawfiq, A. M. (2010). *The Articulation of Arabic Sounds.* Dar Al-Manhal.

Thelwall, R. (1983). Markedness and Arabic phonology. *Journal of Linguistics, 19*(1), 93-112.

Trubetzkoy, N. S. (1939). *Grundzüge der Phonologie.* Vandenhoeck & Ruprecht.

Velde, H. V. D., & Hout, R. V. D. (2002). Rhotics in Belgian and Dutch Standard Dutch. *Linguistics, 33*(2), 337-384.

Watson, J. C. E. (2002). *The phonology and morphology of Arabic.* Oxford University Press.

Wells, J. C. (1982). *Accents of English 3: Beyond the British Isles.* Cambridge University Press.

Wiese, R. (2001). *The Phonology of German.* Oxford University Press.

Youssef, H. (2019). The allophonic and phonemic variations of Arabic /r/ in four Arabic dialects: Jordanian, Palestinian, Saudi and Yemeni. *International Journal of Linguistics, Literature and Translation, 2*(1), 13-28.