

Fossilized Phonetic and Phonological Errors among ESL University Students in Jordan: Evidence from Interlanguage, Markedness, and Speech Perception Models

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Received: April 13, 2026

Accepted: July 17, 2026

Online Published: October 8, 2026

doi:10.5430/wjel.v17n1p128

URL: <https://doi.org/10.5430/wjel.v17n1p128>

Abstract

Persistent pronunciation difficulties remain evident even among advanced learners of English, yet it is still unclear whether such patterns reflect stabilized interlanguage representations or merely limited responsiveness to short-term instruction. This study investigates recurrent phonetic and phonological errors among advanced Jordanian university students majoring in English Language and Literature by examining three pronunciation features that are known to pose challenges for Arabic-speaking learners: /p/–/b/ substitution, production of the velar nasal /ŋ/, and vowel epenthesis in English consonant clusters. The analysis is informed by complementary perspectives drawn from Interlanguage Theory (Selinker, 1972, 1978), the Speech Learning Model (Flege, 1995, 1998), the Perceptual Assimilation Model (Best, 1995), and the Markedness Differential Hypothesis (Eckman, 1977).

A quasi-experimental pre-test–post-test design was employed with 20 advanced Jordanian university students who completed recorded pronunciation tasks before and after an eight-week period of focused pronunciation instruction. Pronunciation performance was analyzed using phonetic transcription, descriptive statistics, and McNemar tests to examine changes across the three targeted phonological features.

The findings revealed modest reductions in error rates following instruction; however, pronunciation difficulties remained widespread across all categories. Although participants showed greater accuracy in controlled production tasks, the observed improvements were not statistically significant ($p > .05$). Consonant cluster epenthesis proved the most resistant feature, while /p/ production demonstrated the greatest descriptive improvement.

The findings suggest that these pronunciation patterns were resistant to short-term instructional intervention rather than providing conclusive evidence of permanent fossilization. Interpreted through complementary models of interlanguage development, speech perception, and phonological markedness, the results highlight the continuing influence of first-language phonology on advanced English pronunciation. The study concludes by emphasizing the value of early pronunciation instruction, sustained perceptual-articulatory training, and explicit phonological awareness in supporting long-term pronunciation development among Arabic-speaking learners.

Keywords: phonological fossilization, interlanguage, Speech Learning Model, Perceptual Assimilation Model, Markedness Differential Hypothesis, Jordanian Arabic, ESL pronunciation

1. Introduction

Accurate pronunciation remains one of the most demanding aspects of second language (L2) acquisition, particularly for adult learners whose first-language (L1) phonological system has been firmly established through years of linguistic experience. Unlike vocabulary or grammar, pronunciation requires learners to develop new perceptual and articulatory categories that often remain resistant to change even after prolonged exposure to the target language. As a result, learners who demonstrate advanced proficiency in reading, writing, and grammar may still experience persistent pronunciation difficulties that affect speech intelligibility and oral communication.

Within the Jordanian context, English occupies an important position in higher education, international communication, and professional development. Students majoring in English Language and Literature typically receive more than twelve years of formal English instruction before entering university and continue studying advanced courses in linguistics, phonetics, literature, and language skills throughout their undergraduate programs. Despite this extensive educational experience, many advanced learners continue to experience recurring pronunciation difficulties, particularly when producing English sounds and phonological structures that have no direct equivalents in Arabic. This raises an important question in second language acquisition research: do these pronunciation patterns simply reflect incomplete learning, or do they indicate greater resistance to instructional change once L1-based phonological representations have become firmly established?

Selinker's (1972, 1978) theory of interlanguage provides one useful framework for interpreting such persistent patterns. Rather than viewing learner language as a collection of random errors, the theory conceptualizes it as a systematic and evolving linguistic system. Within this developmental process, some linguistic features may stabilize despite continued exposure to the target language and regular classroom instruction. Although this phenomenon has often been described as fossilization, demonstrating fossilization empirically requires caution because persistence over a limited instructional period does not necessarily imply permanent stabilization. Accordingly, the present study adopts a measured interpretation by examining learners' responsiveness to short-term pronunciation instruction rather than claiming definitive evidence of fossilization.

The phonological relationship between Arabic and English offers a particularly appropriate context for investigating these issues. The two languages differ substantially in their phonemic inventories, syllable structures, and phonotactic constraints. Standard Arabic, for example, lacks the voiceless bilabial stop /p/, which frequently leads Arabic-speaking learners to substitute /b/ in English words. Likewise, the velar nasal /ŋ/ does not function as an independent phoneme in Arabic, creating additional perceptual and articulatory challenges. Differences in syllable structure also contribute to pronunciation difficulties because Arabic permits fewer complex consonant clusters than English. Consequently, learners often insert vowels to simplify clusters in words such as *spring* and *texts*. These recurrent pronunciation patterns provide theoretically meaningful examples for examining the interaction between cross-linguistic transfer, speech perception, and phonological development.

The selection of these three phonological features—/p/, /ŋ/, and consonant clusters—was guided by both theoretical and empirical considerations. Each represents a different dimension of phonological learning, encompassing segmental contrasts, perceptual categorization, and syllable-structure constraints. Previous research has consistently identified these features as persistent sources of difficulty for Arabic-speaking learners, making them suitable targets for investigating whether different types of pronunciation errors respond similarly to focused pronunciation instruction.

Several complementary theoretical perspectives inform the present study. Interlanguage Theory (Selinker, 1972, 1978) explains learner language as a developing linguistic system that may stabilize over time. Flege's (1995, 1998) Speech Learning Model proposes that successful acquisition of L2 sounds depends on learners' ability to establish new phonetic categories rather than assimilating unfamiliar sounds into existing L1 categories. Best's (1995) Perceptual Assimilation Model similarly argues that unfamiliar speech sounds are interpreted through native-language phonological categories, influencing both perception and production. From a structural perspective, Eckman's (1977) Markedness Differential Hypothesis predicts that linguistic features absent from, or more marked than, those of the first language are generally more difficult to acquire. Considered together, these frameworks provide complementary explanations for why certain pronunciation features remain resistant to improvement despite years of language learning.

Although these theoretical perspectives have considerably advanced research on second-language phonological acquisition, several gaps remain. Much of the existing literature has focused on beginning or intermediate learners, while comparatively little attention has been given to advanced Arabic-speaking university students who have received extensive formal instruction in English. In addition, many studies have interpreted pronunciation difficulties through a single theoretical perspective, with limited integration of interlanguage development, speech perception, and phonological markedness. Recent phonological research on Jordanian Arabic (Alsharif & Khasawneh, 2025a, 2025b; Alsharif et al., 2025) has further expanded understanding of the linguistic system underlying learners' first language, yet these findings have rarely been incorporated into empirical investigations of English pronunciation among Jordanian university students. Addressing these gaps is particularly relevant within Jordanian higher education, where English majors are expected to achieve advanced communicative competence but often continue to experience persistent pronunciation challenges.

Accordingly, this study investigates persistent phonetic and phonological errors among advanced Jordanian university students majoring in English Language and Literature before and after an eight-week period of focused pronunciation instruction. Specifically, the study aims to:

1. Identify the most recurrent and resistant phonological errors in the speech of advanced Jordanian learners of English.
2. Examine whether focused pronunciation instruction leads to statistically significant improvement across the selected phonological features.
3. Interpret the observed pronunciation patterns through the complementary perspectives of Interlanguage Theory, the Speech Learning Model, the Perceptual Assimilation Model, and the Markedness Differential Hypothesis.

By examining multiple phonological domains within an integrated theoretical framework, this study contributes to a more comprehensive understanding of persistent pronunciation difficulties among advanced Arabic-speaking learners of English. Rather than treating limited short-term improvement as definitive evidence of fossilization, it interprets the findings within broader processes of second-language phonological development, cross-linguistic influence, and speech perception, thereby offering theoretical and pedagogical insights relevant to English language teaching in the Jordanian context.

2. Literature Review and Theoretical Framework

2.1 Language Transfer, Interlanguage, and Fossilization

Language transfer has long been recognized as a central process in second language acquisition (SLA), particularly in the development of phonological competence. Rather than representing isolated learner errors, transfer reflects the systematic influence of previously acquired linguistic knowledge on the learning and use of a new language. Early work by Richards and Sampson (1972) and Beardsmore (1986)

argues that learners naturally rely on their first language when encountering unfamiliar linguistic forms, especially during the early stages of acquisition. Brown (2007) further notes that transfer operates at both conscious and unconscious levels, enabling learners to compensate for gaps in their linguistic knowledge by drawing on established phonological and grammatical representations. Consequently, transfer should be viewed as a normal component of language development rather than merely as a source of error.

Although language transfer explains many recurring pronunciation patterns, it cannot account for all learner deviations. Odlin (1989) defines transfer as the influence arising from similarities and differences between the target language and languages previously acquired by the learner, emphasizing that such influence may either facilitate or hinder learning. Likewise, Dulay et al. (1982) distinguish between developmental errors that emerge as learners gradually construct the target language system and interference-based errors that originate from first-language influence. This distinction suggests that persistent pronunciation difficulties often result from the interaction of developmental processes, perceptual constraints, and cross-linguistic transfer rather than from a single underlying cause.

A broader explanation of learner language is provided by Selinker's (1972) theory of interlanguage, which conceptualizes learner production as an evolving linguistic system governed by its own internal rules. From this perspective, learners continually revise their linguistic knowledge as they receive new input, gain communicative experience, and test hypotheses about the target language. Interlanguage is therefore systematic and dynamic, reflecting ongoing development rather than random variation.

Building on this framework, Selinker (1978) introduced the concept of fossilization to describe the apparent stabilization of specific linguistic features despite continued exposure to the target language, sustained instruction, and learner motivation. Since then, fossilization has become one of the most influential—and most debated—concepts in SLA. Although persistent pronunciation errors are frequently interpreted as evidence of fossilization, later research has questioned whether limited instructional gains are sufficient to support such a conclusion. Ellis (1985), for example, argues that learner language may reach temporary developmental plateaus without necessarily indicating irreversible stabilization. For this reason, many contemporary researchers distinguish between resistance to short-term instructional change and genuine fossilization.

This distinction is especially relevant to pronunciation research. Developing accurate pronunciation involves more than acquiring new articulatory habits; learners must also establish new perceptual categories that differ from those of their first language. Consequently, pronunciation patterns that remain stable following a relatively brief instructional period should not automatically be regarded as permanently fossilized. Instead, they should be interpreted within broader processes of interlanguage development while taking into account complementary explanations related to speech perception and phonological representation.

These considerations are particularly important in the Arabic–English context because the two languages differ substantially in their phonemic inventories, syllable structures, and phonotactic constraints. Such differences create favorable conditions for cross-linguistic transfer when learners encounter English sounds and syllable patterns that have no direct counterparts in Arabic. Rather than treating these pronunciation patterns as isolated learner deficiencies, current SLA research increasingly interprets them as the outcome of interactions among first-language phonology, perceptual processing, language experience, and instructional exposure. This perspective provides the foundation for the speech perception models and phonological theories discussed in the following section.

2.2 Speech Perception, Phonological Transfer, and Arabic Phonology

While Interlanguage Theory explains how learner language develops over time, it does not fully account for the persistence of particular pronunciation errors after years of formal instruction. To address this issue, contemporary research has increasingly emphasized the role of speech perception in second-language phonological acquisition. Rather than viewing inaccurate pronunciation solely as an articulatory problem, speech perception models argue that successful production depends largely on how unfamiliar sounds are perceived, categorized, and represented cognitively.

Within this perspective, Flege's (1987, 1995, 1998) Speech Learning Model (SLM) proposes that successful acquisition of second-language sounds depends on learners' ability to establish new phonetic categories. When an unfamiliar L2 sound is perceived as sufficiently different from existing L1 categories, learners may gradually develop a new phonetic representation. Conversely, if the perceived difference is minimal, learners tend to assimilate the target sound into an existing native-language category through a process known as equivalence classification. This process helps explain why pronunciation difficulties may persist even after prolonged exposure to the target language, as learners continue to rely on well-established perceptual categories acquired through their first language.

A closely related account is provided by Best's (1995) Perceptual Assimilation Model (PAM), which explains non-native speech perception in terms of the relationship between unfamiliar sounds and native-language phonological categories. According to PAM, learners interpret unfamiliar speech sounds through the perceptual framework of their first language, making some phonemic contrasts easier to distinguish than others. Although PAM and SLM differ in their assumptions regarding category formation, both converge on an important point: pronunciation difficulties often originate in perception before they become evident in production. Together, these models provide a strong cognitive explanation for the persistence of pronunciation errors among advanced learners.

From a structural perspective, Eckman's (1977) Markedness Differential Hypothesis (MDH) offers an additional explanation. The hypothesis argues that learning difficulty is influenced not only by differences between languages but also by typological markedness. Linguistic features that are absent from the learner's first language or are structurally more marked tend to require greater learning effort and are therefore more resistant to acquisition. This perspective is particularly relevant to English pronunciation among Arabic-speaking learners because several English phonological features, including the voiceless bilabial stop /p/, the velar nasal /ŋ/, and complex consonant

clusters, have no direct equivalents or are subject to different phonotactic restrictions in Arabic. These characteristics make them appropriate targets for examining persistent pronunciation difficulties.

Recent research on Jordanian Arabic further strengthens this interpretation by demonstrating that the Arabic sound system is governed by systematic phonological principles extending beyond individual phonemes. Using an Optimality-Theoretic framework, Alsharif, Khasawneh, and Abu-Elrob (2025) showed that the formation of superheavy syllables in Urban Irbid Arabic is constrained by language-specific phonotactic principles that regulate consonant sequencing and syllable complexity. Although their study does not investigate second-language acquisition directly, it provides an important linguistic explanation for why Jordanian learners frequently insert vowels when producing English consonant clusters that violate familiar Arabic syllable patterns.

Complementing this structural account, Alsharif and Khasawneh (2025a) examined the acoustic realization of Jordanian Arabic vowels across two major dialects, demonstrating how subtle phonetic variation reflects the underlying organization of the Jordanian vowel system. In a separate study, Alsharif and Khasawneh (2025b) investigated the production of laterals by Arabic-English bilingual children, illustrating how bilingual language experience influences phonetic realization while highlighting the continuing role of first-language phonology. Although neither study focuses directly on English pronunciation among adult learners, both contribute valuable insights into the phonological characteristics of Jordanian Arabic that shape learners' perceptual and articulatory representations. Incorporating these recent Jordanian studies also situates the present research within the broader context of current phonological scholarship conducted in Jordan.

Taken together, Interlanguage Theory, the Speech Learning Model, the Perceptual Assimilation Model, the Markedness Differential Hypothesis, and recent phonological research on Jordanian Arabic provide complementary perspectives on persistent pronunciation difficulties. Rather than attributing these difficulties to a single factor, the present study interprets them as the outcome of interactions among first-language phonology, perceptual processing, phonological markedness, and second-language development. This integrated framework provides the theoretical basis for examining the production of /p/, /t/, and English consonant clusters among advanced Jordanian learners of English.

2.3 Empirical Evidence on Persistent Phonological Errors

Empirical research has consistently demonstrated that first-language phonology exerts a substantial influence on second-language speech production. Nevertheless, previous studies differ considerably in their theoretical perspectives, linguistic focus, and research design, leading to different interpretations of persistent pronunciation difficulties. While some scholars attribute these difficulties primarily to cross-linguistic transfer, others emphasize the combined roles of speech perception, phonological representation, and instructional experience. As a result, persistent pronunciation errors are increasingly viewed as a multidimensional phenomenon rather than the consequence of a single explanatory factor.

Early studies established the importance of cross-linguistic transfer in second-language development. Bhela (1999) found that learners frequently relied on phonological patterns from their first language when producing the target language, demonstrating that previously acquired linguistic knowledge continues to shape second-language performance even at relatively advanced stages of learning. Similarly, August et al. (2002) and Gottardo et al. (2001) reported significant cross-linguistic relationships in phonological awareness, suggesting that phonological processing skills developed in the first language may either facilitate or constrain second-language acquisition depending on the degree of similarity between the two linguistic systems. Although these studies confirmed the importance of transfer, they provided only limited explanation for why some pronunciation errors persist despite prolonged instruction.

Subsequent research shifted attention from general transfer to pronunciation features that appear particularly resistant to change. Lord (2008) demonstrated that second-language learning may also influence first-language phonological production, indicating that phonological interaction between languages is bidirectional rather than exclusively L1-to-L2. Demirezen (2009) likewise documented persistent difficulties in producing the English velar nasal /ŋ/ among Turkish learners, arguing that pronunciation habits established through the first language may remain stable despite formal instruction. Because these investigations relied primarily on cross-sectional evidence, however, they cannot determine whether the observed patterns represent permanent fossilization or temporary developmental stabilization.

Research involving Persian learners has produced comparable findings regarding syllable structure. Jabbari and Samavarchi (2011) reported that learners frequently inserted vowels to simplify English consonant clusters that conflicted with Persian phonotactic constraints, while Fatemi et al. (2012) similarly identified epenthesis as a systematic strategy for resolving unfamiliar consonant sequences. Although these studies support the influence of native-language phonotactics on English pronunciation, their findings should be interpreted cautiously because Persian and Arabic differ in important phonological respects.

Additional evidence was reported by Betu (2020), who found that advanced learners continued to experience difficulty producing the English vowel /æ/ despite years of formal instruction. The study argued that persistent pronunciation patterns arise from the interaction of first-language transfer, perceptual limitations, and learning experience rather than from a single source. This interpretation aligns with contemporary models of second-language phonological development and reinforces the value of adopting multiple theoretical perspectives when examining pronunciation performance.

Recent phonological research conducted in Jordan provides an important linguistic background for understanding pronunciation patterns among Jordanian learners of English. Using an Optimality-Theoretic framework, Alsharif, Khasawneh, and Abu-Elrob (2025) demonstrated that syllable structure in Urban Irbid Arabic is governed by systematic phonotactic constraints that regulate consonant sequencing and

syllable complexity. These findings offer a plausible linguistic explanation for the frequent use of vowel epenthesis when Jordanian learners produce English consonant clusters that violate familiar Arabic syllable patterns. In addition, Alsharif and Khasawneh (2025a) presented an acoustic analysis of Jordanian Arabic vowels, while Alsharif and Khasawneh (2025b) examined the production of laterals by Arabic-English bilingual children. Although neither investigation focuses directly on adult English pronunciation, both contribute to a more detailed understanding of the phonological system that forms the first-language background of Jordanian learners. Their inclusion therefore strengthens the linguistic context within which cross-linguistic transfer can be interpreted.

Despite the substantial body of previous research, several issues remain insufficiently explored. First, relatively few studies have examined advanced Arabic-speaking university students who have already completed many years of formal English education. Second, many investigations interpret pronunciation difficulties through a single theoretical framework, despite growing evidence that persistent pronunciation patterns are better understood through the combined perspectives of interlanguage development, speech perception, and phonological markedness. Third, although recent Jordanian phonological studies have significantly expanded knowledge of Jordanian Arabic, these findings have rarely been integrated into empirical investigations of English pronunciation among Jordanian university learners.

The present study addresses these gaps by investigating persistent phonetic and phonological errors among advanced Jordanian university students before and after focused pronunciation instruction. By integrating Interlanguage Theory, the Speech Learning Model, the Perceptual Assimilation Model, and the Markedness Differential Hypothesis, while drawing on recent descriptions of Jordanian Arabic phonology, the study offers a more comprehensive interpretation of pronunciation development than approaches based on a single theoretical perspective. This integrated framework provides the foundation for the methodological procedures described in the following section.

3. Methodology

3.1 Research Design

This study employed a quasi-experimental pre-test–post-test design to examine the persistence of selected phonetic and phonological errors among advanced Jordanian learners of English following a period of focused pronunciation instruction. Participants' pronunciation performance was evaluated before and after the instructional period to determine whether measurable changes occurred in the targeted phonological features.

A quasi-experimental design was considered appropriate because the participants constituted an intact university class and could not be randomly assigned to experimental and control groups. Consequently, the study focused on changes within the same group across two testing occasions rather than comparisons between different instructional conditions. This design is widely used in applied linguistics and educational research where random assignment is not feasible in authentic classroom settings.

The investigation targeted three pronunciation features that have consistently been identified as problematic for Arabic-speaking learners of English: substitution of the voiceless bilabial stop /p/ with /b/, production of the velar nasal /ŋ/, and vowel epenthesis in English consonant clusters. These features were selected because they represent distinct aspects of phonological acquisition, including segmental contrasts, speech perception, and syllable-structure constraints, while also providing an appropriate basis for interpreting pronunciation development through Interlanguage Theory (Selinker, 1972, 1978), the Speech Learning Model (Flege, 1995), the Perceptual Assimilation Model (Best, 1995), and the Markedness Differential Hypothesis (Eckman, 1977).

Rather than establishing a direct causal relationship between instruction and pronunciation development, the study sought to determine whether short-term pronunciation instruction was associated with measurable changes in persistent pronunciation patterns and how those changes could be interpreted within established theories of second-language phonological acquisition.

3.2 Research Questions

The study addressed the following research questions:

1. To what extent do advanced Jordanian EFL university students exhibit persistent phonetic and phonological errors in the production of selected English sounds and phonological structures?
2. Which targeted pronunciation features demonstrate the greatest resistance to improvement following focused pronunciation instruction?
3. Does focused pronunciation instruction result in statistically significant differences between participants' pre-test and post-test pronunciation performance?

3.3 Participants

The participants were 20 undergraduate students (10 males and 10 females) enrolled in the third and fourth years of the English Language and Literature program at the University of Jordan. All participants were native speakers of Jordanian Arabic who had completed approximately twelve years of formal English education before entering university. At the time of the study, they were undertaking advanced language courses delivered primarily in English.

Purposive sampling was adopted because the study specifically targeted advanced learners with extensive experience of English language instruction. This population was considered particularly suitable for examining pronunciation patterns that persist after many years of

formal learning rather than those associated with the initial stages of second-language acquisition.

3.4 Research Instrument

Data were collected using a researcher-designed pronunciation word list developed to elicit the production of three phonological features frequently reported as problematic for Arabic-speaking learners of English: the voiceless bilabial stop /p/, the velar nasal /ŋ/, and English consonant clusters.

The lexical items were selected on the basis of previous research on cross-linguistic transfer, speech perception, and phonological markedness (Best, 1995; Eckman, 1977; Flege, 1995). Target words represented different phonetic environments to provide multiple opportunities for eliciting each pronunciation feature.

The same instrument was administered during both the pre-test and post-test to ensure direct comparability of participants' pronunciation performance across the two testing occasions and to minimize potential variation attributable to differences in assessment materials.

3.5 Instructional Intervention and Data Collection Procedure

Data collection was conducted in two stages corresponding to the pre-instruction and post-instruction phases of the study. During the first stage, each participant individually completed the pronunciation task by reading the researcher-designed word list in a quiet classroom under identical recording conditions. Participants were given sufficient time to familiarize themselves with the word list before recording and were instructed to read the words at a natural speaking rate. Individual recording sessions were used to minimize background noise and ensure high-quality speech samples for phonetic analysis.

Following the pre-test, participants received eight weeks of focused pronunciation instruction integrated into their regular English language coursework. The instructional activities targeted the three pronunciation features investigated in this study: the English phoneme /p/, the velar nasal /ŋ/, and consonant cluster production. Instruction combined explicit explanation of articulatory features, perceptual discrimination activities, guided oral practice, corrective feedback, and repeated pronunciation exercises designed to increase learners' awareness of phonological differences between Arabic and English. The intervention formed part of normal classroom instruction rather than an independent experimental training program.

At the end of the instructional period, participants completed the same pronunciation task under conditions equivalent to those used during the pre-test. Employing the same instrument and maintaining consistent recording procedures ensured that any observed differences were more likely to reflect changes in pronunciation performance rather than variations in testing conditions.

All recordings were collected by the researcher using the same equipment and procedures throughout the study before being prepared for phonetic transcription and statistical analysis.

3.6 Data Analysis

The speech recordings were analyzed using both qualitative and quantitative procedures.

First, all recordings were transcribed using the International Phonetic Alphabet (IPA) to identify participants' production of the targeted pronunciation features. The qualitative analysis focused on recurrent phonological processes, including substitution and vowel epenthesis, together with the specific contexts in which these deviations occurred.

The quantitative analysis involved calculating the frequencies and percentages of correct and incorrect productions for each phonological feature during both the pre-test and post-test. Because the study compared paired nominal data collected from the same participants at two points in time, McNemar's test was used to determine whether the observed changes were statistically significant. Statistical analyses were performed using IBM SPSS Statistics, with statistical significance established at $p < .05$.

The results were subsequently interpreted in relation to the research questions and discussed within the theoretical framework of Interlanguage Theory, the Speech Learning Model, the Perceptual Assimilation Model, and the Markedness Differential Hypothesis.

3.7 Reliability and Validity

Several procedures were implemented to strengthen the methodological rigor of the study.

Content validity was established through expert evaluation. The pronunciation word list was independently reviewed by two university specialists in English phonetics and phonology to determine whether the selected lexical items adequately represented the targeted pronunciation features and aligned with the objectives of the study. Their recommendations resulted in minor refinements to several lexical items before the instrument was finalized.

To enhance the reliability of the phonetic analysis, approximately 25% of the recorded speech samples were independently transcribed by a second specialist experienced in IPA transcription. The independent transcriptions were compared with those completed by the researcher, and any discrepancies were resolved through discussion before the final coding and statistical analyses were completed. This procedure increased the consistency and credibility of the phonetic analysis.

3.8 Ethical Considerations

The study adhered to established ethical principles governing research involving human participants. Before data collection, participants were informed of the purpose of the study, the recording procedures, and the nature of the pronunciation tasks. Participation was entirely voluntary, and written informed consent was obtained from all participants.

Participants were assured that their involvement would not affect their academic standing or course assessment and that they could withdraw from the study at any stage without penalty. To protect confidentiality, all recordings and research data were anonymized before transcription and analysis. Personal identifiers were removed from the dataset, and all collected materials were used solely for research and publication purposes.

These procedures ensured compliance with accepted standards of research integrity, including voluntary participation, informed consent, confidentiality, and responsible management of research data.

4. Results

This section presents the findings of the pre-test and post-test analyses of the targeted phonetic and phonological features. The results are organized according to the study's research questions and include descriptive statistics, statistical comparisons, and observations of participants' pronunciation performance. The analysis focuses on three recurrent pronunciation patterns: (1) substitution of /p/ with /b/, (2) production of the velar nasal /ŋ/, and (3) vowel epenthesis in English consonant clusters.

Participants' pronunciation performance was examined before and after the eight-week period of focused pronunciation instruction to determine whether measurable changes occurred in the targeted phonological features. Descriptive statistics are presented first, followed by inferential analyses.

Table 1. Pre- and Post-Intervention Error Rates Across Target Phonological Categories (N = 20)

Phonological Feature	Pre-Test Error (%)	Post-Test Error (%)	Improvement (%)
/p/ → /b/ substitution	87	72	15
/ŋ/ misproduction	83	70	13
Consonant cluster epenthesis	63	58	5

Note. Post-test percentages indicate reduced but persistent error rates following the eight-week pronunciation intervention.

As shown in Table 1, error rates declined across all three phonological categories following instruction. The largest descriptive reduction was observed in /p/ production, followed by the velar nasal /ŋ/, whereas consonant cluster epenthesis showed only limited improvement. Despite these reductions, substantial residual error remained in every category.

Figure 1 provides a visual comparison of pre-test and post-test error rates across the three pronunciation categories.

Figure 1. Pre- and Post-Intervention Error Rates Across Phonological Categories

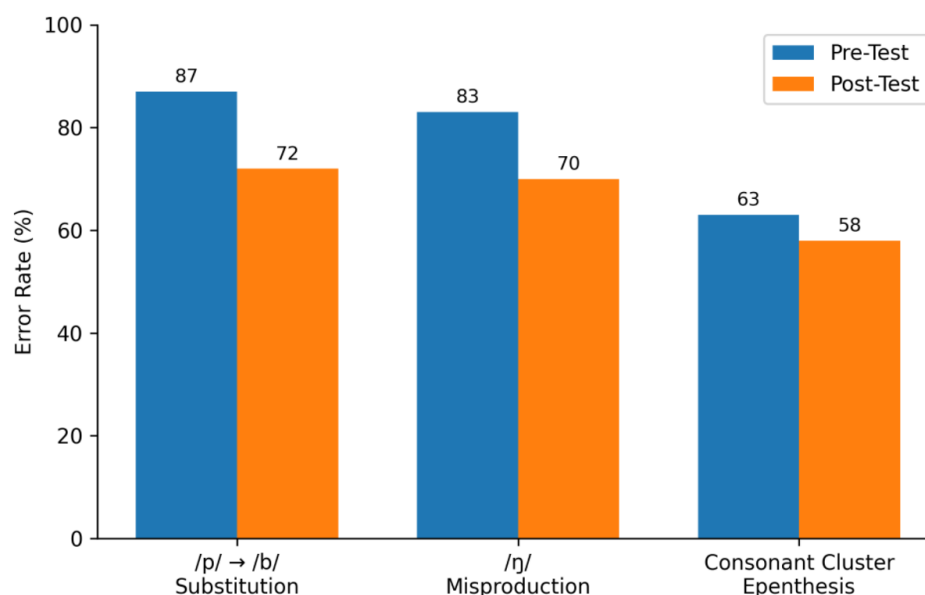


Figure 1. Pre-test and post-test error rates across the three targeted phonological categories

Note. The figure illustrates modest reductions in segmental errors (/p/ and /ŋ/) and comparatively limited improvement in consonant cluster epenthesis.

As illustrated in Figure 1, segmental pronunciation errors responded more positively to instruction than syllable-structure deviations involving consonant clusters. Nevertheless, improvement remained partial across all pronunciation categories.

To determine whether these descriptive reductions reflected statistically significant changes, McNemar tests were conducted for each

phonological feature.

Table 2. McNemar Test Results for Pre-Test and Post-Test Comparisons

Phonological Feature	McNemar χ^2	p	Interpretation
/p/ substitution	2.10	.147	Not significant
/ŋ/ misproduction	1.85	.173	Not significant
Consonant cluster epenthesis	0.89	.345	Not significant

Note. All p -values exceeded the .05 significance level. Estimated effect sizes (Cohen's g) ranged from .10 to .18, indicating small practical effects.

The inferential analyses presented in Table 2 indicate that none of the observed reductions reached statistical significance. Although participants demonstrated modest improvement following instruction, the magnitude of change was insufficient to support statistically significant differences between the two testing occasions.

4.1 /p/–/b/ Substitution

The substitution of /p/ with /b/ represented the most frequent segmental error during the pre-test. Many participants produced words such as *park* as *bark*, reflecting the absence of the phoneme /p/ in Standard Arabic. Before instruction, this pronunciation pattern was observed in 87% of the participants (Table 1).

Following the instructional period, the error rate decreased to 72%, indicating a noticeable descriptive improvement. Greater accuracy was observed during the controlled reading task, suggesting that explicit pronunciation practice increased learners' awareness of the target contrast. Nevertheless, the substitution remained common among many participants.

Consistent with the McNemar analysis reported in Table 2, the reduction did not reach statistical significance. Individual differences were also evident, with some learners showing substantial improvement while others continued to rely on their established pronunciation pattern throughout both testing sessions.

4.2 Production of the Velar Nasal /ŋ/

Production of the velar nasal /ŋ/ constituted another recurrent source of difficulty. During the pre-test, participants frequently substituted /n/ for /ŋ/ or produced the sequence /ŋg/ in words such as *sing*, *long*, and *bringing*. Overall, 83% of the participants demonstrated this pronunciation pattern before instruction (Table 1).

Following the intervention, the error rate declined to 70%, indicating moderate descriptive improvement. Although participants generally produced the target sound more accurately during the post-test, deviations remained common across the sample.

As indicated by the McNemar results, the observed reduction was not statistically significant. The findings suggest that increased articulatory awareness alone was insufficient to produce substantial restructuring of this pronunciation feature during the intervention period.

4.3 Consonant Cluster Epenthesis

Consonant cluster production proved to be the most resistant pronunciation category. Pre-test recordings revealed frequent vowel insertion in both word-initial and word-final clusters, with pronunciations such as /sɪprɪŋ/ for *spring* and /tekɪsts/ for *texts*. This pattern occurred in 63% of the participants during the pre-test (Table 1).

Following instruction, the error rate declined only slightly to 58%, representing the smallest improvement among the three targeted features. Although some learners produced simpler clusters more accurately after instruction, vowel epenthesis remained evident in many post-test recordings, particularly in more complex syllable structures.

The statistical analysis confirmed that this reduction was not significant. These findings suggest that syllable-structure constraints associated with learners' first language may be more resistant to short-term instructional intervention than individual segmental contrasts.

4.4 Comparative Trends Across Pronunciation Categories

Comparison of the three pronunciation features reveals a consistent overall pattern. As shown in Table 1 and Figure 1, all categories demonstrated descriptive improvement following the instructional period, although the degree of improvement varied. Production of /p/ showed the largest reduction in error rates, followed by /ŋ/, whereas consonant cluster epenthesis exhibited the least change.

Despite these descriptive gains, the statistical analyses presented in Table 2 indicate that none of the improvements reached the conventional level of statistical significance. Taken together, the findings suggest that the eight-week instructional program contributed to modest

improvements in controlled pronunciation performance but did not produce sufficient change to substantially alter the underlying pronunciation patterns. These results provide the basis for the theoretical interpretation presented in the following discussion.

5. Discussion

The present study examined whether focused pronunciation instruction could reduce persistent phonetic and phonological errors among advanced Jordanian university students majoring in English Language and Literature. Three pronunciation features were investigated: /p/–/b/ substitution, production of the velar nasal /ŋ/, and consonant cluster epenthesis. Although descriptive improvements were observed after the eight-week instructional period, none of the changes reached statistical significance. These findings indicate that short-term instruction enhanced pronunciation performance to a limited extent but did not substantially alter the underlying pronunciation patterns.

The high frequency of /p/–/b/ substitution before instruction is consistent with previous research on Arabic-speaking learners of English (Bhela, 1999; Odlin, 1989). Because Arabic lacks the phoneme /p/, learners frequently assimilate it to the nearest native-language category, namely /b/. From the perspective of the Speech Learning Model (Flege, 1995), this pattern reflects *equivalence classification*, whereby learners perceive the English sound as sufficiently similar to an existing L1 category and therefore fail to establish a distinct phonetic representation. The descriptive reduction observed after instruction suggests that explicit articulatory practice can improve awareness of this contrast, but the absence of statistical significance indicates that establishing a stable new phonetic category is unlikely to occur over a relatively short instructional period.

A similar pattern emerged in the production of the velar nasal /ŋ/. Although participants demonstrated modest improvement following instruction, pronunciation remained inconsistent for many learners. These findings align with Demirezen (2009), who reported comparable difficulties among Turkish learners, and support Best's (1995) Perceptual Assimilation Model, which proposes that unfamiliar speech sounds are interpreted through native-language perceptual categories. If learners do not consistently perceive /ŋ/ as an independent phonological category, accurate production is likely to remain unstable despite explicit instruction. The results, therefore, suggest that perceptual development and articulatory practice should be viewed as complementary rather than independent aspects of pronunciation learning.

Among the three pronunciation categories, consonant cluster epenthesis proved to be the most resistant to improvement. Only a minimal descriptive change was observed following instruction, and statistical analysis confirmed that this reduction was not significant. This finding is consistent with research on syllable structure conducted by Jabbari and Samavarchi (2011) and Fatemi et al. (2012), both of whom reported vowel insertion as a common strategy for resolving unfamiliar consonant sequences. Unlike individual phoneme substitutions, consonant cluster production requires learners to modify well-established phonotactic patterns that govern syllable organization in their first language. Consequently, these errors appear less responsive to short-term instructional intervention.

The findings also correspond with recent descriptions of Jordanian Arabic phonology. Alsharif, Khasawneh, and Abu-Elrob (2025) demonstrated that syllable structure in Jordanian Arabic is constrained by systematic phonotactic principles governing consonant sequencing and syllable complexity. Although their study did not examine English pronunciation, it offers a plausible linguistic explanation for the persistence of vowel epenthesis among Jordanian learners. Similarly, the phonetic studies reported by Alsharif and Khasawneh (2025a, 2025b) highlight the complexity of Jordanian Arabic sound patterns, reinforcing the importance of considering learners' first-language phonological system when interpreting second-language pronunciation.

Taken together, the findings support an integrated interpretation rather than a single theoretical explanation. Interlanguage Theory explains why learner language may stabilize over time, while the Speech Learning Model and Perceptual Assimilation Model account for the perceptual mechanisms underlying persistent pronunciation difficulties. The Markedness Differential Hypothesis further explains why phonological features that are absent from Arabic or structurally more complex require greater learning effort. Viewed collectively, these frameworks suggest that persistent pronunciation patterns arise from the interaction of cross-linguistic transfer, perceptual categorization, and phonological markedness rather than from any single factor.

At the same time, the findings should not be interpreted as conclusive evidence of phonological fossilization. Although pronunciation patterns remained relatively stable during the eight-week intervention, resistance to short-term improvement does not necessarily imply permanent stabilization. As Ellis (1985) argued, learner language may pass through extended developmental plateaus before further restructuring occurs. The present findings, therefore, provide stronger evidence for limited responsiveness to short-term instruction than for irreversible fossilization. Longer periods of intensive perceptual and articulatory training may produce additional improvement that could not be detected within the timeframe of the present study.

Overall, the study demonstrates that advanced Jordanian learners continue to experience measurable pronunciation difficulties despite extensive formal instruction. While explicit pronunciation teaching produced modest descriptive gains, particularly in segmental production, the persistence of substantial residual error suggests that deeply established phonological representations are not easily modified through short-term classroom intervention alone. These findings reinforce the importance of integrating linguistic, perceptual, and developmental perspectives when examining pronunciation acquisition among advanced second-language learners.

6. Conclusion

This study investigated persistent phonetic and phonological errors among advanced Jordanian university students majoring in English Language and Literature, with particular attention to the production of /p/, /ŋ/, and English consonant clusters before and after eight weeks of focused pronunciation instruction. Although participants demonstrated modest descriptive improvement across all three pronunciation

categories, the statistical analyses indicated that these changes were not significant. The findings therefore suggest that short-term pronunciation instruction can enhance learners' performance in controlled production tasks but may be insufficient to substantially modify well-established pronunciation patterns developed through prolonged first-language influence.

The results support the view that persistent pronunciation difficulties should be interpreted from multiple complementary perspectives rather than through a single theoretical framework. Interlanguage Theory provides an explanation for the relative stability of learner language, while the Speech Learning Model and the Perceptual Assimilation Model highlight the importance of perceptual category formation in second-language speech learning. The Markedness Differential Hypothesis further explains why phonological features that are absent from Arabic or involve greater structural complexity present continuing challenges for advanced learners. Together, these perspectives offer a more comprehensive account of pronunciation development than any single model in isolation.

An important contribution of the present study lies in its focus on advanced Jordanian university learners, a population that has received comparatively limited attention despite extensive formal exposure to English. By integrating established theories of second-language phonological acquisition with recent descriptions of Jordanian Arabic phonology, the study also provides a broader linguistic context for understanding persistent pronunciation patterns among Arabic-speaking learners.

The findings should be interpreted in light of several limitations. The study involved a relatively small sample drawn from a single university, and the instructional intervention extended over only eight weeks. In addition, pronunciation was assessed through a controlled word-list task, which may not fully reflect learners' performance in spontaneous speech. These factors limit the generalizability of the findings and suggest that caution is warranted when interpreting the persistence of pronunciation errors.

Future research would benefit from larger and more diverse participant samples, longitudinal designs that examine pronunciation development over extended periods, and the inclusion of spontaneous speech alongside controlled pronunciation tasks. Further studies may also investigate additional English phonological features and compare the effectiveness of different instructional approaches, particularly those that combine perceptual training with explicit phonetic instruction.

Pedagogical Implications

The findings have several implications for English pronunciation teaching in Arabic-speaking contexts. First, pronunciation instruction should begin early in the language-learning process before first-language phonological patterns become firmly established. Second, classroom instruction should combine explicit articulatory explanation with perceptual training that helps learners develop new phonetic categories rather than relying exclusively on repetitive production practice. Third, pronunciation should receive sustained attention throughout advanced language programs instead of being confined to introductory phonetics courses. Finally, targeted feedback on phonological features known to be problematic for Arabic-speaking learners—particularly /p/, /ŋ/, and complex consonant clusters—may contribute to gradual improvement when incorporated into regular communicative language instruction over an extended period.

Acknowledgments

The authors would like to express their sincere gratitude to the colleagues and academic peers who provided valuable comments and constructive feedback during the development of this study. Their insights helped improve the clarity and overall quality of the manuscript. We also extend our appreciation to those who assisted with data organization, proofreading, and technical support during the preparation of the research materials. Finally, we are grateful to all individuals who provided assistance in the preparation and formatting of the manuscript for submission.

Author contributions

Member	Position	Primary Contribution
Tamadur Al-Shamayleh	Faculty member	Project administration and supervision, critical manuscript review and editing, quality assurance, coordination among co-authors, responding to reviewers' comments, and serving as the corresponding author.
Mohammad Hanaqtah	Faculty member	Conceptualization of the study, development of the research design, preparation of the article outline, and writing of the Introduction.
Mheel Al-Smaiheeyen	Faculty member	Developing the Methodology, preparing the dataset/materials, and describing the data collection procedures.
Manar Abu Darwish	Faculty member	Performing Data Analysis, preparing tables and figures, and reporting the Results/Findings.
Fatima Al Qaisiya	Faculty member	Writing the Discussion, interpreting the findings, comparing them with previous studies, and explaining the theoretical and practical implications.
Yasmeen A. Abu-Taleb	Faculty member	Writing the Conclusion, outlining the study's limitations, providing recommendations for future research, formatting references, proofreading the manuscript, and ensuring compliance with the target journal's guidelines.

Funding

This research received no external funding.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Sciedu Press.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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