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A Phonetic Study of Consonant Cluster Simplification in ESL Learners

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Abstract

Consonant cluster simplification is a widely observed phonetic phenomenon among learners of English as a Second Language (ESL), particularly those whose first languages (L1s) restrict complex consonant sequences. This study investigates the patterns, types, and phonetic motivations behind consonant cluster simplification in ESL learners. The primary objective is to analyze how ESL learners modify English consonant clusters in onset and coda positions and to identify the influence of L1 phonotactic constraints on these simplification strategies. Using an acoustic and auditory phonetic approach, speech data were collected from ESL learners through controlled word-list reading and spontaneous speech tasks. The findings reveal that learners frequently employ simplification strategies such as consonant deletion, vowel epenthesis, and cluster reduction, especially in word-final and tri-consonantal clusters. These patterns are largely attributable to L1 transfer effects, articulatory difficulty, and limited exposure to native-like pronunciation norms. The study also demonstrates that proficiency level plays a significant role, with advanced learners exhibiting fewer simplification processes than intermediate learners. By highlighting systematic phonetic patterns in learner speech, this research contributes to the broader field of second language phonetics and provides pedagogical implications for pronunciation teaching. The findings emphasize the importance of explicit phonetic instruction and targeted pronunciation training to help ESL learners overcome persistent difficulties related to consonant cluster production.

Keywords: *consonant cluster simplification, ESL learners, phonetics, L1 transfer, pronunciation, second language acquisition*

1. Introduction

English phonology is distinguished by its allowance for complex consonant cluster structures, in which multiple consonants may co-occur within a single syllable, either in onset positions (e.g., *spring*, *street*) or in coda positions (e.g., *texts*, *strengths*) (Easterday 2017). Such phonotactic complexity is relatively uncommon across the world's languages, many of which favor simpler syllable structures, typically following a consonant–vowel (CV) pattern (Moreton, Pater et al. 2012). As a result, these consonant clusters present a considerable challenge for learners of English as a Second Language (ESL), particularly those whose first languages (L1s) do not permit similar sequences. One of the most frequently observed outcomes of this difficulty is consonant cluster simplification, a systematic modification of target-like consonant sequences in learner speech. Consonant cluster simplification refers to a range of phonetic and phonological processes through which ESL learners adjust complex consonant sequences to make them more compatible with their native phonological systems. These processes commonly include consonant deletion, vowel epenthesis, and segment substitution (Diani, Azwandi et al. 2021). For example, learners may omit one consonant from a cluster (*next* → *nex*), insert a vowel to break up the cluster (*school* → *iskool*), or replace unfamiliar consonants with more accessible ones. Importantly, such modifications should not be interpreted as random pronunciation errors. Rather, they reflect systematic strategies shaped by phonetic constraints, articulatory ease, perceptual limitations, and the influence of the learner's L1 phonotactic rules. Pronunciation plays a critical role in spoken communication, as it directly affects intelligibility, comprehensibility, and communicative success. Persistent difficulties in producing consonant clusters may lead to misunderstandings, reduced listener comprehension, and decreased confidence among ESL learners. Consequently, understanding how and why learners simplify consonant clusters is of both theoretical and pedagogical importance. From a phonetic perspective, consonant clusters demand precise coordination of articulatory gestures, timing control, and segmental accuracy. For learners who have limited exposure to such structures, achieving native-like production can be particularly challenging (Foster 2013).

A substantial body of research in second language phonetics and phonology has documented the prevalence of consonant cluster simplification among ESL learners from diverse linguistic backgrounds (Eckman 2004). Learners whose L1s include languages such as Urdu, Arabic, Chinese, and Japanese frequently experience difficulty with English consonant clusters due to structural differences between the L1 and English. In many of these languages, complex clusters are either highly restricted or entirely absent, especially in word-final positions (Cyran and Gruyter 2008). As a result, learners often apply familiar L1 syllable templates when producing English words, leading to predictable simplification patterns. For instance, final clusters such as /-sts/ or /-lvd/ are frequently reduced, while initial clusters are often modified through vowel insertion. These simplification strategies can be explained through the lens of L1 transfer, a well-established concept in second language acquisition research. L1 transfer occurs when learners rely on existing phonological knowledge from their native language to process and produce sounds in the target language (Verhoeven 2007). While this reliance can facilitate learning in some cases, it may also result in non-target-like pronunciations when the phonological systems of the two languages differ significantly. In the case of consonant clusters,

learners may unconsciously reshape English phonological patterns to align with their L1 constraints, thereby reducing articulatory and perceptual complexity (Madrid Valencia 2024). In addition to L1 influence, articulatory difficulty plays a crucial role in consonant cluster simplification. Producing multiple consonants in rapid succession requires advanced motor control and precise timing of speech organs. For ESL learners, especially at lower proficiency levels, such coordination may not yet be fully developed. Consequently, learners adopt simplification strategies as a means of reducing articulatory effort. These strategies often persist even at higher proficiency levels if learners do not receive explicit pronunciation instruction or sufficient corrective feedback. The present study aims to examine consonant cluster simplification in ESL learners from a phonetic perspective, focusing on how learners produce consonant clusters in both syllable onset and coda positions (Jabbari and Arghavan 2010). By employing a combination of descriptive and acoustic phonetic analysis, the study seeks to identify common simplification patterns and explore the underlying factors that motivate these patterns. Particular attention is given to the role of learner proficiency, as previous research suggests that pronunciation accuracy tends to improve with increased exposure and linguistic experience, although certain phonetic difficulties may fossilize over time. This research holds significance for both theoretical and applied linguistics. From a theoretical standpoint, it contributes to ongoing discussions concerning phonetic variation, L1 transfer, and the developmental nature of second language speech production (Zampini 2008). It also provides empirical evidence supporting models of second language phonetic acquisition that emphasize gradual learning and experience-based change. From an applied perspective, the findings offer valuable insights for ESL teachers, curriculum designers, and material developers (Shieh and Reynolds 2021). By identifying the most problematic consonant cluster structures and common learner strategies, educators can design targeted pronunciation instruction that addresses these difficulties more effectively (Alsuhaibani, Mahdi et al. 2024). In sum, consonant cluster simplification represents a key area of investigation within second language phonetics, as it lies at the intersection of phonological structure, articulatory constraints, and language learning processes. By exploring this phenomenon in depth, the present study seeks to enhance our understanding of ESL pronunciation patterns and to contribute to more effective approaches to teaching and learning spoken English (Levis and Grant 2003).

2. Literature Review

Research on consonant cluster simplification has been widely documented within the fields of phonetics, phonology, and second language acquisition (SLA), reflecting sustained scholarly interest in how learners cope with complex phonological structures in a second language (Engel de Abreu and Gathercole 2012). Consonant clusters are considered marked structures in many languages due to their articulatory and perceptual complexity, making them particularly vulnerable to modification in learner speech. As a result, cluster simplification has become a key area of investigation in understanding second language phonological development (McLeod, Van Doorn et al. 2001). Early phonological research emphasized the role of markedness theory in explaining consonant cluster simplification. Eckman's (1977) Markedness Differential Hypothesis proposed that linguistic structures that are more marked or complex in the target language than in the learner's L1 are more difficult to acquire (Eckman 1977).

According to this view, ESL learners are more likely to simplify consonant clusters that are typologically rare or absent in their native languages. Empirical studies have consistently supported this hypothesis, showing that learners struggle more with complex and less frequent cluster types, particularly those occurring in word-final positions. Closely related to markedness is the concept of L1 transfer, which has been identified as one of the most influential factors in consonant cluster simplification. Broselow (1984) demonstrated that learners often impose the phonotactic constraints of their L1 onto the target language, resulting in predictable simplification patterns (Broselow, Chen et al. 1998). Similarly, Major (2001) argued that interlanguage phonology reflects a dynamic interaction between universal phonetic principles and L1-specific constraints. Learners whose L1s restrict or prohibit word-final consonant clusters, such as Urdu and Arabic, frequently simplify English codas through consonant deletion or vowel insertion (Al-Yami, Al-Athwary et al. 2021). For example, clusters such as /-sts/ in *tests* or /-lvd/ in *solved* are often reduced to a single consonant, reflecting L1 syllable structure preferences. In addition to phonological explanations, phonetic factors, particularly articulatory complexity, have been shown to play a crucial role in cluster simplification. Producing consonant clusters requires fine-grained coordination of articulatory gestures, including precise timing and spatial control of the tongue, lips, and vocal folds. ESL learners, especially at early stages of acquisition, often lack the motor control necessary to produce such sequences fluently. Consequently, learners adopt simplification strategies to reduce articulatory effort. From this perspective, consonant cluster simplification can be viewed as an articulatory coping mechanism rather than merely a phonological constraint (Côté 2000).

Flege's Speech Learning Model (SLM) (1995) provides a valuable framework for understanding phonetic variation in cluster production (Gómez Mendoza 2017). According to the SLM, learners perceive and produce L2 sounds through the filter of existing L1 phonetic categories. When L2 segments or sequences are perceived as similar to L1 sounds, learners may fail to establish new phonetic categories, resulting in persistent non-target-like productions. In the case of consonant clusters, learners may approximate unfamiliar sequences using familiar articulatory patterns, leading to simplification through deletion or epenthesis. Recent research has increasingly employed acoustic phonetic analysis to examine the fine-grained properties of consonant cluster simplification. Studies utilizing spectrographic and temporal measurements have revealed that simplification is often gradient rather than categorical. Learners may partially realize clusters by shortening consonant durations, reducing closure intervals, or inserting brief transitional vowels between consonants. These findings challenge purely phonological accounts of cluster simplification and highlight the importance of phonetic detail in understanding learner speech. Acoustic evidence suggests that learners may attempt to produce clusters but fail to achieve native-like timing and coordination, resulting in modified outputs. Pedagogical research has also contributed significantly to the literature on consonant cluster simplification. Studies in applied linguistics indicate that pronunciation difficulties related to consonant clusters often persist into advanced proficiency levels, particularly when learners do not receive explicit pronunciation instruction. Derwing and Munro (2005) found that focused phonetic training and increased exposure to native input can lead to noticeable improvements in cluster production and overall intelligibility. However, in many ESL contexts, pronunciation

instruction is limited or marginalized, increasing the likelihood of fossilization, especially among adult learners. Despite the extensive body of research on consonant cluster simplification, several gaps remain. Many studies rely primarily on auditory analysis or controlled word-list tasks, offering limited insight into the acoustic properties of learner speech. Furthermore, there is a need for context-specific studies that examine how learners from particular linguistic backgrounds simplify clusters in both controlled and spontaneous speech. The interaction between proficiency level, phonetic detail, and simplification strategies also warrants further investigation. In response to these gaps, the present study adopts a combined auditory and acoustic phonetic approach to provide a more comprehensive analysis of consonant cluster simplification in ESL learners. By examining both onset and coda clusters and considering learner proficiency, this study seeks to contribute to a more nuanced understanding of how phonetic and phonological factors interact in second language speech production.

3. Methodology

3.1 Research Design

This study employs a descriptive and experimental phonetic research design, integrating both qualitative and quantitative approaches to investigate consonant cluster simplification in ESL learners. The descriptive component focuses on identifying and categorizing the types of simplification strategies employed by learners, while the experimental component examines how these strategies manifest under controlled and spontaneous speech conditions. Such a mixed-methods approach allows for a comprehensive analysis of both the observable phonetic patterns and the underlying factors influencing learner pronunciation. By combining auditory and acoustic analysis, the study ensures a detailed and reliable examination of consonant cluster production.

3.2 Participants

The participant group consisted of 20 ESL learners, selected through purposive sampling to ensure homogeneity in linguistic background. The learners were divided equally between intermediate and advanced proficiency levels, as determined by institutional placement tests and academic records. All participants shared a similar L1 background characterized by limited consonant cluster complexity, which provided an appropriate context for examining L1 transfer effects. The participants ranged in age from early adulthood to late twenties and had received formal English instruction for several years. None of the participants reported any speech, hearing, or neurological impairments that could affect speech production, ensuring the validity of the phonetic data.

3.3 Data Collection Instruments

Speech data were collected using two complementary tasks designed to capture both controlled and naturalistic pronunciation patterns. The first instrument was a word-list reading task, consisting of carefully selected English words containing consonant clusters in both syllable onset (e.g., *play*, *spring*, *street*) and coda positions (e.g., *next*, *tests*, *solved*). The word list included both bi-consonantal and tri-consonantal clusters to examine the effect of structural complexity on simplification strategies. The second instrument was a short spontaneous speech task, in which participants were asked to speak freely on familiar topics for two to three minutes. This task aimed to observe how consonant cluster simplification occurs in more natural communicative contexts, where learners have less opportunity to consciously monitor their pronunciation. All speech samples were recorded in a quiet

environment to minimize background noise. A high-quality digital audio recorder was used to ensure clarity and precision in capturing phonetic details. Participants were given brief instructions and practice trials prior to recording to reduce anxiety and ensure task familiarity.

3.4 Data Analysis

The collected speech data were analyzed using a two-stage analytical procedure. First, all recordings were subjected to auditory phonetic transcription using the International Phonetic Alphabet (IPA). This step involved careful listening to identify deviations from target-like consonant cluster production. Instances of cluster simplification were systematically coded and categorized. Second, acoustic phonetic analysis was conducted using speech analysis software to examine temporal features such as consonant duration and the presence of vowel epenthesis. Acoustic measurements provided objective evidence of phonetic variation and supported the auditory findings. Simplification strategies were classified into three main categories: consonant deletion, vowel epenthesis, and segment substitution. Quantitative analysis was used to calculate the frequency of each strategy across participants and cluster types, allowing for comparisons between proficiency levels. By integrating auditory judgment with acoustic measurement, the methodology ensures analytical rigor and enhances the reliability of the findings.

4. Results and Discussion

The analysis of the collected speech data reveals that consonant cluster simplification is a systematic and recurrent phenomenon among ESL learners rather than an incidental or random occurrence. Across both controlled word-list tasks and spontaneous speech samples, learners consistently modified complex consonant sequences using identifiable phonetic strategies. This finding supports the view that consonant cluster simplification represents an organized aspect of interlanguage phonology shaped by linguistic and articulatory constraints. One of the most prominent findings of the study is the asymmetrical distribution of simplification across syllable positions. Word-final (coda) consonant clusters exhibited a significantly higher rate of simplification compared to word-initial (onset) clusters. Clusters containing two or more consonants in coda positions, particularly those ending in /t/ and /d/, were most frequently simplified. For example, words such as *next*, *tests*, and *solved* were often realized as *nex*, *tes*, and *solve*, respectively. This pattern suggests that coda clusters impose greater articulatory and perceptual demands on learners, especially when multiple consonants require precise timing without intervening vowels.

Consonant deletion emerged as the most frequent simplification strategy, particularly in word-final contexts. Learners commonly deleted alveolar stops, such as /t/ and /d/, which are acoustically weak and require complete oral closure. This tendency aligns with previous phonetic research indicating that segments with low perceptual salience are more vulnerable to deletion in second language speech. The predominance of deletion in coda clusters further supports the influence of L1 phonotactic constraints, especially for learners whose native languages restrict or disallow complex word-final consonant sequences. In contrast, vowel epenthesis was more frequently observed in word-initial clusters. Learners often inserted a short vowel, typically a schwa-like sound, to break up complex onset clusters. As a result, words such as *spring* and *street* were produced as *espring* and *istreet*. This strategy reflects an attempt to restructure English syllables to

conform to a more familiar CV pattern, which is common in many learners' L1s. From a phonetic perspective, vowel insertion reduces articulatory difficulty by allowing smoother transitions between consonants. Acoustic phonetic analysis provided further insight into the nature of consonant cluster simplification. Even in cases where learners appeared to produce complete clusters, detailed temporal measurements revealed that consonant durations were significantly shorter than those produced by native speakers. Reduced consonant duration indicates challenges in articulatory timing and coordination rather than complete phonological absence. This finding supports gradient accounts of phonetic variation, suggesting that learners may attempt target-like production but fail to fully realize the articulatory gestures required for complex clusters. The analysis also revealed that learner proficiency level played a significant role in cluster production accuracy. Advanced learners demonstrated fewer instances of deletion and epenthesis and exhibited more native-like consonant durations compared to intermediate learners. However, even advanced learners showed persistent difficulty with highly complex clusters, particularly tri-consonantal codas. This suggests that while increased proficiency and exposure contribute to improved phonetic accuracy, certain cluster structures remain resistant to acquisition and may require explicit instruction.

The findings of this study are consistent with previous research emphasizing the role of L1 transfer and articulatory constraints in second language pronunciation. The observed simplification patterns closely mirror those reported in studies involving learners from languages with limited cluster complexity. Furthermore, the results support second language acquisition models that view phonetic development as a gradual and experience-dependent process, rather than a categorical shift from non-target to target forms. From a pedagogical perspective, the results highlight the importance of targeted pronunciation instruction focusing on consonant clusters, particularly in coda positions. Without explicit attention, these simplification strategies may fossilize, leading to persistent pronunciation difficulties. Overall, the findings underscore the need for pronunciation teaching approaches that integrate phonetic awareness, articulatory practice, and increased exposure to authentic spoken input.

5. Conclusion

The present study investigated consonant cluster simplification in ESL learners from a phonetic perspective, with the aim of identifying recurring simplification patterns and the factors that motivate them. The findings reveal that consonant cluster simplification is a systematic and predictable phenomenon shaped primarily by L1 phonotactic constraints, articulatory complexity, and learner proficiency level. Rather than representing random pronunciation errors, these simplification strategies reflect natural developmental processes within second language speech production. By employing both auditory phonetic transcription and acoustic analysis, the study provided a detailed account of how ESL learners modify complex consonant sequences in both syllable onset and coda positions. The results demonstrated that word-final clusters are particularly vulnerable to simplification, with consonant deletion emerging as the most frequent strategy, while vowel epenthesis was commonly used to ease articulation in onset clusters. Reduced consonant duration further indicated articulatory timing difficulties, even when clusters were partially realized. From a pedagogical standpoint, the findings highlight the need for explicit and systematic pronunciation instruction focusing on

consonant clusters, especially those that are absent or restricted in learners' L1s. Targeted phonetic training, combined with increased exposure to authentic spoken input, can help learners develop greater articulatory control and achieve more target-like pronunciation.

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