

Phonotactic Divergence and Consonant Cluster Adaptation in Javanese and English: A Contrastive Analysis

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ABSTRACT: This study examines consonant cluster patterns in Javanese and English through a contrastive phonological analysis. It focuses on phonotactic constraints cluster types, sonority sequencing, and repair strategies in cross-linguistic and bilingual contexts. Using corpus-based data and phonological inventories, the study identifies onset and coda combinations and evaluates their conformity to the Sonority Sequencing Principle (SSP). Javanese generally favors simple onset clusters such as C+r/l and s+{r,w}, while complex codas or CCC onsets appear mainly in loanwords. In contrast, English allows a wide variety of clusters, including s+stop+liquid sequences that often violate the SSP, and codas of up to four consonants. These typological differences are reflected in structural adaptations: Javanese and Indonesian speakers regularly apply vowel epenthesis to repair illegal clusters in both loanwords and interlanguage forms (e.g., /stress/ → /setres/, /spring/ → /sepering/). Dialectal variation within Javanese and cognitive control in bilinguals further shape these outcomes. The results show that Javanese conforms more strictly to the SSP and syllable templates, while English permits greater phonotactic flexibility. Repair strategies such as epenthesis, simplification, and truncation illustrate the interaction between native phonological rules and second language adaptation. These findings contribute to phonotactic theory, bilingual phonology, and language teaching by clarifying how learners adjust to foreign cluster structure.

Keywords: Consonant Clusters, Phonotactics, Sonority Sequencing Principle, Epenthesis, Bilingual Phonology, Javanese, English.



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INTRODUCTION

Languages differ greatly in how they organize permissible sound sequences. Phonotactics the rules governing allowable sound combinations provides a key lens of analysis. Consonant clusters,

defined as sequences of two or more consonants without an intervening vowel, are particularly revealing for comparative study. This study undertakes a contrastive analysis of consonant cluster patterns in Javanese and English, two typologically distinct languages, focusing on their phonotactic structures, conformity to the Sonority Sequencing Principle (SSP), and repair strategies in cases of language contact and interlanguage.

Cross linguistic typologies demonstrate substantial variation in how consonant clusters are formed and processed. For instance, Garman et al. (2020) document how Norwegian speakers often insert vowels to simplify initial clusters a strategy less frequent in English. Kwon et al. (2016) further demonstrate how articulatory timing differences shape the perception of clusters in a language specific manner. These findings suggest that consonant clusters differ not only in terms of phonemic inventory but also in their phonetic realization and processing across languages.

Phonotactic constraints are shaped by a complex interplay of language specific phonological rules and segmental preferences. Orzechowska (2016) highlights that the segmental properties of consonants, such as place and manner of articulation, significantly influence their combinability. Yin et al. (2023) emphasizes how these properties interact with broader phonological tendencies, particularly with respect to the SSP. The resulting typologies offer a window into the internal structure of syllables and their role in language variation.

A major phonological distinction between Javanese and English lies in their syllable templates. Javanese, a member of the Austronesian family, predominantly employs simple syllable patterns, favoring open CV structures. Irawan et al. (2024) emphasize that this simplicity aligns with a general preference in Austronesian languages to avoid complex clusters. In contrast, English, a Germanic language, permits a wide range of complex onsets and codas. This contrast has significant implications not only for linguistic theory but also for the processing and acquisition of phonological structure in bilingual or contact situations.

The Sonority Sequencing Principle (SSP) provides a theoretical lens for understanding consonant cluster arrangement. It posits that sounds within a syllable rise in sonority toward the vowel nucleus and then decrease. Languages vary in their adherence to this principle. According to Hülst et al. (2017), sonority differences play a key role in determining cluster legality. Orzechowska (2018) further notes that variations in sonority ranking across languages contribute to differences in permissible cluster types. Javanese tends to conform more strictly to SSP, while English often violates it, particularly in s+stop onsets such as /str / and /skw /.

In addition to phonological rules, orthographic systems significantly influence phonotactic awareness. Ven et al. (2022) show how spelling conventions and language specific orthographies shape perceptions of sound combinations. Freeman et al. (2021) extend this finding to second language learners, illustrating how orthographic familiarity can both support and constrain phonotactic processing. Such research underscores the need to consider orthographic influence when examining phonotactic phenomena across writing systems and languages.

The acquisition of phonological systems further highlights the divergence between Javanese and English learners. Fabiano-Smith & Cuzner (2017) show that while English learning children exhibit early consonant bias in lexical processing, Javanese children develop phonological sensitivity under different constraints due to the language's simpler cluster inventory. Nazzi et al. (2016) report that such biases emerge later in English acquiring infants than might be expected, pointing to language specific timelines for phonological development. This aligns with structural properties of Javanese phonology and may explain differences in the adaptation of foreign cluster forms.

This study aims to explore these contrasts through a structured analysis of cluster inventories and syllable templates in Javanese and English. It also investigates the application and violation of the SSP, especially in complex onset and coda environments. Finally, the study examines how speakers of Javanese/Indonesian respond to English phonotactic forms through epenthesis and related repair strategies. By comparing native structures and cross linguistic adaptations, this work contributes to a deeper understanding of phonotactic systems, language contact, and second language phonology.

METHOD

This study adopts a comparative phonological approach to explore the structural constraints governing consonant clusters in Javanese and English. It analyzes cluster inventories, sonority patterns, and phonotactic repair mechanisms using both descriptive and corpus based methods. Data were extracted from language corpora and annotated manually and computationally. The framework also incorporates language contact phenomena through the study of adapted loanwords and interlanguage forms.

For Javanese, corpora were compiled from jv.wikipedia and the Djaka Lodang digital archives, supported by the Indonesian Corpus and Multilingual Corpus of Language Rights (Rakun et al., 2022). These resources provided authentic, syllabified lexical entries reflecting a range of dialectal and orthographic variations.

English data were sourced from the Cambridge English Pronouncing Dictionary (EPD), the Corpus of Contemporary American English (COCA), and the CELEX lexical database. These resources offered phonetic transcriptions and distributional frequencies of cluster forms (Forkel et al., 2018).

Praat was employed for phonetic analysis and waveform visualization (Cychosz et al., 2021). Sonority based annotations were conducted using syllable parsing and visualization tools within ELAN and Transcriber, aiding in mapping sonority contours within clusters.

To test conformity to the SSP, each consonant cluster was annotated using a sonority scale ranking common in phonological literature. Annotated segments were compared to theoretical predictions,

identifying both SSP conforming and violating sequences. This method reflects empirical procedures discussed in Hamza et al. (2023).

Clusters were classified into onset (2C, 3C) and coda (1C–4C) categories. Each cluster was tagged for:

- Cluster type (e.g., stop+liquid, s+stop)
- Frequency and productivity
- Source (native vs. borrowed)
- Sonority profile
- Repair mechanism (if applicable)

Epenthesis detection was based on consistent structural deviations from native phonotactics in adapted forms. These were identified using tagged corpora with operational definitions derived from phonotactic literature. Speech samples containing cluster simplifications were evaluated using a manual classification system and inter rater validation (Vyatkina, 2016).

Epenthetic strategies were categorized as:

- Prothetic vowel insertion (e.g., /club/ → /kelab/)
- Medial vowel insertion (e.g., /spring/ → /sepering/)
- Coda simplification (e.g., /sixths/ → /siks/)

Frequencies of cluster types and epenthesis patterns were compared against expected phonotactic norms. Quantitative modeling included frequency distributions, relative productivity of cluster types, and rates of SSP violations. Historical data and corpus based trend tracking provided further insight into phonotactic evolution in contact settings (Rathje et al., 2024).

The methodology integrates corpus linguistics, phonological theory, and computational tools to analyze consonant cluster structures in Javanese and English. It systematically evaluates phonotactic constraints, sonority sequencing, and adaptation behaviors using both empirical and theoretical perspectives. These methods lay the groundwork for robust comparative analysis across typologically distinct language systems.

RESULT AND DISCUSSION

Javanese Cluster Patterns

The inventory of onset clusters in Javanese primarily includes CC clusters such as /kr/, /st/, and /kl/, with CCC forms like /str/ and /spr/ appearing predominantly in borrowed words (Jayanti et al., 2023). Gusdian (2019) affirm that CCC structures are rare in indigenous phonology and more typical in loanwords. Dialectal variation also affects cluster preferences; Saputra & Masykuri

(2023) note that dialects like Surabaya accept broader CC types compared to Yogyakarta. Such variation illustrates sociophonological diversity within Javanese.

Table 1. Javanese Cluster Inventory by Type and Source

Cluster Type	Example	IPA	Native or Loan	Notes
C + Liquid	praja	/pra.dʒa/	Native	Productive onset cluster
C + Lateral	klambi	/kla.mbi/	Native	Supported by orthography
s + Liquid/Glide	srawun g	/sra.wu ŋ/	Loan (Sanskrit)	Common in classical borrowings
CCC	skripsi	/skri.ps i/	Loan (English)	Appears mostly in technical terms
Prenasal Obstruent	+ nderek	/nde.rɛ k/	Native	Debated: unit vs. cluster

English Cluster Range

English phonotactics permits a broad range of clusters in both onset and coda positions. Common onsets include /str/, /tr/, and /sp/, while frequent codas include /mp/, /kt/, and /ld/ (Wiese et al., 2017). These combinations appear widely in corpora such as the British National Corpus.

Cluster frequency correlates with lexical distribution: highly frequent clusters in common words (e.g., "street," "glass") become phonologically entrenched (Wiese et al., 2017). Less frequent clusters, by contrast, may pose perceptual or articulatory challenges.

Morphologically, complex codas often cross morphemic boundaries. Orzechowska et al. (2019) emphasize how morphological affixation contributes to coda complexity and affects stress and syllable structure.

Table 2. English Cluster Inventory with Frequency and Notes

Cluster Type	Example	IPA	Frequency	Notes
CC Onset	play	/pleɪ/	High	Stop + liquid; very productive
CCC Onset	street	/stri:t/	High	Frequent despite SSP violation
CC Coda	help	/help/	High	Common word final combination
CCC/CCCC Coda	texts	/tɛkst s/	Moderate	Morphologically derived; complex articulation

In second language contexts, learners with restrictive native phonotactics (e.g., Javanese or Mandarin) simplify English clusters via epenthesis or deletion. Studies by Wardani & Suwartono

(2019) confirm that L1 constraints guide cluster adaptation, often reducing sC or final CCC clusters.

SSP Patterns

SSP is variably observed cross linguistically. While many languages support it, exceptions are common especially in contact languages and dialects (Anandakiththi, 2021). Nikolaev & Grossman (2020) stress that social and linguistic environments modulate sonority patterns.

English shows frequent SSP violations in s+stop clusters (e.g., /fl/, /sn/, /sp/). Nikolaev (2023) relate these to diachronic phonological changes and persistent lexical patterns. Klok (2024) traces sC origins to Proto Germanic processes, illustrating the historical embedding of phonotactic irregularities.

Javanese generally adheres to SSP except in borrowed CCC clusters. Second language learners facing SSP violations such as in /speak/ or /street/ often apply repair strategies (Wiese et al., 2017).

Table 3. SSP Conformity in Select Cluster Examples

Language Cluster IPA			SSP Status Source	
Javanese	pr	/pra.dʒa/	Conforms	Native onset
Javanese	skr	/skri.psi/	Violates	Loanword
English	str	/stri:t/	Violates	Native lexicon
English	pl	/pleɪ/	Conforms	Canonical pattern

Repair Strategies

Epenthetic vowel strategies vary by language. In Javanese and Indonesian, schwa like /ə/ is the dominant insert to mediate illicit clusters (Bahar et al., 2025). This maintains phonotactic harmony without disrupting syllabic structure.

Lexical borrowings and interlanguage data differ in repair behavior. Spontaneous epenthesis in interlanguage (e.g., /spring/ → /sepering/) is more variable than systematic epenthesis in adapted loanwords (Herawati & Setiyadi, 2021).

Table 4. Examples of Epenthetic Repair in Javanese/Indonesian

Source Word	Adapted Form	Strategy	Cluster Repaired	Notes
stress	setres	Prothetic epenthesis	CCC Onset	Preserves stress pattern
club	kelab	Prothetic schwa	CC Onset	Adds vowel at word onset
spring	sepering	Medial epenthesis	CCC Onset	Breaks up cluster with vowel
sixths	siks	Truncation	CCC/CCCC Coda	Simplifies final cluster

Perceptual salience determines epenthesis choice: learners opt for acoustically familiar vowels that align with their L1's vowel inventory (Orzechowska et al., 2019; Bahar et al., 2025).

Stress preservation through epenthesis is evident in Indonesian adaptations. Inserting a vowel helps maintain rhythmic integrity in stress bearing syllables (Cummings & Thompson, 2019). This reflects phonological alignment with Javanese and Indonesian speaking norms.

This study offers an in depth contrastive phonological analysis of Javanese and English, focusing on consonant cluster patterns, phonotactic constraints, and repair strategies used in response to phonotactic violations. The findings reveal fundamental and consistent asymmetries between the two languages, driven by internal phonological systems, diachronic development, sociolinguistic variation, and bilingual influence. The following discussion elaborates on these divergences, consistently linking them to the study's empirical data and relevant theoretical models.

Javanese demonstrates a marked preference for simple, permissible onset clusters, typically those following C+r/l and s+r/w configurations. These clusters are firmly embedded in the native phonotactic system. In addition, prenasalized segments such as /mb/ and /nd/ are frequent and phonologically integral. These forms reflect Javanese's alignment with cohesion and sonority based principles in cluster formation. The absence of complex CCC onset clusters in native vocabulary and their limited occurrence only in loanwords further confirms Javanese's structural tendency toward phonotactic conservatism. The language's core syllable template (C)(C)V(C) inherently restricts the range of cluster formations and favors simplicity over flexibility.

In contrast, English presents a much broader phonotactic range. It accommodates a rich inventory of both onset and coda clusters, including up to three consonants in the onset (e.g., /str /) and four in the coda (e.g., /lps/, /ksts/). Many of these combinations violate the Sonority Sequencing Principle (SSP), particularly those involving initial /s/ plus a stop, followed by a liquid or glide. The persistence of these clusters is often attributed to morpholexical regularization and long term entrenchment from Proto Germanic roots. These historical factors have endowed English with a high tolerance for SSP violations, enabling it to maintain complex phonotactic forms across lexical categories.

The difference in SSP conformity is particularly striking. Javanese onset clusters typically exhibit a clear sonority rise toward the syllabic nucleus, in line with traditional SSP principles. However, English tolerates exceptions, especially in high frequency clusters. This tolerance reflects broader

phonological priorities in English that favor structural economy and lexical familiarity over strict sonority sequencing. In bilingual settings, this contrast often leads to perceptual and productive challenges for learners whose L1 adheres more strictly to the SSP.

Phonotactic repair strategies, particularly epenthesis, serve as adaptive mechanisms in Javanese and Indonesian. The insertion of schwa like vowels, either at the beginning (prothesis) or within clusters (medial epenthesis), helps speakers conform to native syllable constraints while preserving intelligibility and rhythm. These adaptations are not arbitrary; they reflect perceptual preferences rooted in the native phonological system and are influenced by factors such as syllable weight, stress preservation, and acoustic familiarity. For example, adapting "stress" as /setres/ demonstrates a dual function: repairing an illicit cluster while preserving prosodic contours.

Sociophonological variation within Javanese dialects further complicates the picture. Dialects like Surabaya are known to permit a wider variety of CC clusters, while others like Yogyakarta are more restrictive. This dialectal diversity suggests that cluster permissibility is not uniform but contextually mediated through regional speech norms and contact induced variation. These differences underscore the importance of viewing Javanese phonotactics as a dynamic, evolving system rather than a fixed constraint set.

Theoretical models help elucidate how native phonotactic constraints persist in bilingual speech. The Cognitive Control Model and WEAVER++ suggest that bilinguals continuously regulate cross linguistic interference and maintain activation of L1 constraints during speech planning and production (Freeman et al., 2016, 2017). These models argue that bilinguals do not fully suppress one system in favor of another but rather navigate between them, often resulting in interlanguage forms that reflect structural compromise.

Languages inherently negotiate a balance between systemic constraints and flexibility. Kilpatrick et al. (2019) show that speakers of languages with rigid phonotactic systems (e.g., Japanese) exhibit difficulty when producing phonemes that violate their L1 rules, even when learning a more permissive language like English. Javanese displays similar tendencies: prioritizing structural consistency and rule governed combinations while occasionally integrating borrowed forms through repair. These phonological negotiations support the idea that phonotactic flexibility is not uniform but highly language specific.

The pedagogical implications of cluster adaptation in second language learning are significant. Adaptations like vowel epenthesis help L2 learners approximate unfamiliar clusters, but they can affect intelligibility, especially across linguistic boundaries. Leeuw et al. (2019) document how Spanish speakers insert a vowel before English sC clusters (e.g., "sport" → "esport"), a strategy echoed in Javanese and Indonesian learners. While such modifications can improve pronunciation comfort, they may impede mutual intelligibility with native English listeners. Recognizing these patterns allows educators to develop targeted interventions that balance phonological ease with communicative clarity (Souza, 2017).

Moreover, contact induced phonological change has long term implications. Gosselin (2022) and Stoeckert et al. (2017) observe that bilingualism can lead to lasting restructuring of phonotactic norms. When speakers of Javanese frequently adapt English forms through epenthesis or truncation, these patterns may become ingrained, particularly among heritage speakers. This dynamic can generate hybrid phonotactic forms that blur the boundaries between L1 and L2, influencing both formal and informal registers.

In sum, this discussion underscores the deep and multifaceted differences in phonotactic architecture between Javanese and English. These differences manifest through cluster inventory profiles, sonority principles, adaptation mechanisms, dialectal variation, and bilingual processing. From both structural and cognitive perspectives, the analysis affirms the resilience of native phonological systems even amidst linguistic contact and acquisition pressures. Ultimately, the findings contribute to broader debates in phonological theory, interlanguage development, language pedagogy, and sociophonetic research.

CONCLUSION

This study highlights the key phonotactic contrasts between Javanese and English, particularly in consonant cluster structures, their conformity to the Sonority Sequencing Principle (SSP), and repair strategies. Javanese demonstrates a strong preference for simple, sonority-conforming clusters and a tightly regulated syllable template, while English exhibits greater tolerance for complex onsets, codas, and frequent SSP violations.

The findings also reveal that adaptation strategies such as vowel epenthesis, simplification, and truncation are systematically employed by Javanese and Indonesian speakers to accommodate non-native clusters. These strategies reflect both structural constraints of the native system and cognitive adjustments in bilingual contexts. Dialectal variation and bilingual influence further shape how cluster forms are processed and integrated.

Overall, this research contributes to phonotactic theory and bilingual phonology by illustrating how language-specific rules interact with cross-linguistic adaptation. It also offers practical insights for second language instruction, showing how awareness of native phonotactic constraints can inform more effective teaching strategies in managing consonant cluster acquisition.

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