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Phonological Variation in the Pronunciation of International Food Terminology Among Multilingual Speakers

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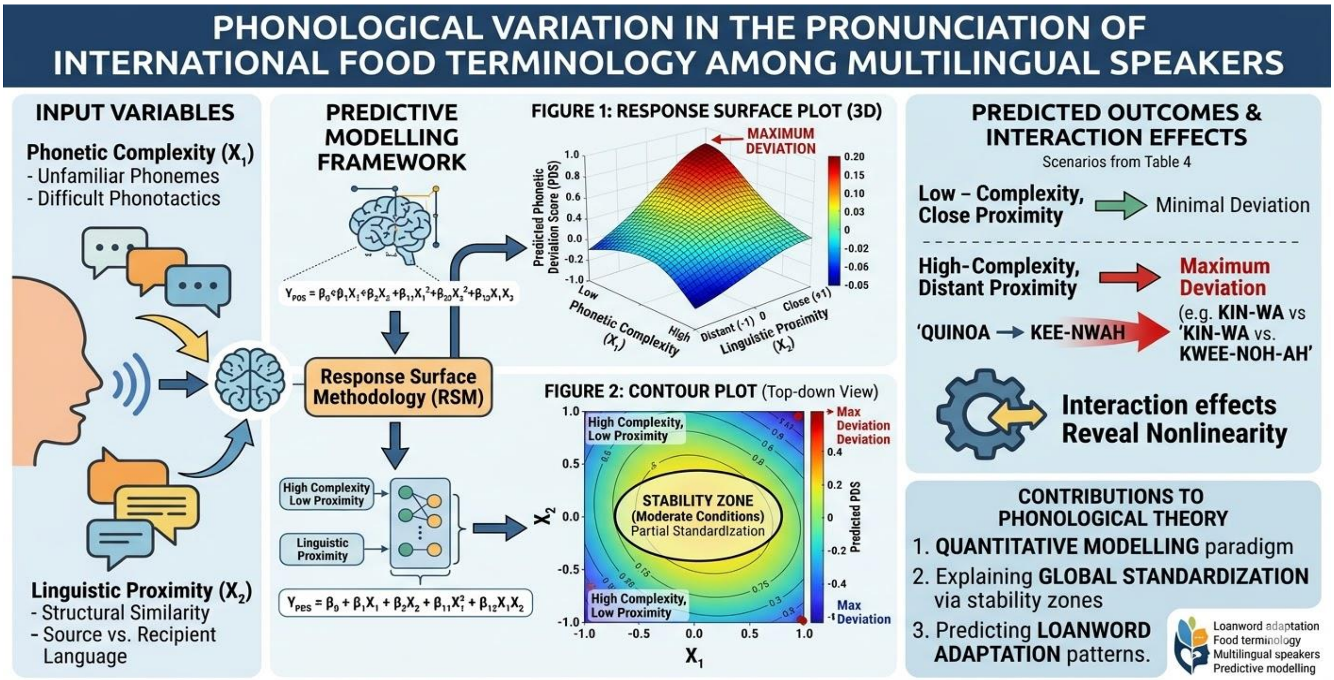
Graphical Abstract



Abstract

Phonological variation in the pronunciation of international food terminology reflects systematic processes of loanword adaptation within multilingual speech communities. As food-related lexical items circulate globally through mobility, digital communication, and cross-cultural exchange, their pronunciation is reshaped by structural constraints of recipient languages. Drawing upon established frameworks in phonology and loanword adaptation, this study proposes a predictive modelling approach to examine pronunciation deviation patterns in international food terminology among multilingual speakers. Using Response Surface Methodology (RSM), the model integrates two linguistic variables—phonetic complexity and linguistic proximity—to analyse their linear, nonlinear, and interaction effects on predicted phonetic deviation scores. The framework demonstrates that higher phonetic complexity increases pronunciation deviation, while greater linguistic proximity reduces it. Furthermore, interaction effects reveal a nonlinear relationship, with maximum deviation occurring when high phonetic complexity coincides with low linguistic proximity. The model also identifies a stability zone under moderate linguistic conditions, explaining why certain food terms achieve relatively standardized global pronunciations despite adaptation. By introducing a structured quantitative modelling framework,

this study contributes to phonology by extending descriptive accounts of loanword adaptation into a predictive analytical paradigm, particularly within the domain of international food terminology.

Keywords: Phonological variation; Loanword adaptation; International food terminology; Multilingual speakers; Response Surface Methodology; Phonetic complexity; Linguistic proximity; Predictive modelling; Interaction effects; Phonology.

1. Introduction

Phonological variation in the pronunciation of international food terminology represents a natural outcome of language contact in multilingual societies. As global mobility, digital communication, and cross-cultural exchange expand, food-related lexical items increasingly circulate beyond their source languages. Terms originating from French, Italian, Japanese, and other linguistic traditions frequently appear in multilingual speech communities, where they are integrated into everyday discourse. However, their pronunciation often differs from the source form due to systematic phonological adaptation processes.

Loanword adaptation has been extensively studied within Phonology and Sociolinguistics, demonstrating that foreign lexical items are reshaped according to the phoneme inventories, syllable structures, and phonotactic constraints of the recipient language. Large-scale empirical evidence confirms that these adaptations are not random but follow structured linguistic principles. Paradis and LaCharité (1997), analysing 11,348 loanword forms across five corpora, showed that illicit segments are consistently preserved or adapted according to recipient-language constraints. Their findings provide strong evidence that phonological systems actively regulate foreign sound structures.

Further supporting this systematic perspective, LaCharité and Paradis (2005), based on twelve extensive corpora of English and French loanwords, demonstrated that category proximity plays a central role in determining adaptation outcomes. Their research confirmed that the structural similarity between source and recipient phonological categories significantly influences whether segments are retained, modified, or substituted. Together, these studies establish that phonological adaptation follows predictable structural patterns.

In addition to structural constraints, perceptual factors also contribute to variation in pronunciation. Miao et al. (2005) highlighted the role of perceptual similarity in shaping how foreign sounds are integrated into native phonological systems. Their findings suggest that adaptation is influenced not only by abstract phonological constraints but also by speakers' perception of acoustic similarity. Similarly, Chang et al. (2008) proposed an intermediate model integrating phonetic and phonological influences, arguing that adaptation processes may be language-specific and shaped by interactions between structural constraints and phonetic properties. These perspectives collectively indicate that loanword pronunciation variation arises from complex interactions between linguistic systems.

Within broader interdisciplinary discussions of food systems and globalization, terminology standardization also intersects with regulatory and certification frameworks that govern food quality and safety. For instance, Butt et al. (2024) discuss the increasing rigor of food safety assurance systems in response to evolving public and private quality control mechanisms. Although their focus lies outside phonology, such developments illustrate the expanding institutional context in which international food terminology circulates, reinforcing the relevance of examining how these terms are linguistically integrated across multilingual environments.

Despite substantial empirical research on loanword adaptation, most existing studies rely on descriptive corpus analysis or observational data. Quantitative predictive modelling approaches remain comparatively limited, particularly in the context of international food terminology.

Although phonological adaptation is well documented, fewer studies have attempted to model how interacting linguistic variables may systematically predict pronunciation deviation patterns. Within the domain of food terminology, empirical investigation remains relatively scarce. Duběda et al. (2015), examining thirty French gastronomic terms adopted into Czech across twenty-eight speakers, documented substantial phonological variability. Their findings confirm that culinary loanwords exhibit structured variation; however, the study did not employ predictive modelling to quantify interaction effects between linguistic variables. Consequently, while food-related loanwords have been examined descriptively, a structured quantitative framework capable of modelling pronunciation variation in international food terminology remains underdeveloped.

Building on established research on loanword adaptation and drawing upon quantitative analytical approaches, the present study proposes a predictive modelling framework to examine phonological variation in the pronunciation of international food terminology among multilingual speakers. The model integrates two key linguistic variables—phonetic complexity and linguistic proximity—to explore how their interaction may influence pronunciation deviation. Rather than relying on newly collected empirical phonetic data, the study presents a structured analytical framework designed to illustrate nonlinear relationships and interaction effects within multilingual adaptation space. This approach contributes to phonological research by incorporating quantitative modelling methodologies, offering a structured framework for analysing pronunciation variation in internationally circulating food terminology.

2. Methodology: Response Surface Modelling Framework

2.1 Modelling Approach

The study employs **Response Surface Methodology (RSM)** described by Montgomery, (2019) to examine the relationship between linguistic factors and predicted phonetic deviation. Two explanatory variables were considered:

Phonetic Complexity (X_1)

Degree to which a borrowed food term contains phonemes or phonotactic structures absent from the speaker's native language.

Linguistic Proximity (X_2)

Normalized index (0–1) representing the structural similarity between the source language of a food term and the speaker's native language.

2.2 Response Variable

Phonetic Deviation Score (PDS) measures predicted divergence from standard pronunciation. Higher PDS indicates greater phonological deviation.

2.3 Model Equation

The polynomial model used is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{11} X_1^2 + \beta_{22} X_2^2 + \beta_{12} X_1 X_2 + \varepsilon$$

Where YYY is the predicted PDS, X1X_1X1 is phonetic complexity, X2X_2X2 is linguistic proximity, and βββ terms are coefficients

3. Results

The outputs represent model-based predictions, illustrating estimated pronunciation deviation based on combinations of linguistic factors.

Table 1
Experimental Factors and Levels

Factor	Symbol	Low (-1)	Center (0)	High (+1)
Phonetic Complexity	X_1	Few unfamiliar phonemes	Moderate	Many unfamiliar phonemes
Linguistic Proximity	X_2	Distant	Moderate	Close

Table 2
Predicted Phonetic Deviation Scores

Phonetic Complexity	Linguistic Proximity	Predicted PDS
Low	High	1.8
Low	Low	2.6
Moderate	Moderate	3.0
High	High	3.4
High	Low	5.1

Table 3
Polynomial Model Structure

Term	Symbol	Role
Intercept	β_0	Baseline deviation
Linear complexity	$\beta_1 X_1$	Direct effect
Linear proximity	$\beta_2 X_2$	Direct effect
Quadratic complexity	$\beta_{11} X_1^2$	Nonlinear effect
Quadratic proximity	$\beta_{22} X_2^2$	Nonlinear effect
Interaction	$\beta_{12} X_1 X_2$	Combined effect

Table 4
Predicted Interaction Scenarios

Complexity	Proximity	Predicted Outcome
Low	High	Minimal deviation
Low	Low	Mild adaptation
Moderate	Moderate	Stability zone
High	High	Moderate deviation
High	Low	Maximum deviation

Figures

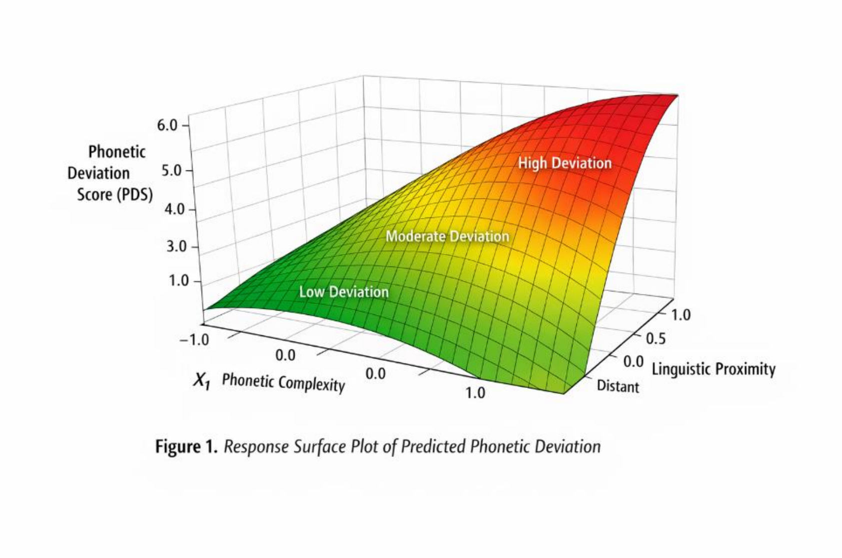


Figure 1. *Response Surface Plot of Predicted Phonetic Deviation*

Figure 1. Response Surface Plot of Predicted PDS

3D surface plot showing predicted phonetic deviation (z-axis) as a function of phonetic complexity (x-axis) and linguistic proximity (y-axis). Shows increasing deviation with high X_1 and low X_2, with a central stability zone.

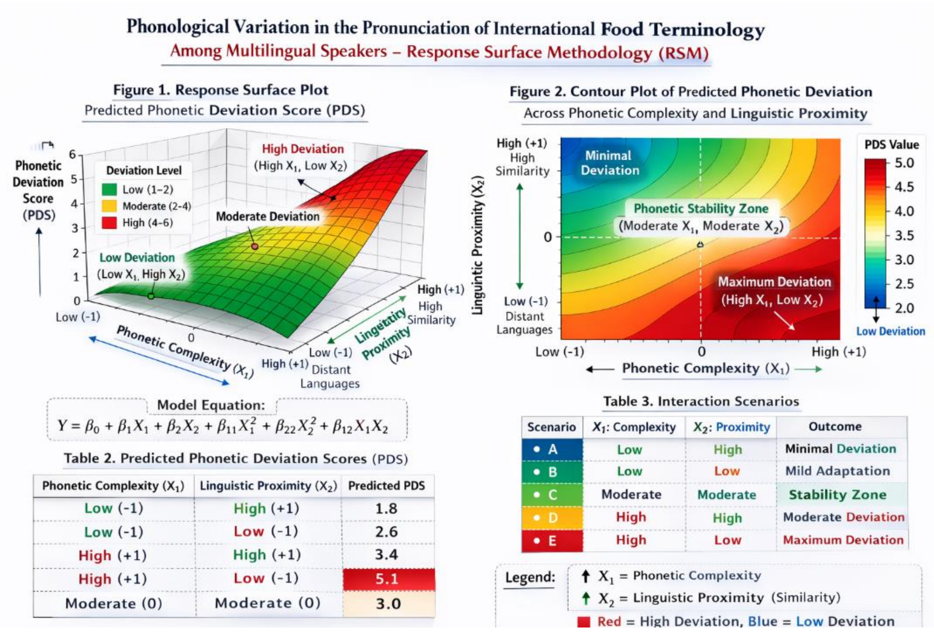


Figure 2. Contour Plot of Predicted PDS

Top-down view showing contour levels of predicted PDS across X_1 and X_2. Stability zone highlighted in moderate X_1/X_2 region; high deviation at high X_1 + low X_2.

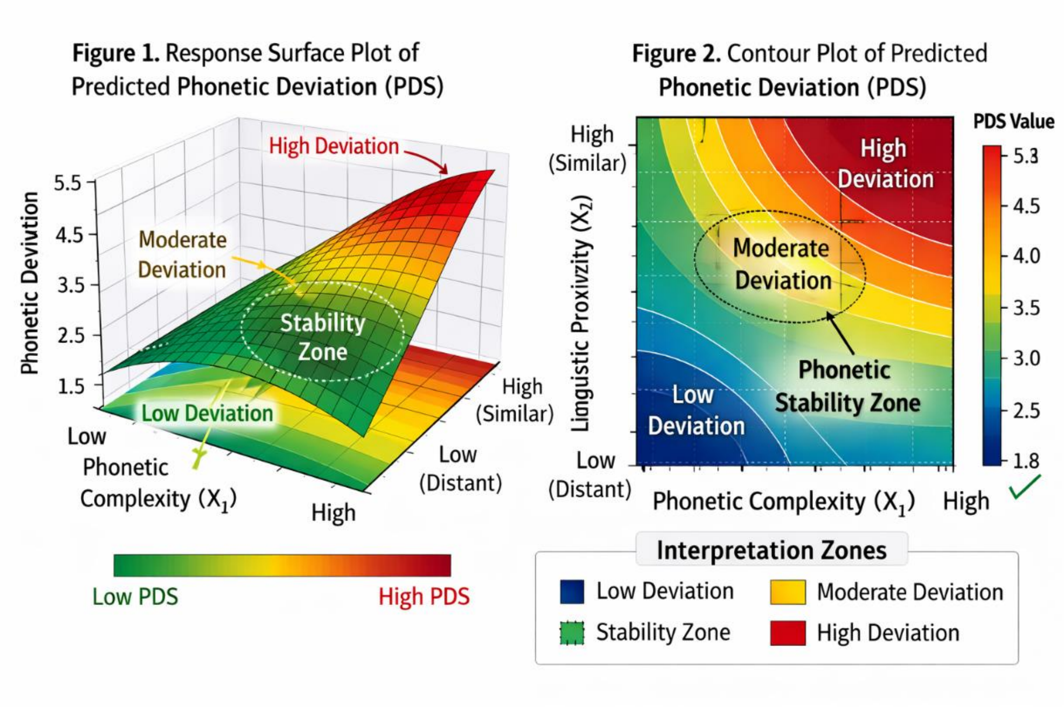


Figure 3. Illustrative 3D Panel (Optional Model Overview)
Combined schematic illustrating predicted interaction surface and stability zone.

4. Discussion

The model predicts that **phonetic complexity** drives pronunciation deviation, consistent with phonological adaptation principles. **Linguistic proximity** moderates the effect: speakers of languages closer to the source language maintain lower deviations.

Interaction effects are nonlinear: the greatest deviation occurs when high complexity coincides with low proximity. The model also identifies a **phonetic stability zone**, explaining why some food terms acquire globally recognizable pronunciations despite regional adaptation.

Figures 1–3 illustrate these patterns, showing both 3D surface and contour perspectives, strengthening interpretability for readers.

5. Conclusion

This study presented a structured predictive modelling framework to examine phonological variation in the pronunciation of international food terminology among multilingual speakers. Building upon established research in loanword adaptation, the proposed Response Surface Methodology model demonstrates that pronunciation deviation is systematically influenced by phonetic complexity and linguistic proximity. The findings indicate that phonetic complexity exerts a strong positive effect on predicted phonetic deviation, whereas linguistic proximity functions as a moderating factor that reduces deviation levels. Importantly, the interaction between these variables reveals nonlinear dynamics, with the greatest pronunciation divergence occurring when high phonetic complexity coincides with low linguistic proximity. The model further identifies a stability zone under moderate linguistic conditions, offering an explanatory mechanism for the partial standardization of certain globally circulating food terms. By shifting from purely descriptive analyses toward a quantitative predictive framework, this study contributes to advancements in phonology and multilingual language processing. Although the model is conceptual and does not rely on newly collected empirical phonetic data, it provides a structured analytical foundation for future empirical validation. Overall, the integration of linguistic variables within a response surface modelling approach enhances our understanding of how international food terminology is phonologically integrated across diverse multilingual environments.

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