

Interdental Substitution and the Role of Constriction Length

Leah Sternefeld
University of Oxford

This study examines why speakers of different first languages substitute the English interdental /θ/ with either /s/ or /t/. We test the novel hypothesis that the **constriction length** of /t/ in the speaker's L1 predicts their substitution pattern. Specifically, we argue that shorter constriction lengths in the L1 /t/ make it less suitable as an interdental substitute, while longer constriction lengths make stop-based substitution more likely. Following previous work, this study thus considers how non-contrastive phonetic detail in the L1 shapes the acquisition of novel L2 sounds.

Background: The hypothesis is motivated by the observation that both laminal and dental stops have frequently been reported as substitutes for interdentals, while apical or alveolar stops have not (Brannen 2011). We propose that the relevant factor that unites these articulatory patterns is *constriction length*. Dental stops are rarely produced with a purely apical closure and minimal tongue-blade contact; instead, they involve a relatively large constriction. Likewise, laminal stops, regardless of their place of articulation, typically engage a large part of the tongue surface. Both articulations therefore share a comparatively long constriction length, whereas apical stops create only a short constriction.

Methodology: Articulatory and acoustic data were collected from 6-10 speakers of five L1s (German, Dutch, Turkish, Egyptian Arabic, and Moroccan Arabic), selected to represent different substitution patterns and L1 /t/ articulations. Static palatography was used to document native /t/ and /s/ in controlled phonological environments. Substitution patterns were determined empirically from a production task in which the same speakers produced English materials containing interdentals, which were subsequently analysed. Constriction length of /t/ was measured as a percentage (see Figure 1) and z-scored for analysis. A linear mixed-effects model with Language, Syllable position, Gender, and Vowel as fixed effects and random intercepts for Speaker and Item was used to analyse differences in constriction length. A logistic regression then tested whether this measure predicts /θ/-substitution patterns.

Results: The findings partially support the hypothesis. Languages that substituted /θ/ with /t/ showed consistently long constriction lengths due to dental or laminal /t/ articulations (see Figure 2). German, with short apical constrictions, patterned as expected by substituting /θ/ with /s/. Egyptian Arabic speakers, despite using /s/ as a substitute, showed constriction lengths that did not differ statistically from the /t/-languages Dutch, Turkish, and Moroccan Arabic, and thus do not align cleanly with the hypothesis. Even so, a logistic regression on z-scored constriction lengths revealed a significant positive relationship between constriction length and /t/-substitution ($p < .001$), though this effect should be interpreted with caution given the small sample size.

Conclusion: Constriction length appears to play a role in shaping interdental substitution patterns, but it cannot be the only factor. Languages with relatively long /t/ constrictions tend to show more /t/-based substitutions, while those with shorter constrictions more often favour /s/. Egyptian Arabic remains an exception: despite using /s/ as a substitute, its constriction lengths do not differ from those of languages that show /t/-substitution. Future work with larger samples and additional languages will be needed to assess the robustness of these trends and clarify the factors that shape L2 interdental substitution in L1–L2 mapping models.

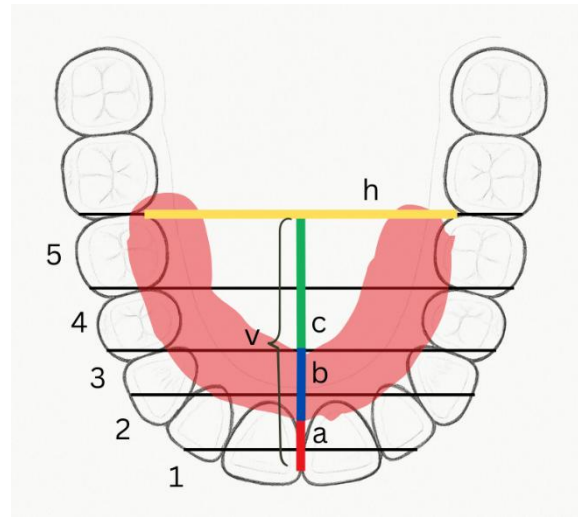


Fig. 1. Illustration of the measurement of normalised constriction length (b), defined as the proportion of contact relative to the total length (v), measured from the tip of the front incisors to a line (h) between the first and second molars.

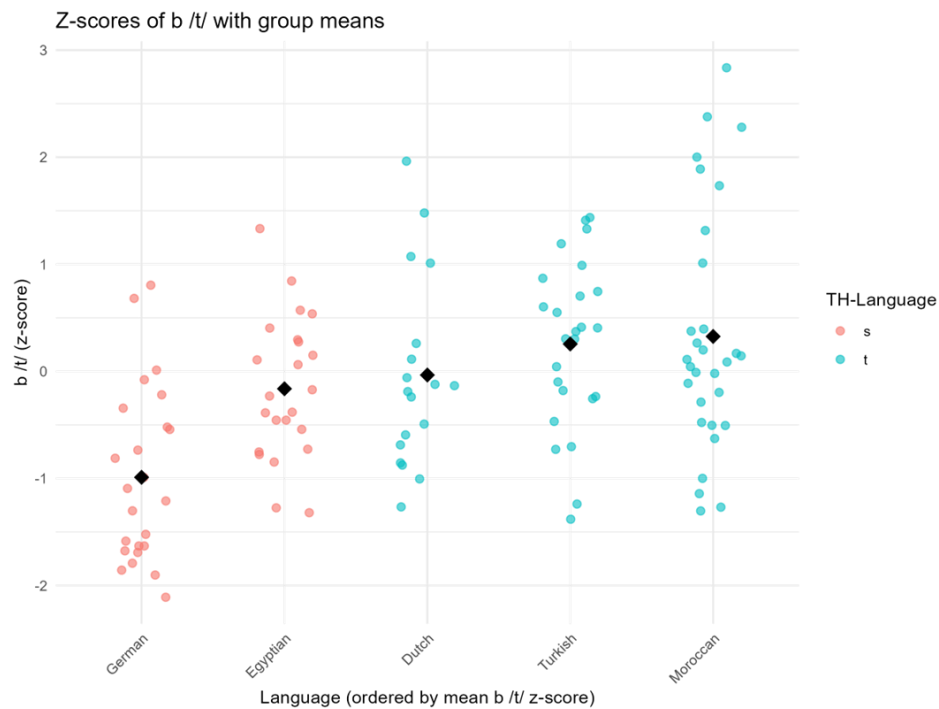


Fig. 2. Mean constriction length (b) by L1, ordered from smallest to largest. Colours indicate substitution patterns confirmed in the production task (red = /s/-substituting, blue = /t/-substituting).

References

- [1] Brannen, Kathleen J. (2011). The perception and production of interdental fricatives in second language acquisition. PhD thesis, McGill University.