Phonological processes in code-mixed utterances:
a study of tapping by English-Spanish bilinguals

Introduction: A phonological rule A → B / X__Y has the *structural description* XAY, composed of the *target* A and the *environment* X__Y. For example, the English cross-word tapping rule, roughly {t,d} → ɾ / V__#V, has the target {t,d}, and environment V__#V. There has been limited research on how phonological rules apply in code-mixed utterances, when part of the structural description is provided by a word from a different language.

One of the few studies that addresses this issue is Olson (2019). Olson examines how Spanish-English bilinguals apply Spanish s-voicing (s → z / __(#)[C, +voice]) and Spanish spirantization (stop → spirant / [+cont](#)__) when there is a language switch between target and environment (*escucha**s** **n**oises* "(you) hear noises, *lleva **g**uns* "carries guns"). Olson found that bilinguals can apply the Spanish rules when their environments come from English, but code-mixed tokens exhibited a phonetically lesser degree of voicing or spirantization compared to monolingual Spanish tokens. Crucially, the two rules Olson examined produce phonetically gradient outputs even in monolingual utterances (e.g., Hualde et al. 2011). Do bilinguals apply phonological rules that exhibit more categorical changes?

We examine the English cross-word tapping rule in English-Spanish code-mixed utterances, such as *he's g**o**t **a**bejas*. We have two goals: (i) to determine whether tapping can apply when part of its environment comes from Spanish, and (ii) if so, to analyze what affects the rate of application.

Methods: 34 US-born English-Spanish bilinguals (33 female, 1 male) performed a reading task on Zoom and completed the Bilingual Language Profile (Birdsong et al. 2012). The reading task elicited 60 sequences (x 2 repetitions) containing /t/ or /d/-final English words followed by either a vowel-initial Spanish noun (Code-Mixed condition *The boy has g**o**t **a**bejas* 'bees') or a vowel-initial English noun. There were also filler items. Participants recorded themselves using the smartphone app ShurePlus MOTIV in an uncompressed format. Authors' narrow transcriptions were collapsed into four groups: [ɾ]-variants, [ʔ]-variants, [t/d]-variants, and [t/d]+[ʔ]-variants. Data were analyzed with mixed-effects Bayesian logistic regression; we remark here on effects that were deemed credible, but for space and readability we do not present the model's quantitative results.

Results and discussion: Tapping occurred in both the English and the Code-Mixed conditions for both /t/ and /d/, as shown in Figure 1. In an Optimality Theory (OT) analysis, this means that the English constraint driving tapping, *VTV, can apply even when some of the material meeting its structural description comes from Spanish.

However, speakers produced fewer taps in the Code-Mixed condition than the English condition. Notably, this difference is driven by English-dominant bilinguals, as shown in Figure 2, splitting the participants into more English-dominant and more balanced-bilingual halves. This finding suggests that the lower rate of tapping in the Code-Mixed condition is not caused by the grammar's being sensitive to the language of the environment but rather by processing factors.

Kilbourn-Ceron, et al. (2020), for instance, studied tapping in all-English utterances and found that the less frequent or less predictable the second word is, the less often tapping applies; in OT terms, the *VTV constraint was not detected early enough to plan a tap. In our study, for the English-dominant participants, Spanish words are effectively lower frequency (all else being equal) than English words, which should make them slower to retrieve. This might cause a slowdown in speech planning that prevents the vowel-initialness of the following word (e.g., *abejas*) from being accessed in time for it to be present in the tableau.

We are thus proposing that tableaux sometimes include the following word (e.g., /gɑt abexas/) and sometimes does not (e.g., /gɑt/). When it does include that word, be it English or Spanish, tapping can apply, and when it does not, tapping cannot apply. A mix of the two tableau types occurs, regardless of participant type or utterance type. But in code-mixed utterances, English-dominant bilinguals are more likely to generate tableaux without the following word.

We adopt an analysis in the spirit of MacSwan and Colina (2014). Each word is subject to its own language's grammar, implemented as a MaxEnt constraint grammar, but material from the other language can be present in the candidate. Simultaneously fitting constraint weights and the probability of retrieving the second word achieves a close match to the experimental results.

In summary, we propose that, at least in our experimental task, which sets the base language of each utterance to English (by beginning the sentence in English), English phonological constraints applying to an English word don't care if part of their structural description comes from another language. But, a language switch can still affect the rate of process application, at least for English-dominant speakers, because of the increased difficulty the language switch causes for production planning.

Figure 1

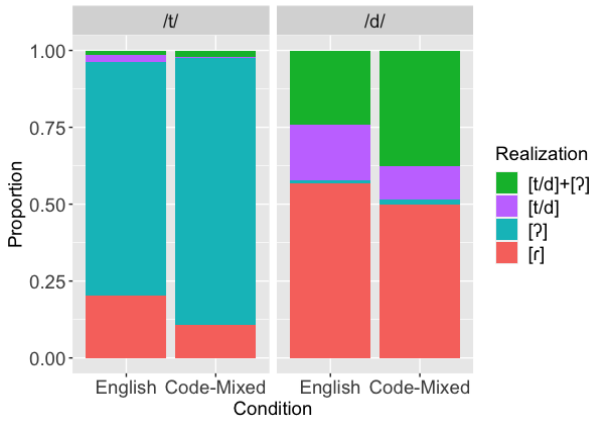
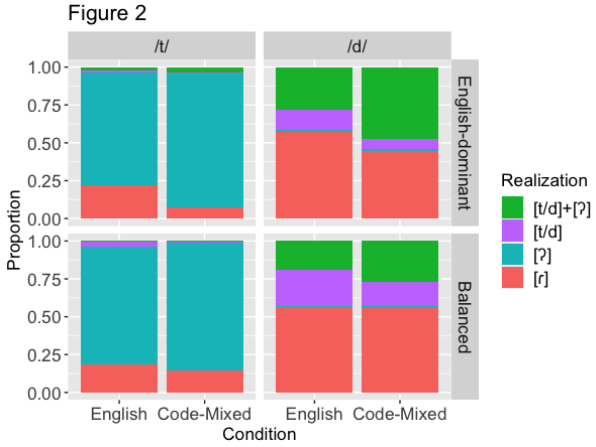


Figure 2



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