

## Explaining trill production within a usage-based framework: The case of Panama City Spanish

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Although the trill in Spanish has been described as a voiced alveolar multiple vibrant (Martín Celdrán, 1997; Hualde, 2005), several acoustic analyses have revealed other realizations, such as a pre-aspirated trill, a pre-breathy trill, an approximantized trill, an assibilated trill, and a uvular trill (Lewis, 2004; Colantoni, 2006; Willis, 2006; Díaz-Campos, 2008; Henriksen & Willis, 2010; Bradley & Willis, 2012; Lamy, in press). Furthermore, (extra)linguistic factors, such as type of preceding segment, syllable stress, and speaker sex have been shown to condition variable trill production (e.g., Díaz-Campos, 2008; Lamy, in press). However, these analyses have not focused on factors that could explain trill production within a usage-based framework, specifically, lexical frequency and rate of speech.

Since trill production shows a pattern of articulatory weakening brought about by coarticulatory effects (Lewis, 2004; Recasens, 1991; Recasens & Pallerès, 1995; Vázquez Carranza, 2006), frequency and speech rate could be propagating the use of reduced forms. Usage-based models of phonology (e.g., exemplar models) hypothesize that as frequency increases, phones become more reduced. These reduced forms are recorded in the lexicon and become stronger and easily activated with further use (Langacker, 2000; Bybee, 2001; Ernestus, 2014). Additionally, usage-based models predict that a faster rate of production brings about more acoustically reduced sounds (Ernestus, 2014). Therefore, the present study seeks to test these predictions by including lexical frequency and speech rate in the analysis of trill production in Panama City Spanish (PCS).

The analysis includes sociolinguistic interviews with 11 native speakers of PCS. 608 tokens of the trill were extracted and acoustically analyzed using Praat (Boersma & Weenink, 2012) considering cues such as presence of occlusions, waveform amplitude reduction, transition in formant structure, and intensity (cf. Bradley & Willis, 2012). Subsequently, multivariate analyses with mixed effects were carried out in Rbrul (Johnson, 2009) with three dependent variables: (i) non-reduced/reduced alternation, (ii) mean occlusions, and (iii) mean duration. The independent factors included were frontness of the preceding and following segment, syllable stress, number of syllables, lexical frequency (calculated based on the PCS corpus), speech rate (syllables per second) and individual speaker and lexical item as random effects.

The results reveal that in all three analyses speech rate is the most significant factor ( $p < 0.00$ ). As speech rate increases, reduced variants are favored (-0.254), and mean occlusions and mean duration decrease (-0.082 and -4.425, respectively). The lexical frequency factor is only significant in the analysis of non-reduced/reduced alternation ( $p < 0.05$ ). Reduced variants are favored as frequency increases (-0.034). Although frequency is not significant for mean occlusions and duration, there is a similar tendency of smaller mean values occurring as frequency increases (-0.011 and -0.284, respectively). These findings help better explain the wide range of variability that has been observed in trill production by considering frequency and speech rate, two factors that play significant roles in real language use. This study, therefore, makes important contributions to literature concerned with sociophonetics, acoustic analyses, and the mental representation of phones.