

**Gemination is more than duration:  
Evidence for segment-specific cues to quantity from Maltese rhotics**

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Maltese is traditionally described as having an alvolar trill as its rhotic, though a recent study (Reinisch & Mitterer, 2024, ICLaVE) found that taps and approximants ([ɹ]) are frequent allophones; the latter especially among younger speakers and in Coda position. Interestingly, geminate /r/ frequently appeared to be produced with frication noise, sometimes completely devoiced. We asked whether in perception, this fricative allophone of /r/ is used as a secondary cue to gemination compared to the approximant - above and beyond duration. Mitterer (2018, JPhon) had already shown that, in Maltese, the glottal consonants /ʔ/ and /h/ have additional cues that are strong cues to gemination. In fact, listeners do not perceive a (very) long [h] to be a geminate unless it is produced with a secondary oral constriction. Here we test whether and to what extent frication is used as a cue to gemination on rhotics. As argued by Mitterer (2018, JPhon), such results question accounts of gemination that assume that it applies relatively unitary to all segments.

Two duration continua were created based on approximant and fricative allophones of /r/ for the minimal word pairs *marad-marrad* (Engl. ‘to become sick’ vs. ‘to make someone sick’) and *feraħ-ferraħ* (Engl., ‘to be happy’ vs. ‘to make someone happy’). Continua were generated from natural productions, in which F0 of the approximant was set to 200Hz using PSOLA, so that the successive removal of glottal cycles led to a continuum with 5ms steps. Consonant duration ranged from 60 to 110ms. The continua were presented to listeners in a two-alternative forced choice (2AFC) task. Results showed that listeners only provided more “geminate” answers when the stimuli contained a fricative rather than an approximant in *feraħ-ferraħ*. Since, however, the word pairs differed in their vowel contexts, we hypothesized that the fricative allophone may be conditioned by vowel height. An analysis of the production corpus of Mitterer et al. confirmed that this is the case with fricative geminates being more frequent in high-vowel contexts.

Therefore two additional continua with high-vowel contexts were generated: *ixtri remote-ixtri rremote* (Engl. “buy a remote!” vs. “buy the remote!”) and *irid-irrid* (Engl., “I want” vs. “he wants”). In a 2AFC task, the allophonic variation again only influenced the singleton-geminate distinction in one of the pairs (here: *ixtri remote-ixtri rremote*). For the second pair, the identification functions were overall much shallower, possibly because *rrid* (Engl. “I want”) is an unusual geminate /r/ that arises out of an assimilation of /n/ as 1<sup>st</sup> person singular prefix to the onset of the root; an assimilation that is specific to “weak” verbs with a Semitic root.

Overall, we find that allophonic variation influences the singleton-geminate distinction, but in a very specific way, depending on vowel context and type of underlying geminate. Moreover, these cues are less strong than observed for /h/, where duration alone is insufficient to achieve a convincing geminate percept.