Phonotactic markedness increases processing demands in speech production

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Background: Recent debate in speech production concerns phonological markedness, and whether it differs from within-language lexical statistics and articulatory complexity in its effect on speech production. While Romani et al. (2017) argue markedness is based entirely on articulatory complexity, others hold that the link between phonological markedness and articulatory complexity is tenuous at best in non-clinical populations (Ziegler 2017, Berent 2017) and that within-language distributional regularities (biphone probabilities, positional phoneme probabilities, phoneme frequencies) are better predictors of processing cost in speech production (Goldrick 2017, Pouplier & Kochetov 2017). This discussion raises important questions about the relationship between within-language lexical statistics and phonological markedness, and about the interface between phonological grammar and speech production.
Current experiment: To probe what type of markedness, if any, influence processing in production, in this pilot study I examine *phonotactic markedness,* a type of phonological markedness which closely corresponds to language-specific segmental distributional regularities. Importantly, however, the two are not equivalent: some distributional regularities correspond to robust phonotactic acceptability judgements (ex., **keshsel,* which violates English's ban on adjacent sibilants) while others do not (ex., ✓*luhallem*, even though English lacks high back vocoids before *h*) (Hayes & White 2013). Thus, phonotactic violations allow us to probe if more abstract notions of markedness influence processing in speech production.
Experimental design: Because phonotactic well-formedness is correlated with other measures that influence speeded response latencies (e.g., biphone and positional phoneme probabilities), I use a modified speeded production paradigm: participants read aloud ten pairs of "sentences," each made up of four nonwords (ex., *bosh, flerm, tib, zipe*), with each pair-member having the same words in a different arrangement. One pair-member's arrangement of nonwords creates phonotactic-violating sequences across each of the three word boundaries in the sentence, while the other does not. Three types of phonotactic violations were chosen from well-established phonotactic restrictions of English: a ban on adjacent identical consonants, a ban on adjacent sibilants, and a gradient dispreference for consonant clusters. Thus, the four nonwords above appeared in a *marked* arrangement (*tib bosh zipe flerm*)*,* with one violation each of the three phonotactic constraints in order, and an *unmarked* arrangement (*flerm zipe bosh tib*). This design holds lexical statistics of sentences constant across differently-arranged pairs, while manipulating just phonotactic markedness. If markedness impacts processing in production, participants should take longer to being speaking marked sentences, with a possible interaction with presentation order since the pilot has a repeated-measures design.
Procedure: 30 participants were familiarized with each nonword individually, completed a distractor task, and then read each sentence unprepared as quickly as possible, without breaks or pauses. Response latencies (ms) for each complete utterance were inverse-normal transformed (Brysbaert & Stevens 2018) and modeled using hierarchical Bayesian regression.
Results: I found a significant inhibitory effect of markedness ($\beta = 0.78$, 95% CI [0.07, 1.50]), and significant facilitatory interaction of markedness with order ($\beta = -0.78$, 95% CI [-1.33, -0.25]). I also found increased positional probability decreased response latency, as did increased phonological neighborhood density (Vitevitch 2002, Vitevitch et al 2005).
Discussion: I find that violations of phonotactic markedness increase response latencies, above and beyond any confounds of lexical statistics, signaling increased processing demands. This effect is canceled by prior experience with the same syllables in an unmarked arrangement. This finding supports theories of speech production which allow for grammatical information to influence the course of phonological encoding (Goldrick 2011), a framework previously supported primarily using speech-error data.

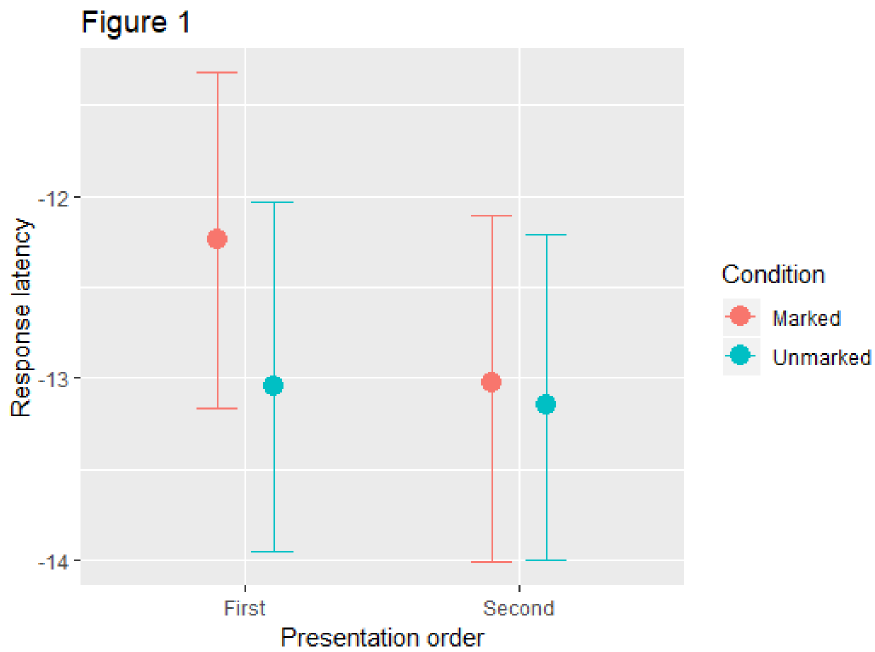

Figure 1: Point estimates and 95% CIs for response latencies for marked and unmarked sentences, by presentation order for each subject. Response latencies for marked sentences seen before their unmarked pair-members have significantly longer response latencies than marked items heard after their unmarked pair-members, and significantly longer than unmarked sentences seen before their marked pair-member counterpart.

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