Does lexical frequency affect phonetic traces in speech errors? A replication study

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Replication is vital, but difficult

- Published experiments in psychological sciences may overestimate effect sizes
- Replicating speech production studies highly resource-intensive
- Manual measurement, Goldrick et al. (2011): 3000 person hours

High-powered replication of Goldrick et al. (2011) using automated phonetic analysis tools

- Tools from Goldrick et al. (2016) measure 97k stop consonant voice onset times (VOTs) elicited in tongue twister paradigm
- Replicate original results with mixed effects regression to better account for participant and item variance
- Pre-registered: https://osf.io/32bhv/
- Statistical power estimated with Monte Carlo simulations; Number of participants set to maximize power ($\beta > 0.85$)

Speech error phonetics influenced by production target and lexicon

- Target productions leave phonetic "trace" in resulting speech error: [b] from *pin* ➔ ***b****in* error more [p]-like (longer VOT) than [b] from correct *bin* ➔ ***b****in* production
- Lexical information modulates traces (e.g., larger traces for nonword vs. word outcome)

Target study: Lexical frequency modulates phonetic traces in errors

- ***Integration hypothesis****:* Lexicon includes abstract phonology, specification of allowable range of phonetic variation
- High frequency (HF) allows substantial variation, weakly constraining phonetics
- LF words specify narrow range of phonetic variation
  - LF targets strongly indicate target properties should be present
  - LF outcomes strongly indicate target properties should be absent

Traces larger for LF targets, HF outcomes (Goldrick et al., 2011)
But effect is very small—is it reliable?

Methods

- 35 participants quickly repeated twisters made up of rhyming pairs differing in initial stop voicing (e.g., *bin pin pin bin*)
- **Frequency of target or error outcome** manipulated to create 20 quadruplets (80 words)

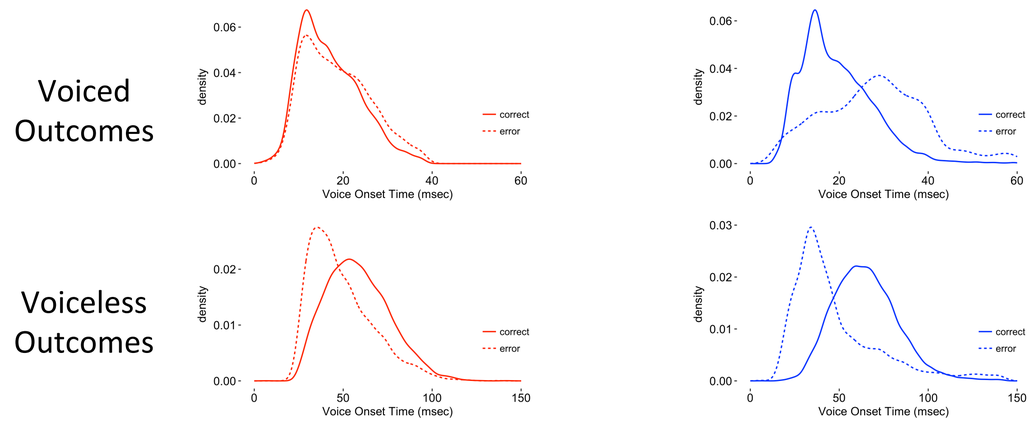
Contrasting Pair	Controlled Pair
bill (freq: 54)	**pill** (freq: 13)
bin (freq: 5)	**pin** (freq: 13)

- 86k VOTs analyzed (9.6k excluded due to poor alignments/ outlier VOT values)
- Gamma mixture model, assuming two target categories (voiced, voiceless) fit to each participant's VOTs
  - Error: intended category ≠ category assigned by mixture

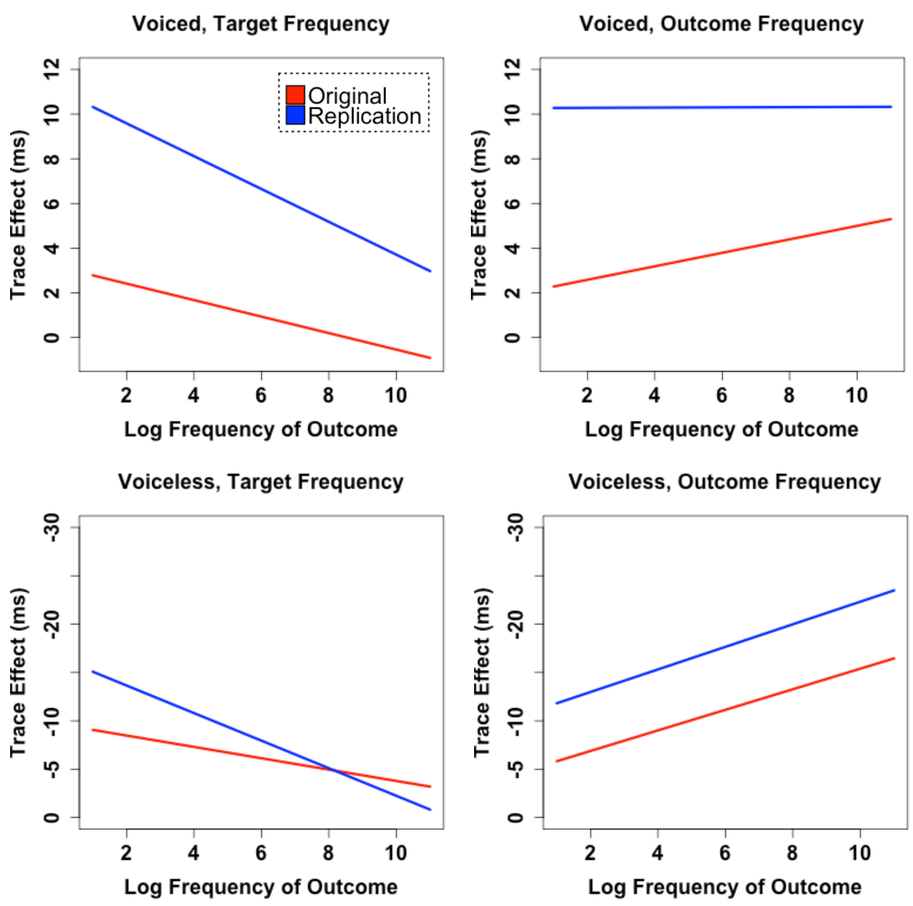
Results: Phonetic traces in errors

Original: 26% error
[range: 13-50%]

Replication: 11% error
[range: 3.6-30%]



Results: Modulation of traces by lexical frequency



Large trace effect robust; Smaller interaction effects less robust

- 4 models, one for each target/outcome frequency combination
- Fixed effects: accuracy, frequency, and interaction
- Original/simple model: **random intercepts only**
- New maximal model: **random intercepts + slopes** (accuracy for items; all fixed effects for participants)
- Main effect of accuracy significant in all analyses.
- Crucial measure: **accuracy:frequency interaction**

Do LF targets and HF outcomes have larger effect on traces?

	Original paper	Simple model	Maximal model
Voiced, target	✔	✔	✔
Voiced, outcome	✔	**n.s.**	✖
Voiceless, target	✔	✔	**n.s.**
Voiceless, outcome	✔	✔	✔

Next steps: Replicate and expand McMillan and Corley (2010)

- Relative to baseline non-switching context (/t/-/t/), VOTs more variable when segments differ in one feature (/t/-/d/) vs. two features (/t/-/k/)
- High-powered replication using automatic phonetic tools
- *Extension 1:* Do different baseline contexts (original: "X X X X" vs. "they X X him"; Goldrick & Blumstein, 2006) change estimates of VOT variability?
- *Extension 2*: Compare original analysis methods to Goldrick, et al., (2011)

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