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Phonological regularity, perceptual biases, and the role of grammar in speech error analysis

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Highlights

- Supports prior work showing that speech errors respect phonotactic constraints.
- However, quantitative analysis shows that speech errors are less phonologically regular than commonly assumed (*n*<95% regularity, cf. 99%).
- Differences in phonological regularity are likely due to perceptual biases in the collection of speech errors.
- Respect for phonotactics can be intrinsic to language production processes, and not necessarily the result of built-in phonotactic rules

Context

- Common theme in speech error research: speech errors respect grammatical constraints (e.g., Fromkin 1971, Bock 2011, Stemberger 1983)
- Consensus in classic work that speech errors respect phonotactics (Wells 1951, Fromkin 1971, Boomer and Laver 1968, Nooteboom 1967, Garrett 1980), with some even arguing for active phonological repairs
- Quantitative assessment from large speech error based on strong methods found 37 phonotactic violations in 6,300 errors, or 0.59% (Stemberger 1983). Used as a standard that speech errors are phonologically regular 99% of time.

Motivation

- It seems likely that reported 99% standard is too high, because the perceptual systems of data collectors may regularize violations, or they may simply not hear these errors (see Cutler 1982, Shattuck-Hufnagel 1983).
- While sound errors do tend to respect phonotactics, other types of speech errors exhibit rampant violations of grammar:
  - Majority of **word shifts** in SFUSED-English are ungrammatical, e.g., *I'm not staying /∅all /up night*. (sfusedE1817)
  - **Sentence blends** frequently ungrammatical: *... in life /I'd never will understand#* (sfusedE348)
  - **Articulatory study** argues phonotactics not a good way to assess lawful speech because most sublexical errors are not of 'alphabetic' symbolic categories (Mowrey MacKay 1990)

Methods

SFUSED-English

Simon Fraser University Speech Error Database

Data collection (cf. Chen 1999 for similar methodology):

- Based in audio recordings of spontaneous speech, typically 2-4 talkers
- Many data collectors (currently 13 data collectors) to reduce researcher bias
- Training regime: one month of training for data collection (phonetic training, speech error identification, feedback on listening tests)
- Verification process: all data verified by at least one other person that is distinct from the original data collector; reduces false positives.

Empirical tests of reliability

- Alderete and Davies 2016 document a number of differences between online (traditional observation) and offline collection from audio recordings, consistent with claim offline collection is less prone to bias:
  - Offline is more diffuse, less concentrated in very salient patterns, e.g., blends and exchanges
  - Offline collects more errors from faster speech
  - More noncontextual and uncorrected errors offline
  - Substitutions are more asymmetrical offline
  - More violations of the category constraint offline
- Some errors in SFUSED collected online, can actually test for effect of collection method – see below.

English Phonotactics

Onset Peak Coda

(s)(C1)(C2) X4 (X5) (C6)(C7)(C8)(C9)

- All C positions are optional.
- Banned C1: *ŋʒ*, Banned Codas: *h, j, w*.
- Onset clusters: obstruent + sonorant
- Appendix + C, C always a voiceless stop, *s* fricative/loans
- Banned onset clusters: vd fric/affricate + sonorant, labial + *w*, coronal nonstrident + *l, θw ʃfV fwʃl sr sh gw stw skl*
- Onglide *j*: part of peak because of limited distribution, but cannot occur in *CCju* cluster.
- Coda clusters X5+C6: falling sonority (r > l > nasals > obstruents) and *s* + *p tk; lg* is banned.
- C7-9 are appendices limited to coronal obstruents
- Nasal + obstruent clusters agree in place and the obstruent is voiceless.
- Tense vowels and diphthongs are bimoraic (fill X4 and X5), lax vowels are short.
- Stressed and final syllables are bimoraic (lax vowels occur in closed syllables) and all syllables maximally trimoraic (syllables tense vowels only have simple codas)

Effect of collection method on phonological regularity

$X(1)^2 = 19.054, p < .0001$

	Regular	Irregular
Online	661	11 (1.64%)
Offline	1,465	91 (5.85%)

Results by Error Type

Substitutions (SFUSED record ID # on left)

Illicit onsets/appendices

4708 … pulled back the /[**z**l**i**p]= sleeping bag and …(sleeping)

1500 … by the maps at the ^selection /[**ʃk**r**i**n] (screen)

4725 … about every ^Xbox /[**s**r]ee ^sixty game that … (three)

5731 … yeah straight up xxx /[**tʃ**r]aight up cold. (straight)

5739 … they shoot, /[**ʒ**u] shoot The Thick of It … (you)

Illicit codas/rimes

1245 … Their HOV /[l**aɪŋ**] xxx lane is like one driver (lane)

2223 Let's see if we can heavy /[ənpʌ] shift Susan (NP).

5898 Vin Diesel got kicked off of /Rei[**ŋ**]deer Games … (reindeer)

Nonnative sounds

5035 Which is maybe one of the /[be**ɬ**] lines ever (best).

5964 … first of all, Katrina /[kl**y**]= clearly defined (clearly)

Additions

Illicit onsets, appendix + onset

49 … get the Ferrari down a /[**flj**u] xxx few ^floors? (few)

1236 … Haha /[**θl**]isten to you.

1248 … teaching me how to /pfly a ^plane. (fly)

1278 I don't like the ^/vriral ^marketing. (viral)

4187 Yeah, you said "/pwhy don't you ^put it on one … (why)

5545 … probably /aft[s]er I ^saw her (after)

5599 … talking a ^dream, what that ^dream /[mr]eans … (means)

6642 … holding it with his /[b]weird ^blue hand. (weird)

Deletions

Illicit codas/rimes

1526 The ^person /[ke**ɪmp**] ^up to the desk.

7682 … [bj**ʌ**t] a down side that (but)

Deletions

3954 … Lisa, /**S**reech and Lisa. (Screech)

8943 … I think you're a /h**u[ŋə**]= hunk-a-rama.

Exchanges

4581 … the children in the trailer for /Moon[raɪ**ŋ**] /Kee**z**= Moonrise Kingdom.

Sequential Blends

4453 … A diary is a /[**sb**]ook xxx a very special book.

5278 … you can't quite /[**pjɹ**rt] xxx put your finger on.

7211 … because we /[sp**ɪlkf**] xxx we, we speak film

Word Blends

870 … … /[s**ʌstæ**] makes me frisky. (pasta, sauce)

7120 Top ten /**thw**ays to make me cry (things, ways)

7270 … /so[m-**bw**ʌn-di] xxx uh in the … (someone, somebody)

Summary Statistics

Type	*N*	Violations	% Irregular
Substitutions	1,461	45	3.08
Additions	394	41	10.41
Deletions	184	3	1.63
Exchanges	37	2	5.41
Shifts	8	0	0.0
Sequential Blends	66	6	9.09
Word Blends	78	5	6.41
Total	2,228	102	4.58

Comparison with prior research

Estimates of regularity and methodology

- 4.58% is many times higher than estimate based on Stemberger (1983)
- Likely due to methodology, because offline data collection is demonstrably less prone to perceptual bias
- Standard for regularity probably much lower: 90-94%, given offline regularity and fact that many errors have been missed

Are phonotactics intrinsic to phonological encoding?

- Dell et al. 1993 showed that model of phonological encoding trained on a sample of English words made errors that respected English phonotactics, but not to the high standard set at the time (99% regularity, modeling results: 92-95%)
- More representative sample given here is rather close to Dell et al.'s model predictions; indeed, probably closer to 94% when online errors removed.

Concluding remarks

- Potential role for grammar: markedness asymmetries (Goldrick 2011, Goldrick and Daland 2009), where observed patterns not predicted by output biases based in raw frequencies.
- Lower standard for regularity raises the question of whether actual errors are shaped by language processes, or just due to random permutation; need permutation test to see if observed regularity is above chance levels.
- Leads to questions about the role of syllables and syllabification in language production processes: are syllable frames necessary for the analysis of the shape of sound errors?