Cross-linguistic trends in speech errors: An analysis of the sub-lexical errors in SFUSED Cantonese

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Motivation

- Very few speech error collections have baselines large enough to establish significant effects in error patterns.
- Only a small handful of these large scale studies analyze facts from non-Indo-European languages.
- Problem: under-studied languages do not fully inform theoretical models, despite extensive evidence of their importance (e.g. Chen 2000, O'Seaghdha et al. 2010).

Objective

Document the sub-lexical (sound) errors in a large collection of Cantonese speech errors:

- Test established generalizations in a typologically distinct language
- Investigate new patterns that emerge from the unique linguistic structures of Cantonese

On tone errors: see Alderete, Chan, Yeung (2019) *Cognition* 191.

Psychological biases

Single phoneme effect: large majority of sound errors are single phonemes, not sequences or features (Nooteboom 1969, Shattuck Hufnagel 1983)

Syllable position effect: sounds tend to assume the same syllabic roles as they do in their source words (Boomer and Laver 1968, Fromkin 1971)

Consonant-vowel category effect: consonants and vowels rarely interact with each other (MacKay 1970, Stemberger 1983)

Repeated phoneme effect: error sounds tend to share a context in intended and source words (Dell 1984)

Phonological similarity effect: intended and intruder sounds tend to be similar (Cutler 1980, Dell & Reich 1981)

Phonological regularity effect: sound errors tend to be phonologically regular, or obey phonotactics (Wells 1951, Stemberger 1983)

Frequency bias: frequent sounds (and sequences) tend to replace infrequent sounds (Motley & Baars 1975, Levitt & Healy 1985)

Word onset effect: sound errors occur more often in word-initial position that non-initial positions (Shattuck Hufnagel 1987, Wilshire 1998).

Table 1. Units of sound errors

Class	Units	Substitutions	Additions	Deletions
Single phoneme	C	717	74	58
	V	280	37	27
	VV (diphthong)	39	0	0
Sub-syllabic	CC (onset)	8	0	0
	VC	47	1	0
Whole syllables	CV, CV(X)	43	3	0
Other	*sequences*	20	1	3
Total		1154	116	88

- Single phoneme effect: 89-97% of all sound errors involve a single phoneme.
- Many of the multi-segment errors are in fact a coherent unit, i.e., onset, rime, or whole syllable.

Table 2. Syllabic roles – all substitutions

Role	Non-contextual	Contextual	Total
Onset	260	372	632 (58.08%)
Nucleus	99	117	216 (19.17%)
Nuc V1	15	41	56 (4.97%)
Nuc V2	9	7	16 (1.42%)
Coda	49	40	89 (7.90%)
Rime	36	17	53 (4.70%)
Syllable	51	14	65 (5.77%)
Total	519	608	1127

- Strong onset bias, nucleus also very prominent.
- Relatively large number of errors affecting whole syllables (see Chen 2000).
- Asymmetry in vowel components of diphthongs: 3.5 to 1 rate favoring V1 substitutions.

Table 3. Syllabic roles – contextual substitutions, error words (rows) by source words (columns)

	Onset	Nucleus	Nuc V1	Nuc V2	Coda	Rime	Syllable
Onset	**373**				6		2
Nucleus	1	**116**	7	6		1	1
Nuc V1		7	**35**				
Nuc V2		7		**5**			
Coda		1			**31**	3	
Rime		1			1	**8**	
Syllable	1	3			1		**9**

- Very evidence for the syllable position effect: 92% have same role, many others have related role.

Table 4. Consonant-vowel substitutions

	Consonant	Vowel
Consonant	705	11
Vowel	11	210

- Strong support for the consonant-vowel category effect: 97.65% of C-V substitutions obey it.

Cantonese Syllable

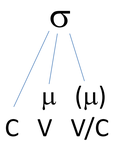


Table 5. Repeated phoneme effect

Type	No	Yes	Total
Substitutions	468 (76%)	150 (24%)	618
Additions	41 (72%)	16 (28%)	57
Total	509 (75%)	166 (25%)	675

- Roughly 1-in-4 contextual sound errors exhibits the repeated phoneme effect.

Table 6. Phonological regularity effect

	Regular	Irregular	Total
Substitutions	1037 (90%)	117 (10%)	4001
Additions	90 (78%)	26 (22%)	116
Deletions	82 (93%)	6 (7%)	238
Tone errors	419 (99%)	1 (1%)	420
Complex set	279 (88%)	37 (12%)	301
Total	1907 (91%)	187 (9%)	186

- About 9% of all errors are phonologically irregular, which is far above expectations from prior research.
- But roughly 45% of irregularity due to non-native segments, which is far above SFUSED English, and may be due to fact our talkers are bilingual in English.

Table 7. Word onset effect

Class	Initial	Non-initial	Total
Contextual Substitutions	274	325	599
Noncontextual Substitutions	215	295	510
Just onsets	270	100	370

- Very strong word onset effect, given 1 (initial) to 2.5 (non-initial) expected rate.
- Significantly above chance rates separate from onset bias, because see same effect in just onsets.

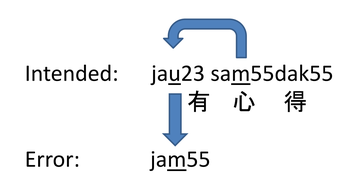
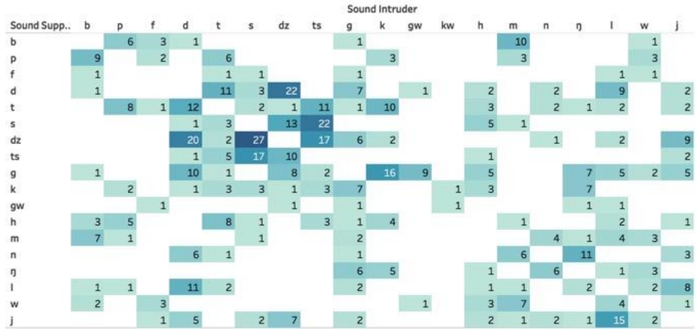
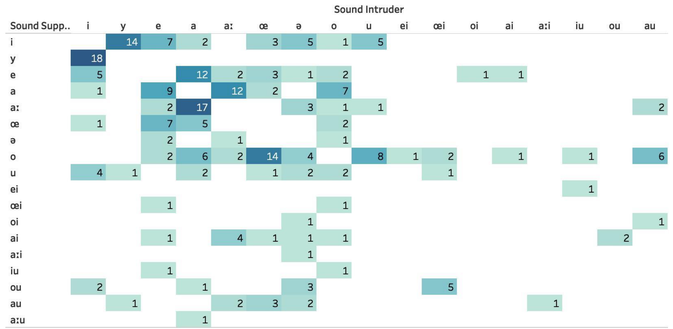


Illustration (SFUSEDC-2917)
20 of 22 'exceptions' are substitutions in CV_, which supports both Cs and Vs; parallel with Japanese (Kubozono 1989)

Consonant Confusion Matrix



Vowel Confusion Matrix



- Phonological similarity effect: 79% of obstruent confusions change a single feature.
- Frequency bias: two most common intruders /d dz/ are high frequency.

Methods

- All errors were collected from audio recordings of unscripted conversations.
- Two trained data collectors listened to each recording, vetted by senior data analyst.
- Classified using standard taxonomy of error types (Stemberger 1993).
- Measures of data quality (incidence of exchanges, phonotactic violations, sound vs. lexical errors) all point to very high sample coverage and high accuracy (see Alderete & Davies 2019).

Discussion

- Many of the known cross-linguistic trends are confirmed here, including the word-onset bias
- Other trends revealed originally by Asian languages are also attested: C-V interaction based on moras, syllable substitutions
- New contribution: asymmetry in vowel components (why more errors in V1 of diphthong?)

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Key References

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