# Markedness bias in phonological learning: a Samoan case study and proposed experiment

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https://www.kuojennifer.com/files/cornell_0217_samoan.pdf

## 1 Background

- How do learners resolve conflicting data patterns in morphophonological paradigms? English example from Berko (1958):

| SG | PL |
|---|---|
| chie[f] | chie[f]s |
| lea[f] | lea[v]es |
| heaf | hea[f]s? hea[v]es? |

  - Learner errors are informative.
  - Reanalysis: errors adopted into speech community, resulting in a type of language change.

- Malagasy: patterns of reanalysis suggest that learners are sensitive to both **frequency matching** and to a **markedness bias**.
  - ...where markedness is restricted to "active" markedness already present in stem **phonotactics**.

- **Goals for today:**
  1. Describe a Samoan case study showing the effect of markedness in reanalysis over time.
     - "replication" of Malagasy results
  2. Propose a nonce-word experiment that builds on these findings, by comparing the effect of learning biases in Samoan L1 vs. heritage speakers.

## 2 A Samoan case study: the reanalysis of ∅∼C alternations

- In the Polynesian languages (and many other Oceanic languages), a consonant of unpredictable quality may surface under suffixation (Pawley 2001)
- Samoan (Mosel and Hovdhaugen 1992): the -Cia 'ERGATIVE' suffix has various allomorphs, which mainly differ in their initial consonant (Table 1). Note: only /-a, -ina/, the vowel-initial allomorphs, are productive.[1]

| ERG. | STEM | SUFFIXED | GLOSS | POc |
|---|---|---|---|---|
| a | rere | rere-a | to take | *rere |
| ina | iloa | iloa-ina | to see, perceive | *qilo |
| **t**ia | pulu | pulu-**t**ia | to plug up | *bulu**t** |
| **s**ia | laka | laka-**s**ia | to step over | *laka**s** |
| **ŋ**ia | tutu | tu-**ŋ**ia | to light a fire | *tutu**ŋ** |
| **f**ia | utu | utu-**f**ia | to draw water | *qutu**p** |
| **m**ia | inu | inu-**m**ia | to drink | *inu**m** |
| **l**ia | tautau | tautau-**l**ia | to hang up | *sau**r** |
| **n**a | ʔai | ʔai-**n**a | to eat | *kae**n** |
| **ʔ**ia | momo | momo-**ʔ**ia | to break in pieces | *mekme**k** |

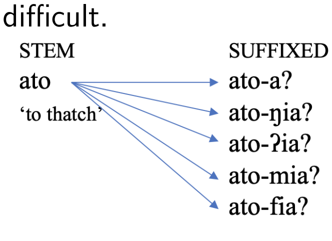
Table 1: Samoan ∅/C alternations

- Historical origin: word-final consonants of Proto-Oceanic (POc) were regularly lost.

| | | | | | |
|---|---|---|---|---|---|
| **POc** | *inum | *inumia | *bulut | bulutia | |
| | inu | – | pulu | – | (C> ∅/__#) |
| **Samoan** | inu | inu-mia | pulu | pulu-tia | |

- Ambiguity in the unsuffixed form can result in reanalysis (Hale 1973):

Conflicting patterns make learning difficult.




**Reanalysis:** errors adopted into speech community and passed through generations of speakers.

| Samoan suffixed form | | | |
|---|---|---|---|
| POc | Expected | Actual | Reanalysis |
| *qatop | ato-fia | ato-a | f→ ∅ |
| *akot | aʔo-tia | aʔo-ina | t→ ∅ |
| *qulin | uli-na | uli-ŋia | n→ ŋ |

[1] The relative distribution of a/ina is partially predictable from the length of a word.

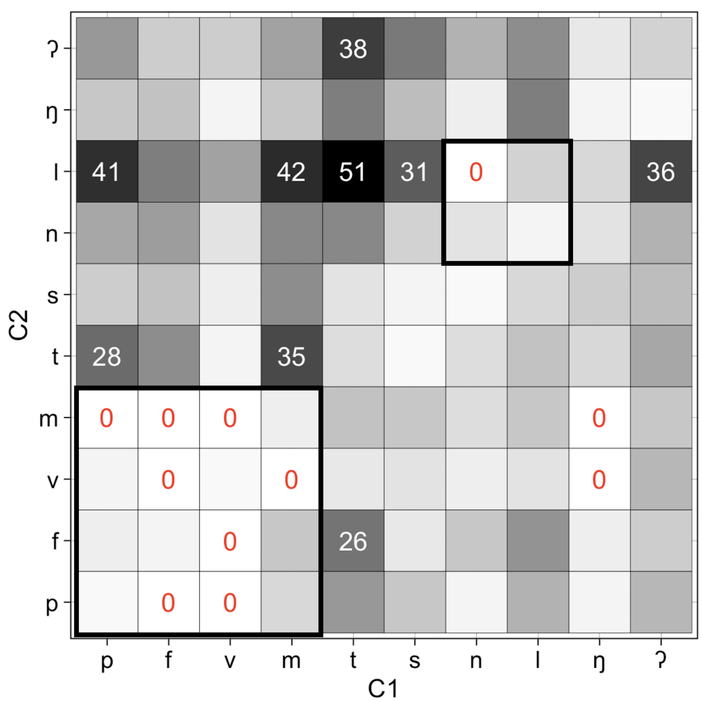
**Preview of results:**

- Reanalysis is towards the more frequent allomorph, but is sensitive to markedness effects.
  - Phonotactically marked outputs are more likely to be reanalyzed.
- How so? Samoan *roots* are subject to (non-local) consonant OCP effects. A model of reanalysis which incorporates these OCP effects outperforms a purely distributional model.

## 2.1 Phonotactic markedness: OCP effects in Samoan roots

- OCP: consecutive identical features are banned/dispreferred.
- Samoan is subject to transvocalic consonant OCP effects (Alderete and Bradshaw 2013)
  - Crosslinguistically well-attested (McCarthy 1988, 1994; Coetzee and Pater 2008; Wilson and Obdeyn 2009)
- OCP effects are particularly strong across:
  - Labials (*[+LABIAL][+LABIAL], e.g. *[fuma])
  - Coronal sonorants (*{n,l}{n,l}, e.g. *[nula])
- Visualized in (1) (data: corpus of 1,512 roots from Milner 1966, narrowed down from around 4200 headwords, and with pseudo-reduplicants removed).[2]

(1) *Transvocalic consonant co-occurences in modern Samoan roots*




[2]Samoan has two registers of speech, *tautala lelei* and *tautala leaga*. *Tautala lelei* preserves more segmental contrasts, but native speakers are generally cognizant of both levels. All data in this paper are from the *tautala lelei* register, as it is the one described in dictionaries and most scholarly work on Samoan.

- Patterns confirmed using the UCLA Phonotactic Learner (Hayes and Wilson 2008)
- Similar OCP effects are suggested to be a general property of Polynesian languages (Krupa 1971)

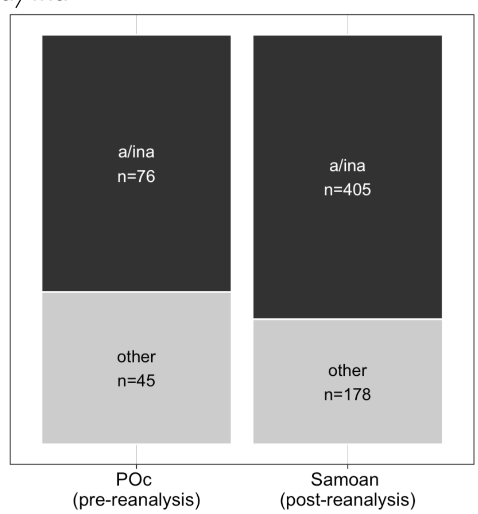
## 2.2 Reanalysis of ergative suffix allomorphs

- The allomorphs that existed prior to reanalysis are inferred by looking at the final consonants in Proto-Oceanic.
  - Data: 583 Samoan stems from Milner (1966), 519 protoforms from the Austronesian Comparative Dictionary (Blust and Trussel 2010) and Polynesian Lexicon Project (Greenhill and Clark 2011)
- **Result 1:** Reanalysis is mostly towards /a, ina/, which is predictable from frequency distributions.

(2) *Historical distribution of final consonants (≈passive allomorphs)*

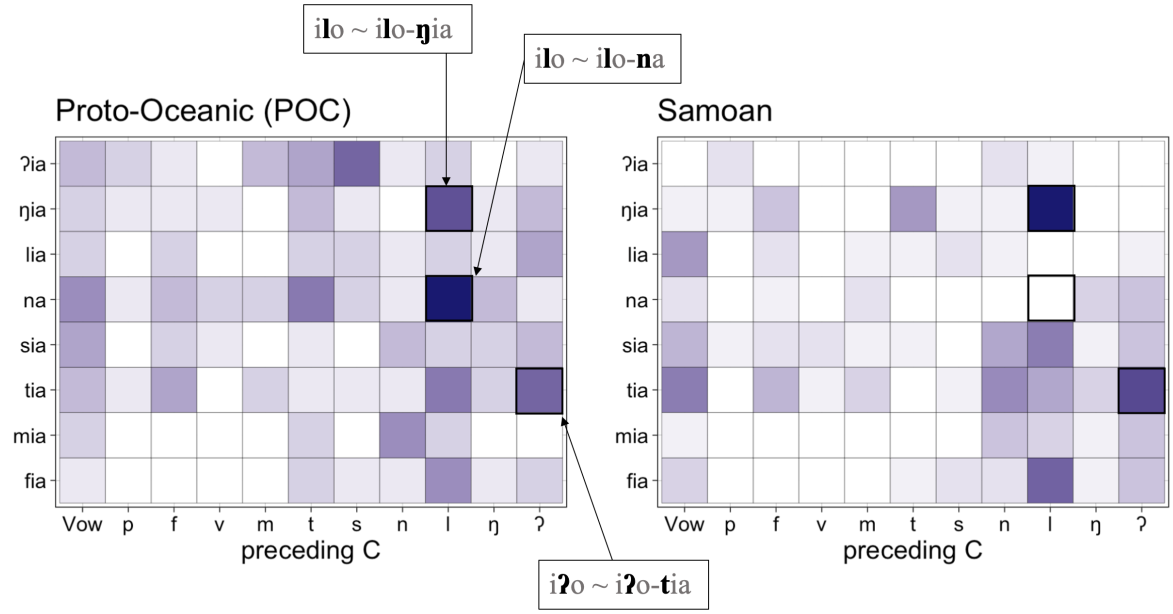
| POc | Erg. | N | P | |
|---|---|---|---|---|
| **vowel,*ʔ,*q** | **a, ina** | **346** | **0.67** | ⇐ ⋆ |
| *p | fia | 13 | 0.03 | |
| *t,*c | tia | 29 | 0.06 | |
| *k | ʔia | 24 | 0.05 | |
| *s | sia | 18 | 0.03 | |
| *m | mia | 11 | 0.02 | |
| *n,*ɲ | na | 41 | 0.08 | |
| *ŋ | ŋia | 21 | 0.04 | |
| *r,*l | lia | 16 | 0.03 | |

(3) *Reanalysis is generally towards a/ina*




- **Result 2:** phonotactically **marked** outputs are more likely to be reanalyzed.
- the Cia allomorph that surfaces is partially conditioned by the identity of the preceding consonant.
- Some regularities in POc are passed down to modern Samoan, while others are not. Figure (4) compares the distribution of Cia allomorphs in POc and Samoan.

(4) *Distribution of Cia allomorphs before and after reanalysis (/a, ina/ excluded)*




- Most notably, suffixed forms of the type [i**l**o-**n**a] were relatively frequency pre-reanalysis, but never observed post-reanalysis.
  - motivated by coronal sonorant OCP (*{n,l}{n,l})

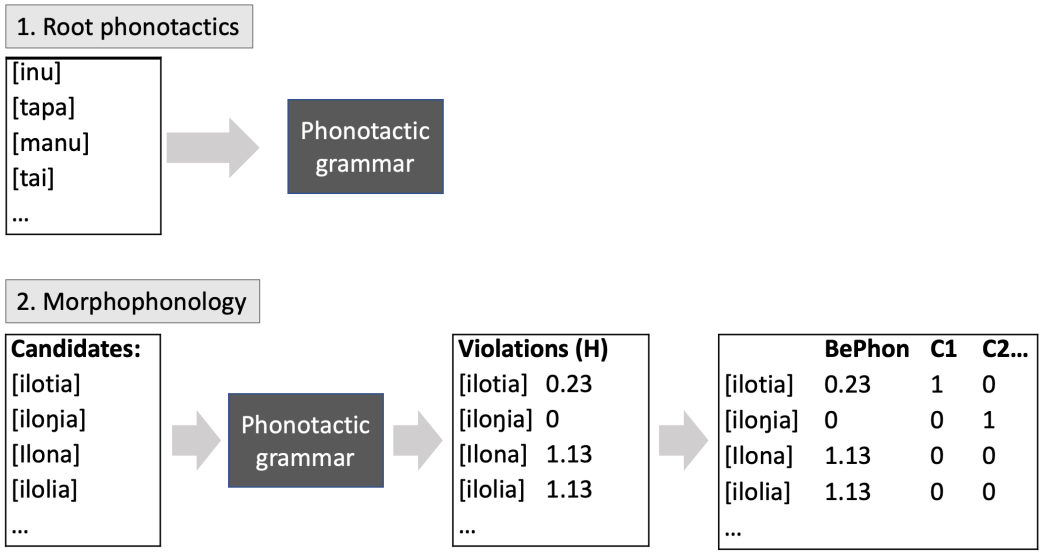
## 2.3 Modeling reanalysis of the Samoan ergative suffix

- Basic idea: use **root phonotactics** to inform model of **morphophonology/reanalysis**.
- Phonotactic markedness constrains
  - A phonotactic model is trained on roots, and then used to assign violations to the candidate suffixed forms in the morphophonological grammar, as in (5).
  - UCLA Phonotactic Learner (Hayes and Wilson 2008), which is based in MaxEnt.
  - Two phonotactic grammars:
    - Bigram grammar: constraints are the set of all possible $C_1C_2$ combinations.
    - OCP grammar: constraints are restricted to OCP constraints that target natural classes,e.g. *[+CORONAL][+CORONAL], $*\begin{bmatrix}+\text{CORONAL}\\+\text{sonorant}\end{bmatrix}\begin{bmatrix}+\text{CORONAL}\\+\text{sonorant}\end{bmatrix}$
- Model of reanalysis:
  - MaxEnt Harmonic Grammar (Smolensky 1986; Goldwater and Johnson 2003)
  - Phonotactically motivated constraints (e.g. OCP-place) are biased to have high weight, following Wilson (2006), White (2013), etc.[3]

[3] Bias is implemented by giving the model a Gaussian prior, and assigning relevant constraints a higher $\mu$.

– Iterated learning component (20 generations)

(5) *Incorporating phonotactic markedness into morphophonological grammar*

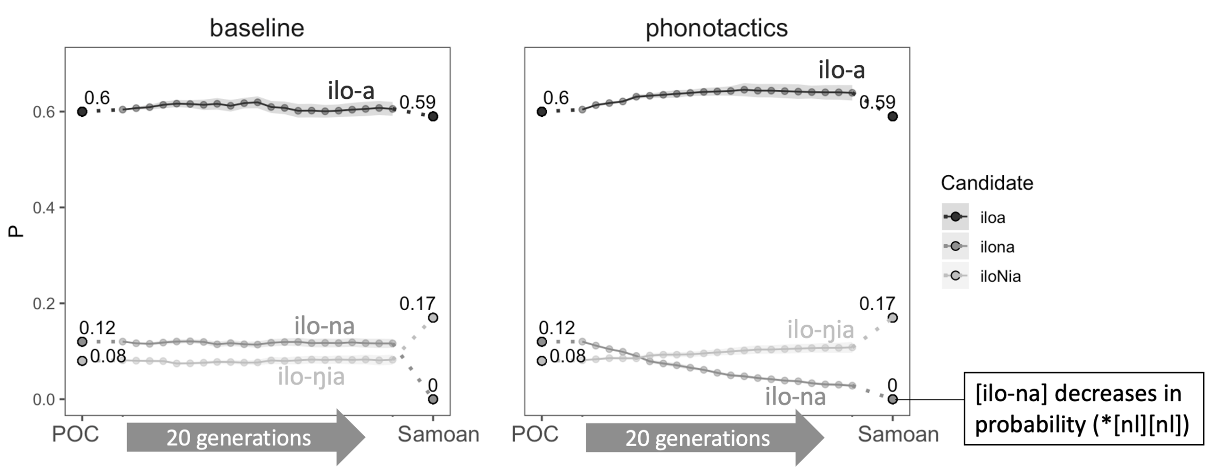



- **Result:** The models with a markedness bias perform better in terms of model fit to the modern Samoan distribution; see (6) for log-likelihood.
- In particular, the markedness models do better at predicting the output for words with coronal dissimilation; see (7).

(6) *Model results*

| **model** | **L** | **p** |
|---|---|---|
| Baseline | -2408.8 | – |
| Phonotactics (OCP) | -2376.1 | $p < 0.00001$ |
| Phonotactics (bigrams) | -2400.746 | $p<0.01$ |

(7) *Subset of model predictions for words with a preceding /l/*



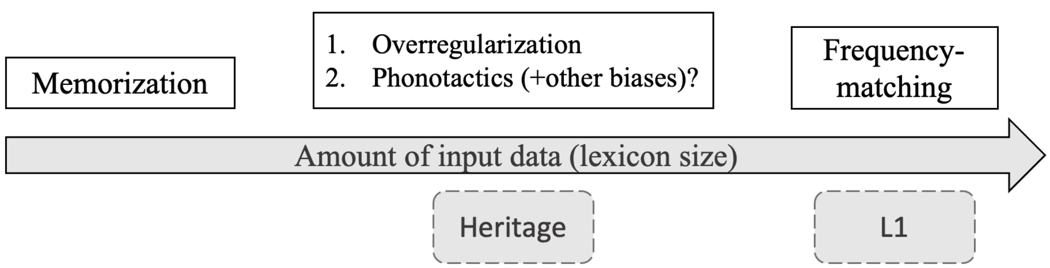
# 3 Next steps: markedness effects in the synchronic Samoan grammar

- Do Samoan speakers frequency-match when applying the ergative suffix to novel words, or are they also sensitive to markedness effects?
- Wug test on both fluent L1 and heritage speakers.
  - Both fluent and heritage speakers of Samoan are contactable.

## 3.1 Background: insights from heritage language phonology

- There is evidence that phonotactic learning is easier than alternation learning; even with limited input, adults possess sophisticated phonotactic intuitions (Oh et al. 2020).
- Many theories of acquisition and learning algorithms predict that learners will become better frequency-matchers as their lexicon increases in size.
  - Tolerance Principle (Yang 2016)
  - MaxEnt Harmonic Grammar (Zymet 2018)
  - Perceptron (online versions of MaxEnt; O'Hara 2020)
- **Prediction**: when learners have limited input, they will be more sensitive to markedness effects, and potentially other biases.

(8) *Relationship between lexicon size and morphophonological learning*




- **Heritage speaker**: a speaker who learns a (minority) language as their L1 at home, but then become dominant in the majority language spoken in the wider community (Polinsky and Kagan 2007).
  - Differs from L1 speakers in having less input data (Polinsky 2008)
  - Predicted to be **more sensitive** to markedness bias (and less prone to frequency-matching)
- In my own work on Seediq (Kuo, forthcoming), I wug-tested both middle-aged speakers (some heritage) and elderly speakers (truly native). Heritage speakers showed evidence of following (and exaggerating) a phonological generalization.

## 3.2 Methodology

- Nonce-word tests (wug tests; Berko 1958)
  - used to demonstrate speakers' knowledge about distributional facts of their lexicon (e.g. Zuraw 2000; Ernestus and Baayen 2003; Hayes and Londe 2006; Becker et al. 2011).
  - When speakers underlearn or overlearn patterns in the lexicon, this suggests the effect of a learning bias (e.g. Wilson 2006; Becker et al. 2011).
- Procedure:
  - Pretest: speakers provide phonological well-formedness ratings for the stimuli (i.e. novel stems).[4]
  - Open response: participants volunteer ergative forms for the wug verbs.
  - Rating task: speakers rate possible ergative forms for wug verbs; for each verb, 4 possible suffixed forms are provided:
    1. default ([ilo-a])
    2. OCP violation; same segment ([ilo-lia])
    3. OCP violation; same class ([ilo-na])
    4. no OCP violation (ilo-fia)
- Stimuli: words of the shape (C)V**C**V, conditioned by final consonant (in boldface).

| **Condition** | **Example** | **Rating task** |
|---|---|---|
| labial | i**m**o | imo-a, imo-mia, imo-fia, imo-tia |
| coronal sonorant | i**l**o | ilo-a, ilo-lia, ilo-na, ilo-mia |
| coronal non-sonorant | i**t**o | ito-a, ito-tia, ito-na, ito-mia |
| filler | i**ʔ**o | iʔo-a, iʔo-ʔia, iʔo-ŋia, iʔo-tia |

- Prediction: Both in production and goodness ratings, speakers will disprefer outputs which result in OCP violations. This effect is predicted to be stronger for heritage speakers.

# 4 Summing up (goals)

- I hope to obtain converging evidence from historical change (reanalysis), L1 speakers, and heritage speakers on how markedness bias interacts with frequency-matching.
- A corpus which aims to connect corpus results with experimental results, which can be used to test different models of learning.
  - Can be expanded to languages such as Tongan.
- Greater understanding of L2/heritage acquisition
  - Most existing work in heritage language phonology has focused on the learning of specific phonemes (e.g. Rao and Ronquest 2015; Kang and Nagy 2016), rather than the learning of morphophonological paradigms.

[4] This step, following Albright and Hayes (2003), is included to address the possible confounding influence of stem well-formedness on morphological intuitions

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