On the relation between cognitive biases, learnability & typological frequency:
The case of vowel & consonant harmony

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Introduction

- The present research investigated the relationship between the frequency and the learnability of phonological patterns

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Introduction

- Some phonological patterns are cross-linguistically more frequent than others

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Introduction

Back vowel harmony (Altaic, Uralic)	**Nasal consonant** harmony (Bantu)

More frequent ⟷ Less frequent

Nasal consonant harmony (Bantu)	**Labial consonant** harmony (unattested in adults)

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Introduction

- Some experimental evidence suggests that **attested patterns are more learnable than unattested arbitrary patterns**
  - Wilson (2003) found that attested nasal consonant harmony is more learnable than unattested arbitrary pattern

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Introduction

Attested harmony patterns are more learnable than unattested arbitrary patterns (Wilson 2003)

Attested harmony pattern ⟷ **Unattested *arbitrary* pattern**

More learnable ⟷ Less learnable

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Research Question 1

Are non-arbitrary, unattested patterns also less learnable than attested patterns?

Attested harmony pattern	**Unattested *non-arbitrary* pattern**

More learnable ⟷ Less learnable

???

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Introduction

- Other experimental evidence indicates that **more frequently attested patterns are not more learnable than less frequently attested ones**
  - Koo & Cole (2006) found that more frequent back vowel harmony is not more learnable than less frequent liquid harmony

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Introduction

More frequent patterns are not more learnable than less frequent patterns (Koo & Cole 2006)

More frequent harmony type	**Less frequent harmony type**

More learnable ⟷ Less learnable

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Research Question 2

Are more frequent harmony types more learnable than less frequent harmony types?

More frequent harmony type	**Less frequent harmony type**

More learnable ⟷ Less learnable

???

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Phonological Harmony

- Vowel harmony
  Long-distance assimilation between one **vowel** and one or more other **vowels** (in the same morpheme or in heteromorphemic contexts)
- Consonant harmony
  Long-distance assimilation between one **consonant** and one or more other **consonants** (in the same morpheme or in heteromorphemic contexts)

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Examples of Harmony

- **Turkish back vowel harmony (highly frequent)**
  /pul-ler/ [pullɑr] 'stamp-nominative plural'
  /ip-ler/ [ipler] 'rope-nominative plural'
- **Yaka nasal consonant harmony (less frequent)**
  /són-ele/ [sónene] 'to color-perfective'
  /sól-ele/ [sólele] 'to deforest-perfective'
- **Labial consonant harmony (Non-arbitrary pattern, unattested in adults)**
  /ʃim-æd/ [ʃimæb]
  /gud-æd/ [gudæd]

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Learnability

- Degree to which subjects grasp/discern/learn a given pattern
- Learnability may be reflective of 'cognitive bias' (Wilson 2003; Pycha, Nowak, Shin & Shosted 2003)

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Learnability

- Artificial Grammar Paradigms
  - Patterns typically taught under laboratory conditions
  - Subsequently, subjects tested on their knowledge of the patterns
  - Test reflects learning and, by inference, the learnability level of the patterns

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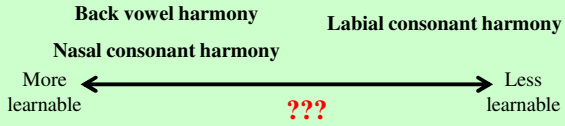
Research Question 1

Are non-arbitrary, unattested patterns also less learnable than attested patterns?



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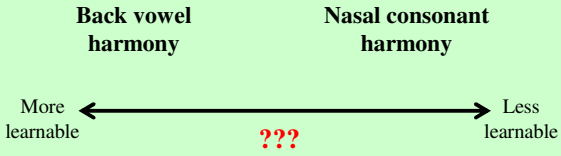
Research Question 2

Are more frequent harmony types more learnable than less frequent harmony types?



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Study Overview

- Artificial grammar paradigm
  - **Training Phase** Subjects listened to words in a made-up language
  - **Testing Phase** Subjects were asked to determine whether words followed the pattern of the words from the training phase

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Subjects

- Recruited from courses at the University of Utah (class credit) and from the University of Utah community (monetary compensation)
- Native English speakers, with no knowledge of harmony languages
- Ages 20 and higher, normal-hearing, no neurological disorders, no medication that may have affected their motor skills, living in Utah

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Subjects

- Randomly assigned to one of six training conditions:
  - Back vowel harmony (n=19)
  - Nasal consonant harmony (n=19)
  - Labial consonant harmony (n=19)
  - Back control (n=15)
  - Nasal control (n=15)
  - Labial control (n=15)

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Stimuli

- Produced by male native speaker of American English in a sound-attenuated booth
- Stimuli edited in Praat (Boersma & Weenink 2005)
- Nonwords (all following English phonotactics)
- Each stimulus consisted of stem plus stem-suffix combination ("sg. – pl. pairs")
- Sound inventories identical across training conditions

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Stimuli: Training Phase

Back vowel harmony condition (More Frequent Harmony Type)

Harmony Pattern	"Sing…Plur" Examples
If stem vowel is [+back], then suffix vowel is [+back]	lɑp…lɑp-**ɑ**d fɛn…fɛn-æd

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Stimuli: Training Phase

Nasal consonant harmony condition (Less Frequent Harmony Type)

Harmony Pattern	"Sing…Plur" Examples
If last consonant of stem is [+nasal], then suffix consonant is [+nasal]	fɛn…fɛn-æ**n** lɑp…lɑp-æd

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Stimuli: Training Phase

Labial consonant harmony condition (Unattested, Non-Arbitrary)

Harmony Pattern	"Sing…Plur" Examples
If last consonant of stem is [+labial], then suffix consonant is [+labial]	lɑp…lɑp-æ**b** fɛn…fɛn-æd

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Procedures: Training Phase

- Subjects heard a block of 6 nonwords ("sg. – pl. pairs"), repeated 30 times in random order (n=180)
- Approx. 1500 msec in length, inter-stimulus interval 3000 msec
- Subjects were instructed to learn the plural formation rule while listening to the "sg. – pl. pairs"

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Stimuli: Testing Phase

Old-Grammatical	Stem is ***familiar from training***; harmony ***follows*** trained harmony pattern → ***Identical to words heard during training***
Old-Ungrammatical	Stem is ***familiar from training***; harmony ***does not follow*** trained harmony pattern

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Stimuli: Testing Phase

New-Grammatical	Stem is ***unfamiliar*** from training; harmony ***follows*** trained harmony pattern
New-Ungrammatical	Stem is ***unfamiliar*** from training; harmony ***does not follow*** trained harmony pattern

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Procedures: Testing Phase

- Immediately followed training
- Subjects heard a block of 24 nonwords ("sg.- pl. pairs"), repeated 4 times in a random order (n=96)
- Subjects were asked to press a 'yes' button on a keyboard when a test item ***followed the same plural pattern*** as the items heard during the training phase
- And were asked to press a 'no' button when a test item ***did not follow the same plural pattern*** as the items heard during the training phase

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Results: Pattern Learnability

- Focus on New-Grammatical and New-Ungrammatical items only
- Pattern Learnability: Responding 'yes' to New-Grammatical more often than to New-Ungrammatical test items

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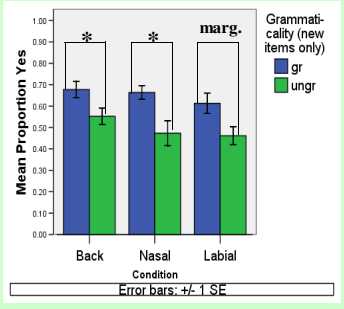
Results: Pattern Learnability



Mean proportion 'yes' responses in New-Grammatical vs. New-Ungrammatical items by condition:

Back/More freq. (p = .013)

Nasal/Less freq. (p = .003)

Labial/unattested (p = .058)

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Results: Comparing Learnability Across Conditions

- Learnability converted to d-prime scores (signal detection theory)
- Higher d-prime score = greater ability to distinguish grammatical from ungrammatical items

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Results: Comparing Learnability Across Conditions

- Looking at all subjects' data, there were ***no significant differences in d-prime scores between conditions***

→No overall differences in learnability among conditions

There were also no differences among conditions after subjects with d-prime score of 0 or below were excluded (Kates et al. 2007)

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Results: Research Question 1

Are non-arbitrary, unattested patterns less learnable than attested patterns?

Back vowel harmony

Nasal consonant harmony

Labial consonant harmony

More learnable ⟷ Less learnable

NO

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Results: Research Question 2

Are more frequent harmony types more learnable than less-frequent harmony types?

Back vowel harmony | **Nasal consonant harmony**

More learnable ⟷ Less learnable

NO

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Summary of Findings

- An attested pattern is not more learnable than an unattested, non-arbitrary pattern
  - (Partially) unexpected, given Wilson (2003)

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Summary of Findings

- A more frequent harmony type is not more learnable than a less frequent one
  - Expected, given Koo & Cole (2006)

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Implications…

- …for previous studies that investigated relation between frequency and learnability (Wilson 2003; Pycha et al. 2003; Koo & Cole 2006)
- …for theories that link typology to learnability (e.g., Chomsky & Halle 1968; Prince & Smolensky 1993; Blevins 2004; Moreton 2008)

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Future directions

- Regressive consonant harmony >> Progressive consonant harmony?

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Thank you!

Please contact me with questions and comments:
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