

LINGUISTIC AND NON-LINGUISTIC STRATEGIES IN ARTIFICIAL LANGUAGE LEARNING



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BACKGROUND

- Goals of linguistic theory:
 - Provide an account of the world's languages that explains the patterns that exist but avoids predicting the unattested patterns
 - Discover the universal cognitive principles that underlie language
- **Vowel Harmony**: a phonological process whereby vowels are forced to agree in some feature value (front, round, height, tenseness)
 - Occurs in wide variety of languages (Turkish, Finnish, Akan, Yokuts, etc.)
 - Wide typology with clear range of attested and unattested patterns allows us to test for universal patterns
 - Round Harmony: Agree in feature round:
 - Round vowels: [u, o]
 - Unround vowels: [i, e]
 - [pugobo], [gikeme], *[miko], *[pedo]
- Directional:
 - Spreading from Left-to-Right: /+ -/ → [+++]
 - Spread from Right-to-Left /++ -/ → [---]
- Dominant:
 - Spread Round (+ = "Round") /- + -/ → [+++]
- Unattested Vowel Harmony Pattern: Majority Rules
 - Change fewest features possible /+ + -/ → [+++]
 - /+ - -/ → [---]
- If attested vowel harmony patterns are part of general linguistic mechanism, then we should find them in learning:
 - Learn attested patterns over unattested patterns
- Use artificial grammar experiments to address assumptions/findings of linguistic theory (e.g. Moreton, in press; Newport and Aslin, 2003; Fycha et al., 2003; Wilson, 2003, 2006; Moreton, in press)

RESEARCH QUESTION

Do adult learning strategies reflect cross-linguistic biases for phonological rules?

EXPERIMENTAL DESIGN

- Artificial Language with Round Harmony
- Withhold data to be ambiguous between:
 - Attested (Directional) vs. Unattested (Majority Rules) patterns
 - Test on disambiguating items to infer what rule is learned (Wilson 2006)
- Participants heard a randomized list of 24 alternations:
 - (/disharmonic/ → [harmonic]) 5 times ("+" = "ROUND")
 - /pibe-do/ → [pibedi] /- - +/ → [---]
 - /gomop/ → [gomopu] /+ + -/ → [+++]
- Participants in control condition heard disharmonic underlying form only /pibe-do/
- Forced-choice test: All Round Vowels vs. All Unround Vowels /pi-be-du/ → [pibedi] (majority rules) vs. /pi-be-du/ → [pubodu] (right-to-left)

PILOT EXPERIMENT

- Design:**
- 3 single-syllable items (/pi/, /go/, /mi/) concatenated into 1 3-syllable harmonic item (/pigomi/)
 - Training Conditions: Majority Rules, Round Dominant, Ambiguous
 - Controls given only single syllables (no concatenations)
 - Force Choice task Round versus Unround concatenations: /pi, go, mi/ [pigomi] vs. [pugomi]
- Participants:**
- 13 adult Native English speakers in each condition (52 total)
- Results:**
- Overwhelming 'majority rules' bias
 - Control participants selected majority rules items 69% of time
 - Ambiguous treat items majority rules
 - Confound: Identity to initial syllable
 - Most items had the majority feature in the first syllable
 - If bias towards initial syllable, would have selected Maj. Rules as well

EXPERIMENT 1

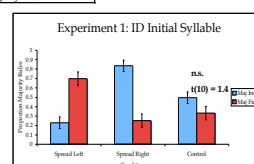
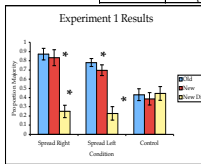
- Artificial (round harmony) grammar learning use morphophonological alternations:
 - /budoge/ → [budogo]
 - Increase memory for lexical items
 - Directional harmony
 - Tease apart directional bias
 - All training conditions ambiguous between Directional rule and Majority Rules
- Stimuli:**
- Naturally produced stimuli from adult male native English speaker
- Participants:**
- 33 total participants (11 participants in each condition)
 - Native English speakers

Design:

Condition	Spread Right	Spread Left	Control
Training	/+ + -/ → [+++]	/- - +/ → [---]	Inputs Only: [-] [-] [-]
	/+ + -/ → [+++]	/+ + -/ → [+++]	[+ + +] [- - -]
Majority Feature on Right Edge	New Dir	Old	Counterbalanced to match Spread
Majority Feature on Left Edge	Old	New Dir	Right / Left

Predictions:

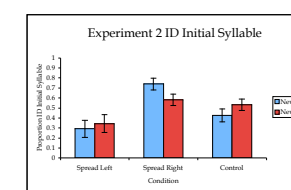
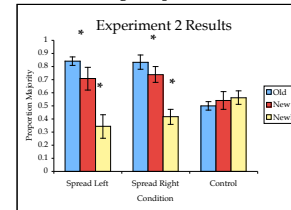
Condition	New Direction	Test Items
Spread Right	/- - +/ → [---]	Directionality [---] Majority Rules
	/+ + -/ → [+++]	Majority Rules [---] Directional Rule
Spread Left	/+ + -/ → [+++]	Majority Rules [---] Directional Rule
	/- - +/ → [---]	Directionality Majority Rules



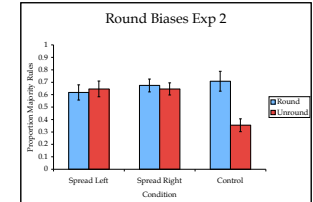
- Results:**
- Learned Directional Rule
 - No Majority Bias in Controls
 - Controls trend towards Initial-Syllable bias
 - No Majority Rules Biases: suggests results of Pilot due to initial syllable bias

EXPERIMENT 2

- Are differences between Pilot and Experiment 1 due to use of directionality or using alternations over concatenations?
- Design:**
- Replicate Experiment 1 (Directional Round Harmony Rule) with concatenations
 - Training stimuli consisted of single syllable items concatenated into 3-syllable items
 - /bu, do, ge/ → [budogo]
- Participants:**
- 24 total participants (8 participants in each condition) (JHU Undergraduates)
 - Native English speakers



- Results:**
- Learned directional constraint
 - Replicates Exp. 1
 - No Majority Rules bias
 - Replicates Exp. 1
 - Round Bias in Controls
 - Round bias holds for minority/non-initial [- + -] items as well
 - Different from Exp. 1 and Pilot
 - No initial syllable bias in controls
 - Different from Exp 1 and Pilot



CONCLUSIONS

- Learners prefer directional rules over 'Majority Rules' strategies
 - directional rules pattern like actual harmony systems
- Different biases for different controls
 - Initial syllable with no direction and with concatenation (Pilot)
 - Trends toward initial syllable with direction and alternations (Exp. 1)
 - Round bias with direction and concatenation (Exp. 2)
- Implication for Theoretical Linguistics:
 - Round biases and Initial Syllable biases attested in Natural Language
 - Majority rules not Attested in Natural Language
 - Our results parallel these patterns
- Learning strategies for artificial grammars tend towards cross-linguistic patterns

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