Learning consequences of derived-environment effects

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Across-the-board generalizations

- Phonological alternations often reflect static phonotactic restrictions in the lexicon
  - Duplication problem (Kenstowicz & Kisseberth, 1977)

1. Sibilants in a root agree in [anterior] (from Martin 2011)
   a. /ʧ'oʒ/ ‘worm’ */ʦ'oʒ/
   b. /ʦ'ózí/ ‘slender’ */ʧ'ózí/

2. Also holds across morph. boundaries → alternation
   a. /ji-s-lééʒ/ → [ji-J-lééʒ] ‘it was painted’
   b. /ji-s-tiz/ → [ji-s-tiz] ‘it was spun’
Derived-environment effects

• a.k.a. non-derived environment blocking (NDEB)

(3) /t, tʰ/ → [ʨ, ʨʰ] / ___+[i] (*ti)
   a. /mat-i/ → [matɕi] ‘eldest.NOM’
   b. /patʰ-i/ → [paʦʰi] ‘field.NOM’

(4) But [ti] and [tʰi] are attested within stems:
   a. /mati/ → [mati] ‘knot, joint’
   b. /tʰim/ → [tʰim] ‘team’

• Implications for phonological learning – mismatch between stem phonotactics and alternation
Questions

Overall question: What is the relationship between phonotactic and alternation learning?

1. Is phonotactically-unsupported phonology learnable at all (as in derived-env. patterns)?

2. Are derived-env. alternations more difficult to learn?
   • Constraint-based models: phonotactic knowledge assist alternation learning (Prince and Tesar, 2004; Jarosz, 2006; Tesar and Prince, 2007; Hayes and Wilson, 2008)
   • Predicts that phonotactic mismatch impedes alternation learning.

3. Does learning an alternation help learners notice a phonotactic gap? Is there a bias to maintain the same generalization?
Phonological knowledge: what do we know?

• Overall studies have generally looked at either:
  • Phonotactic knowledge (e.g. Saffran et al., 1996; Skoruppa & Peperkamp, 2011; Linzen & Gallagher, 2014) OR
  • Alternation learning (e.g. Wilson, 2006; Cristià et al. 2013, White, 2014).

• But not the relation between the two types of generalizations

• That phonotactic learning facilitates alternation learning
  ➔ Lacks experimental support
  ➔ Though see Pater & Tessier (2005)
Pater & Tessier (2005)

- Artificial grammar learning expt. (English speakers)
  - Lang. 1 – [t]-epenthesis driven by Eng. phonotactics – lax vowels don’t occur word-finally
  - Lang. 2 - [t]-epenthesis driven by frontness of final vowel – not supported by Eng. phonotactics

<table>
<thead>
<tr>
<th>Root</th>
<th>Singular</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /blɪ/</td>
<td>[blɪt]</td>
</tr>
<tr>
<td>b. /ɡɛ/</td>
<td>[ɡɛt]</td>
</tr>
<tr>
<td>c. /blej/</td>
<td>[blej]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Root</th>
<th>Singular</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /lij/</td>
<td>[lijt]</td>
</tr>
<tr>
<td>b. /blej/</td>
<td>[blejt]</td>
</tr>
<tr>
<td>c. /fuw/</td>
<td>[fuw]</td>
</tr>
</tbody>
</table>
Pater & Tessier (2005)

• Learners of Lang. 1 (phonotactically motivated) learnt the alternation better than learners of Lang. 2.

→ So: phonotactics helps!

• But pattern in Lang. 2 is typological unnatural

• This could have explained the poorer performance in Lang. 2.
  • Unnatural patterns dispreferred by learners (Hayes et al., 2009; Becker et al., 2011; Hayes & White, 2013)

• Fairer test: alternation motivated by same constraint, but with or without phonotactic support
• Derived env. patterns allow us to look at this.
Present study

• Artificial grammar learning study

• Artificial languages modeled on Korean /t/-palatalization

• Participants are tested on both static phonotactic knowledge as well as alternations.
Artificial languages

• Two languages created:
  1. Across-the-board: Alternation and stem phonotactic go together (like Navajo)
  2. Derived-environment: Alternation but no stem phonotactic (like Korean)
Artificial languages

• Consonants: [p, b, t, d, ŋ, ʒ]; Vowels: [a, i, u]
  • NB: /t/-ʧ/ and /d/-ʤ/ are phonemic
• Singular stems: CVC, CVCV, CVCVC
  • Plural: suffix –i
• Stress on initial syllable
• Highlighted phonotactic gap – increased the Expected value of [ti]/[di] – increased tV and Ci syllables
  • Otherwise, other CV syllables equally frequent in singulars

• Across-the-board: 52 singulars (no [ti]/[di] items)
• Derived-env.: 58 singulars (10 items with [ti]/[di])
  • Only difference was whether or not learners heard words with [ti]/[di]
Artificial languages

1. Plural alternations in both languages

/t, d/ → [ʧ, ʤ] / __i

<table>
<thead>
<tr>
<th></th>
<th>Singular → Plural</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>V: padu</td>
<td>padu-ʔi</td>
<td>~35%</td>
</tr>
<tr>
<td>p: ʧap</td>
<td>ʧap-i</td>
<td>~36%</td>
</tr>
<tr>
<td>b: dupib</td>
<td>dupib-i</td>
<td></td>
</tr>
<tr>
<td>ʧ: dutʧ</td>
<td>dutʧ-i</td>
<td>~7%</td>
</tr>
<tr>
<td>ʤ: pubiʤ</td>
<td>pubiʤ-i</td>
<td></td>
</tr>
<tr>
<td>t: dat</td>
<td>datʧ-i</td>
<td>~21%</td>
</tr>
<tr>
<td>d: dubad</td>
<td>dubadʤ-i</td>
<td></td>
</tr>
</tbody>
</table>

2. Singular stems

Across-the-board

- X tib
- X ʤati
- X titab

Derived-env. pattern

- ✓ tib
- ✓ ʤati
- ✓ titab
Participants

• Native American English participants recruited via UCLA Psych. Pool (received one course credit)
• One of the two language groups:
  • Across-the-board: n = 24
  • Derived-environment: n = 29
• Tested over the internet using Experigen (Becker and Levine, 2014)
Procedure overview

1. Training Phase

2. Blick test – well-formedness judgments on singulars

3. Wug test – decide correct plural
Training phase

• Listeners heard singular and plural forms for a nonce word on each trial
• Also saw images of objects (singular and plural)
• Two blocks of training – heard all words twice
Wug test

- Saw singular image, and heard singular word (as in training)
- Then saw plural image, and heard two plural options – asked to pick correct plural

<table>
<thead>
<tr>
<th>Stem-final C</th>
<th>Changed-plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>tʃ</td>
</tr>
<tr>
<td>b</td>
<td>dʒ</td>
</tr>
<tr>
<td>tʃ</td>
<td>t</td>
</tr>
<tr>
<td>dʒ</td>
<td>d</td>
</tr>
<tr>
<td>t</td>
<td>tʃ</td>
</tr>
<tr>
<td>d</td>
<td>dʒ</td>
</tr>
</tbody>
</table>

• None of the test words contained [ti]/[di] sequences.
• 52 familiar singulars (words heard by both groups)
• 48 novel singulars: 8 per stem-final consonant
Results: Wug test

Modeled % changed plural selected

Learnt alternations equally well!
Blick test

- Well-formedness judgment of both familiar and novel singular stems (no images)
Blick test

• 58 Familiar singulars:
  • Both language groups judged the same familiar words
  • Including [ti]/[di] words – familiar for Derived-env. learners but not Across-the-board learners.

• 36 novel singulars formed in the same vein as familiar words – two types:
  • [ti]/[di] items: words with [ti]/[di] -- e.g. $dʒati$, $ditfap$
  • Filler items: words without [ti]/[di] -- e.g. $puta$, $tfitup$
  • Apart from [ti]/[di] all other CV types occurred roughly equally

• Difference in endorsement of Filler vs. [ti]/[di] singulars
Results: Blick test

**Derived-environment** – Predicted: Filler = [ti]/[di]

- Overall lower endorsement of novel singulars
- No differences in endorsement rate for filler and [ti]/[di] singulars
Results: Blick test

Across-the-board – Predicted: Filler > [ti]/[di]

- Overall lower endorsement of novel singulars
- But no additional dispreference for [ti]/[di] singulars
Interim discussion

• Learners in both languages learned the alternation equally well
  • Learners in derived-environment language noticed [ti]/[di] singulars in training → no difference

• But Across-the-board language learners failed to notice the phonotactic gap – never heard any words with [ti]/[di]
  • Treated [ti]/[di] stems like novel fillers

• Significant effect of familiarity in both languages:
  • Potential task effect: Were participants relying on pure recall of words they had heard?
Experiment 2

• Stimuli exactly the same as in Expt. 1
• Same procedure: but in Blick test, participants only had to rate novel singulars, and not familiar ones.
• Participants were told that they had not heard any of the upcoming words previously.
  • Rely less on pure recall
• Participants:
  • Across-the-board: n = 21
  • Derived env.: n = 22
Results: Wug test

Across-the-board

<table>
<thead>
<tr>
<th>Stem–final C</th>
<th>[p,b]</th>
<th>[ch,dz]</th>
<th>[t,d]</th>
</tr>
</thead>
<tbody>
<tr>
<td>familiar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>novel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Same as in Expt. 1
Results: Blick test

Across-the-board: Filler > [ti]/[di]
Derived-env.: Filler = [ti]/[di]

- In both languages: no differences between filler and [ti]/[di] singulars
- But Derived-env. learners endorsed [ti]/[di] singulars significantly more often than Across-the-board learners.
Discussion

- Wug test results of Expt. 2 replicate Expt. 1.
  - No differences in alternation learning between learners in both languages

- Across-the-board learners still failed to notice the phonotactic gap
  - Although difference endorsement rate for [ti]/[di] singulars by language

- Reasons for failure?
  - Size of the phonotactic gap is too small.
  - Learning both alternations and phonotactics in a task is too demanding? - Alternations are just very salient?
Conclusions

1. Is phonotactically-unsupported phonology learnable at all (as in derived-env. patterns)?
   • Yes – learners in both language groups learnt alternation.

2. Is a derived-env. pattern more difficult to learn?
   • Unclear – crucial condition for comparing the languages not met.
     ➢ Across-the-board learners failed to learn phonotactic constraint.

3. Does learning an alternation help learners notice a phonotactic gap?
   • No – learning an alternation does not have a backwards effect on stem phonotactics (see also Pizzo, 2015).
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References

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References