Modeling failure in morphophonological learning

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This handout may be downloaded from https://linguistics.ucla.edu/people/hayes/.

BACKGROUND

1. SIGMORPHON and morphophonemic learning: the Shared Task
   - The Shared Task at SIGMORPHON has long served to guide and focus research.
   - Several recent Shared Tasks have involved the paradigm fill-in problem:
     - The participants design systems that learn from large sets of morphologically labeled paradigms
     - The systems are tested on their ability to provide correct inflected forms for held-out cases.
     - This task requires (at least implicit) learning of the morphological and phonological patterns.
     - For scientific purposes, this is a realistic task: humans who speak richly inflected languages take this test every day.
   - Toil and inspiration pay off as performance continues to improve.

2. What to do once complete success has been achieved?
   - An interesting further challenge would be to have systems that fail to learn correctly, in the same cases where humans fail.

3. This talk
   - A modest amount is known about human failure, and I will provide a survey here.
   - I will also offer very speculative accounts of the types and causes of human failure.
ABOUT HUMAN FAILURE

4. Who is responsible for failure?

- Pretty obviously: children, who are frequently observed producing ungrammatical paradigm fill-in forms.
  - Many English-learning children go through a stage of saying *brung* as the past participle of *bring*.
  - References:

5. How we learn about children’s errors

- Mostly, classical **diary studies**, now recorded as digital corpora (CHILDES).
- There are nice **experiments**, too; e.g. Do (2018) studies how Korean children perform the paradigm fill-in task.

6. Historical change in language as testimony of past child errors

- The established changes that have occurred in the paradigms of languages are generally agreed to be the acquisition errors of children, that somehow spread through the speech community.
- English *helped* is an innovation, replacing earlier *holp*, and matches errors observed in contemporary children, like *goed*.
- Thus, since Kiparsky (1978), historical change has been studied in hopes of learning something about human language acquisition, particularly in phonology.

SOME RELEVANT FINDINGS OF HISTORICAL LINGUISTICS

7. Some references

- A nice textbook is
- A recent paper that summarizes the points made below and cites the main theoretical literature:

8. Phonetic vs. phonological change

- Change in progress—observed in adult or adolescent speakers—tends to be **phonetic**; i.e. gradient.
- As change continues, it often reaches a **tipping point**:
A new generation of kids **reinterpret**s the evolved phonetic pattern, arriving at a novel categorical grammar — which is phonological change.

9. **A possible example of restructuring**

- The cluster /tr/ (*true, treat, nutritional*) was originally straightforwardly [tr].
- But it has gradually shifted in its articulation, becoming more like [tʃr].
- The gradual change can be tracked in individuals, who might consider [tr] be a more conservative variant, [tʃr] more casual.
- A new form, which surprised me, suggests that the gradual phonetic change has solidified into a categorical, restructured change:
  - [nutʃ], meaning “nutritional yeast”
  - The [tʃ] is now realized as such, even in the absence of the triggering [r].
  - Whoever made up this form probably “feels” a [tʃ] in *nutritional*.

10. **Bigger restructurings produce very noticeable — even catastrophic — language change**

- Key idea: extensive, evolved phonetic change poses an acquisition test for a new generation of children — which they may fail, creating a new form of their language.
  - Hence the title of this presentation.
- I will do three cases, each with a different conjectured cause.

I. **ODAWA ALTERNATING STRESS AND VOWEL DROP**

11. **Background and sources**

- Odawa is Algonquian, spoken in the Great Lakes region.

12. **Historical evolution, earliest stage**

- Our oldest attestation is from the grammar by Frederic Baraga, 1853.
- His description:
  - Stress is placed on even-numbered syllables, counting from left to right.
  - Stress also falls on long-voweled syllables.

  gotígumínágibíná: ‘he rolls someone’
  ní-gótítgómínágibíná: ‘I roll someone’
13. Next stage of evolution: phonetic change in stressless syllables

- Leonard Bloomfield, 1930’s
- His oldest consultants spoke like Baraga’s speakers from long before.
- But in his younger consultants, the stressless vowels where **shorter and more reduced**.

**Shorten:**

\[
\begin{align*}
gö́tígūmínágībíná: & \quad \text{‘he rolls someone’} \\
ní-gö́tígūmínágībíná: & \quad \text{‘I roll someone’}
\end{align*}
\]

**Reduce:**

\[
\begin{align*}
gö́tígūmínágībūná: & \quad \text{‘he rolls someone’} \\
ní-gö́tígūmūnágībíná: & \quad \text{‘I roll someone’}
\end{align*}
\]

- Indeed, bordering on deletion: the reduced vowels were described as “rapidly spoken and often whispered or entirely omitted”.
- It is easy to extrapolate: deletion must have become ever more common.

14. Third stage: children born in the late 1930’s

- These speakers were studied in later life by Rhodes (1985a, b) and other scholars.
- They like were exposed to a variety of Odawa in which the reduced vowels were hardly there at all — leading to a tipping point.
- Here is a good guess about what these children were hearing:

\[
\begin{align*}
gt̥ḡm̄ñ̄ḡb̄n̄: & \quad \text{‘he rolls someone’} \\
ngt̥ḡm̄n̄ḡb̄n̄: & \quad \text{‘I roll someone’}
\end{align*}
\]

- No need to mark stress, since only stressed syllables have survived!

15. The correct textbook-style analysis for the data that these children heard

- **Recapitulate history**: i.e.
- Assume “etymological” underlying representations — all vowels in their correct historical places.
- Assume abstract left-to-right alternating stress, followed by categorical deletion of stressless vowels.

\[
\begin{align*}
\text{‘he rolls someone’} & \quad \text{‘I roll someone’} \\
ḡt̥ḡm̄n̄ḡb̄n̄: & \quad \text{/}-ḡt̥ḡm̄n̄ḡb̄n̄: \\
\emptyset \emptyset \emptyset \emptyset & \quad \emptyset \emptyset \emptyset \emptyset \\
\text{Underlying representation} & \quad \text{Left-to-right alternating stress} \\
\text{Deletion of stressless vowels}
\end{align*}
\]
16. The tipping point for Odawa

- Per Bowers, the children learn a system radically different from their parents, in both grammar and lexicon.
- The new system:
  - For each stem, roughly, *the isolation form is now the underlying form*.
  - Prefixation is to this form.
  - There is essentially no phonology.
- Here are representative forms of what Bowers calls New Odawa:

  - \[ \text{gtgmíngíbná:} \text{ ‘he rolls someone’ unchanged} \]
  - \[ \text{nd}_\lambda-\text{gtgmíngíbná:} \text{ ‘I roll someone’ novel form} \]

(earlier 1 sg. form: \[ \text{ngótgómngíbína:} \])

- Comparable changes happened throughout the vocabulary.
- The adults of the 1930’s must have been very surprised at what their children were saying to them!

17. Where does the “crazy” prefix \[ \text{nd}_\lambda- \] come from?

- **Recutting.** The \([n]\) is part of the old prefix, and the \([d\lambda]\) comes from misapprehension of morpheme boundaries in the old alternations.
- **Historical derivation:**

  - ‘hang’
    - \[ \text{ágódʒín} \text{ ‘I hang’} \]
    - \[ \text{ni-ágódʒín} \text{ original form} \]
    - \[ \text{nd}\lambda\text{ágódʒín} \text{ resolve hiatus with [d]} \]
    - \[ \text{ágódʒín} \text{ ‘I roll someone’} \]
    - \[ \text{ndágódʒín} \text{ Left to right alternating stress} \]
    - \[ \text{ágódʒín} \text{ ‘I roll someone’} \]
    - \[ \text{ndágódʒín} \text{ Vowel Reduction} \]
    - \[ \text{gódʒín} \text{ ‘I hang’} \]
    - \[ \text{nd\lambdaogódʒín} \text{ Vowel deletion} \]

- The child’s straightforward morphological analysis of this, with \[ \text{nd}_\lambda- \] as prefix:

  - \[ \text{n d } \lambda \text{ g o: dʒ i n} \]
  - \[ \text{n d } \lambda \text{ g o: dʒ i n} \]

- Similar prefixes arose from other recut stem material, like \[ \text{nd}_1- \].
• These prefix allomorphs now compete with one another, with a non-etymological
distribution, and much free variation (Bowers).

18. Upshot

• The phonetic drift of Vowel Reduction into full deletion induced a catastrophe:
  ➢ massive stem reshaping
  ➢ loss of the stress system
  ➢ novel prefix system

• Bowers: dating of the sources suggests that the changes occurred essentially the very
  moment that reduction crossed the line to deletion.

19. Explaining the catastrophe

• Usually, the response to phonetic change is less dramatic (see below).
• What could explain such a massive change?

20. Bowers’s proposal

• The data pattern that the restructuring Odawa children encountered, unusually, requires
genuine serial derivation for its analysis.
• You must first assign stress, to know where to delete the vowels.” After the vowels are
dropped, the alternating count that governed stress is no longer present.
• But maybe phonology isn’t serial? Many scholars today opt for the all-at-once
derivations that hold in standard Optimality Theory (Prince and Smolensky 1993 et seq.)
• Standard OT works just fine for pre-vowel-drop Odawa, and falls flat for the pattern that
parents presented to their children in the 1930’s.
• Given that acquisition failed, this may be an explanatory virtue of standard Optimality
Theory, contra its serialist critics (e.g., McCarthy 2008).

21. Upshot

• I present Bowers’s account of Odawa as a vivid instance of failure in human
morphophonological learning.
• I offer one possible account (again from Bowers) for why failure occurred: phonological
grammar does not include the serial computations that would be needed to continue the
old system.
• The posited complete inability of humans to deal with the patently-serial Odawa pattern
explains the extreme response of the Odawa children who were confronted with that
pattern.
II. SEEDIQ PARADIGMS AND THE SINGLE-SURFACE-BASE HYPOTHESIS

22. Language information and sources

- Seediq is Austronesian, eastern Taiwan

23. The classical “cobbling” tradition in phonological analysis

- Phonological processes neutralize (wipe out information) in every member of the paradigm.
- To find an analysis, scan throughout the paradigm, finding the information we need to make an informationally-adequate underlying representation — “cobbling” the UR together.
- Yang (1976), working in classical generative phonology, offered a cobbled analysis for Seediq.

24. An Seediq example of a cobbled underlying form

/umal/ ‘to increase’

- This underlying form is never pronounced as such.
- It surfaces as [’uman] when alone.
- It surfaces as [’mal-an] when followed by the suffix [-an].
- We arrive at /umal/ by reasoning backwards, based on the known phonological rules of Seediq.

25. Deriving the non-suffixed form

/umal/ Underlying representation
  ’umal Penultimate Stress Assignment
  n Final Coronal Neutralization: 1 \rightarrow n / ___ \word
  [’uman] Surface representation

26. Deriving the suffixed form

/umal-an/ Underlying representation
  u’mal-an Penultimate Stress Assignment
  — Final Coronal Neutralization: 1 \rightarrow n / ___ \word
  ∅ Delete unstressed vowels at the beginning of a word.
  [’malan] Surface representation
27. Further justification: contrasting forms

- The underlying /l/ is needed because there are stems that have [n] across the board:
  
  \[\text{['}\text{durun}, \text{[du}'\text{run-an}] \quad \text{‘entrust’}\]
  
  so a rule like \( n \rightarrow l \) could never work.

- The underlying /u/ is needed because there are also stems that are monosyllabic across the board:

  \[\text{['}\text{req}, \text{[}'\text{req-an]} \quad \text{‘to swallow’}\]
  
  so a rule inserting /u/ could never work.

28. /umal/ is cobbled together

\[/u \quad m \quad a \quad l/\]

\[\text{['}u \quad m \quad a \quad n] \quad [\text{‘}m \quad a \quad l \quad (a \quad n)]\]

- Bold lines: correct UR segment obtainable only from this source.
- Dotted lines: either source would suffice.

29. Seediq, analyzed classically, needs a lot of cobbling

- Pretonic vowels delete when initial (as above), otherwise get merged together as [u].

  \[\text{‘}\text{geda}n \quad \text{gu}'\text{dan-an} \quad \text{‘die’} \quad /e/\]
  \[\text{‘}\text{biciq} \quad \text{bu}'\text{ciq-an} \quad \text{‘decrease’} \quad /i/\]
  \[\text{‘}\text{barah} \quad \text{bu}'\text{rah-an} \quad \text{‘rare’} \quad /a/\]
  \[\text{‘}\text{burah} \quad \text{bu}'\text{rah-an} \quad \text{‘new, create’} \quad /u/\]

- Posttonic vowels, under slightly different conditions, get merged as [u].

  \[\text{‘}\text{remux} \quad \text{ru}'\text{mu}x\text{n} \quad \text{‘enter’} \quad /u/\]
  \[\text{‘}\text{pemux} \quad \text{pu}'\text{mexan} \quad \text{‘hold’} \quad /e/\]
  \[\text{‘}\text{do?us} \quad \text{do}'\text{os-an} \quad \text{‘kind of metal’} \quad /o/\]

- \( l \rightarrow n / \_\_\_\_ \)_word is only one of a set four final consonant neutralization rules.

  \[/p/, /b/, /k/ \rightarrow [k]\]
  \[/d/, /t/, /ts/ \rightarrow [ts]\]
  \[/m/, /n/ \rightarrow [n]\]
/l/,/n/ → [n]

30. **Odawa is cobbled too, of course**
   - But it seems a more drastic case.
   - Odawa’s phonetic changes led to catastrophe.
   - As we will see, Seediq has responded much more moderately, changing one word at a time and gradually evolving its lexicon.
   - The Seediq pattern does not require serialism, so the catastrophe-inducing mechanism found in Odawa is not present in Seediq.

31. **What might explain Seediq? The Single Surface Base Hypothesis**
   - In a series of papers, Adam Albright has argued that kids don’t cobble. Rather:
   - They find the slot in the paradigm (Yiddish 1st person sg., Lakhota 2nd pers., etc.) that is most **informationally nutritious** — best permits the other forms to be predicted.
   - They favor this slot, perhaps exclusively, for synthesizing novel forms.
   - Where derivation from the favored slot fails, speakers lexically list the unpredictable form.
   - As with this talk, the hypothesis is supported by data from language change.
   - Refs.:

32. **The Single Surface Base Hypothesis works really well for Seediq**
   - The privileged base for Seediq turns out to be the **isolation form**.
   - Kuo’s work demonstrates this rigorously with machine-implemented grammars that predict either:
     - the suffixed form from the isolation base form: 78% correct
     - the isolation form from the suffixed form: 23% correct
   - Why does the isolation form work so well? Conjecture:
     - Already, generations of Sediiq children, adopting the isolation-form base, have committed errors of learning, on a word-by-word basis, recreating the suffixed form.
     - Each of these individual errors makes the isolation-base analysis work even better.
     - In related languages (Maori; Hale 1973), the gradual repair process is essentially complete, making suffixed forms fully predictable.

33. **Watching Seediq change, per Albright/Kuo**
   - The paradigm [ʼuman] ~ [ʼmal-an], given earlier, was elicited from consultants born ca. 1940.
Kuo’s own consultants, were born ca. 1960, and say [ˈuman] ~ [ˈman-an].

This is just what is expected from the Single Surface Base Hypothesis, given that “[n]-across-the-board” is more common than “[n]-alternating-with-[l]”.

I.e., the children born ca. 1960 synthesized the new form [ˈmanan], following the dictates of their Albrightian bases.

The speakers born ca. 1940 probably had the same grammar, but listed [ˈmal-an] as a lexical entry.

### 34. Upshot: conjectured mechanism

- Seediq does not involve serialism, and has experienced no catastrophes.
- But the superior choice of the isolation form as the Single Surface Base has gradually led to an ironing out of the suffixed forms, making them ever more predictable.

### III. SERBO-CROATIAN PARADIGMS AND PHONETIC SIMILARITY

#### 35. Background and source material

- South Slavic, Bosnia/Croatia/Serbia/Montenegro

#### 36. Serbo-Croatian offers a lovely problem set

<table>
<thead>
<tr>
<th>zelén</th>
<th>zelen-á</th>
<th>zelen-ó</th>
<th>zelen-i</th>
<th>‘green’</th>
</tr>
</thead>
<tbody>
<tr>
<td>béo</td>
<td>bel-á</td>
<td>bel-ó</td>
<td>bel-i</td>
<td>‘white’</td>
</tr>
<tr>
<td>mío</td>
<td>mil-á</td>
<td>mil-ó</td>
<td>mil-i</td>
<td>‘dear’</td>
</tr>
<tr>
<td>veseo</td>
<td>vesel-a</td>
<td>vesel-o</td>
<td>vesel-i</td>
<td>‘gay’</td>
</tr>
<tr>
<td>jásan</td>
<td>jasn-á</td>
<td>jasn-ó</td>
<td>jasn-i</td>
<td>‘clear’</td>
</tr>
<tr>
<td>dóbar</td>
<td>dobr-á</td>
<td>dobr-ó</td>
<td>dobr-i</td>
<td>‘kind’</td>
</tr>
<tr>
<td>múkao</td>
<td>mukl-á</td>
<td>mukl-ó</td>
<td>mukl-i</td>
<td>‘hoarse’</td>
</tr>
</tbody>
</table>

#### 37. The correct answer, in brief

- **Epenthesis**: Break up word-final consonant clusters with an inserted [a].
- **L-Vocalization**: turn /l/ at the end of a syllable into [o]

<table>
<thead>
<tr>
<th>/bel/</th>
<th>/bel-a/</th>
<th>/jasn/</th>
<th>/jasn-a/</th>
<th>/mukl/</th>
<th>/mukl-a/</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>—</td>
<td>jasan</td>
<td>—</td>
<td>mukal</td>
<td>—</td>
</tr>
</tbody>
</table>

Underlying representations

Epenthesis

L-Vocalization

Surface representations
38. Probable history of this pattern: gradual phonetic change of [l] to [o]

- In many languages, English included, [l] at the end of a syllable is “**dark**” = pronounced with backed tongue-body position.
  - Compare light [l] in *let* [let] with dark [ɬ] in *tell* [tɛɬ].
- Dark [ɬ] is partway to [o], relative to light [l].
- Subsequent phonetic change removes the tongue-blade movement, adds lip rounding, and makes the result syllabic.

39. That problem set was **heavily edited!**

- Bochner’s contribution is to show that, with in-depth knowledge of the language, we find a huge amount of exceptionality and irregularity.
- Below is just a selection of the data mess that Bochner bravely wades through.

40. Lexical exceptions

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>val</td>
<td>‘wave-nom. sg.’</td>
<td>not *[vao]</td>
</tr>
<tr>
<td>val-a</td>
<td>‘wave-gen. sg.’</td>
<td></td>
</tr>
<tr>
<td>kal</td>
<td>‘mud-nom. sg.’</td>
<td>not *[kao]</td>
</tr>
<tr>
<td>kal-a</td>
<td>‘mud-gen. sg.’</td>
<td></td>
</tr>
<tr>
<td>ogledalo</td>
<td>‘mirror’</td>
<td></td>
</tr>
<tr>
<td>oglekalce</td>
<td>‘mirror-diminutive’</td>
<td>not *[oglecaoce]</td>
</tr>
<tr>
<td>sedl-o</td>
<td>‘seat’</td>
<td></td>
</tr>
<tr>
<td>sedal-ce</td>
<td>‘seat-diminutive’</td>
<td>not *[sedaoce]</td>
</tr>
</tbody>
</table>

41. Doublets with varying meaning

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>selo</td>
<td>‘village’</td>
<td></td>
</tr>
<tr>
<td>seoce</td>
<td>‘pertaining to villages in general’ (used in poetic or literary contexts)</td>
<td></td>
</tr>
<tr>
<td>selce</td>
<td>‘pertaining to some specific village’</td>
<td></td>
</tr>
</tbody>
</table>

- There are about 12, and in all, the more transparent meaning is the productive one.

42. Implications of the doublets

- This is important: opaque meanings imply memorization, so the innovative form is that one that keeps [l] and *does not alternate.*
- So non-alternation is probably the productive pattern.
43. Why has Serbo-Croatian /l/ to [o] experienced partial breakdown?

- There are many possible explanations, of which my favorite is:
  - **Language disfavor phonetically extreme alternation.**
    - i.e. [l] is phonetically very different from [o]
- There is independent evidence supporting the principle just given.
  - Historical changes that reduce alternation distance (Kiparsky 1978)
- Refs.

**SUMMING UP**

44. The three cases of restructuring discussed here and their conjectured origin

I. Odawa: Mislearning because human grammars are (conjectured to be) **non-serial** — can’t match the result of a sequenced historical change.
II. Seediq: Mislearning because human grammars are constrained by the **Single Surface Base Hypothesis**.
III. Serbo-Croatian: Mislearning because human grammars learning is biased to **resist phonetically extreme alternation**.

45. There are probably many other factors that result in acquisition error, e.g.

- Complexity, unpredictability, low frequency
- A great deal of research remains to be done.
- This research might benefit greatly from computational participation: explicit, implemented models that predict acquisition failure in all its forms.

46. End

- Thanks for listening, and I look forward to your questions.