Evaluating the inevitability of a phonological change: /æ/ in Philadelphia

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Evaluating the inevitability of a phonological change: /æ/ in Philadelphia

What is happening to /æ/ in Philadelphia?

2 allophones of /æ/:
- "Tense": [iə ~ eː]
- "Lax": [æ]

The complex Philadelphia System (Philly) of distributing these allphones is being replaced by the simpler Nasal System (Nasal)

Questions:

Overarching question:
- Is it inevitable that a system as complex as Philly would be replaced by Nasal?

Specific questions:
- What is the likelihood that given Philly input data, learners would hypothesize a Nasal grammar?
- Once both Philly and Nasal grammars are available, is Nasal destined to win in grammar competition?
Outline

• A brief overview of the Philly and Nasal systems.
• A productivity analysis to see whether a Nasal grammar is plausible given Philly input.
• A grammar competition analysis to see whether Nasal is destined to replace Philly.
  • A brief diversion into challenges we faced when trying to apply grammar competition models to phonology.

The Philadelphia and Nasal Systems

The Philadelphia System

Lexical Exceptions:

\[
\begin{align*}
\text{if } \alpha \in L_{\text{tense}} & \text{ then } \beta \\
\text{if } \alpha \in L_{\text{lax}} & \text{ then } \alpha
\end{align*}
\]

Phonological Regularity

\[
if \ \alpha x \ \text{ and } \ x \in \text{stem and } x \in P \ \text{ such that } \\
\{P = (\text{nasals} \cup \text{voiceless fricatives}) \cap \text{anterior} \}
\]

else \ \alpha

The Philadelphia System

Anteriority:

\[
\begin{array}{c|c|c}
\hline
\text{tense} & \text{lax} & \\
\hline
\text{ham} & \text{ban} & \text{bang} \\
\text{calf} & \text{path} & \text{pass} & \text{cash} \\
\hline
\end{array}
\]

Syllabiety:

\[
\begin{array}{c|c|c}
\hline
\text{tense} & \text{lax} & \\
\hline
\text{ham} & \text{hammer} & \\
\text{cast} & \text{castle} & \\
\hline
\end{array}
\]
The Philadelphia System: Abstractness

Affixation ← tense lax →

<table>
<thead>
<tr>
<th>class</th>
<th>classes</th>
<th>classic</th>
</tr>
</thead>
<tbody>
<tr>
<td>man</td>
<td>manning</td>
<td>Manning</td>
</tr>
</tbody>
</table>

Truncation ← tense lax →

| mathematics | math |
| examination | exam |

The Philadelphia System: Abstractness

Syncope ← tense lax →

<table>
<thead>
<tr>
<th>family:</th>
<th>camera:</th>
</tr>
</thead>
</table>

Assimilation ← tense lax →

<table>
<thead>
<tr>
<th>fan club:</th>
<th>fang club:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[fæn.klʌb]</td>
<td>[fæŋ.klʌb]</td>
</tr>
</tbody>
</table>

The Philadelphia System: Lexical Exceptions

\[ L_{\text{lax}} \] \{(ran, swam, began, and, can, than), aspirin, carafe, alas\}

\[ L_{\text{tense}} \] \{mad, bad, glad\}
The Philadelphia System

- Basic segmental conditioning
- Complicated morphological interactions
- Lexical exceptions

Tensing of /æ/ before anterior, tautosyllabic [nasals, voiceless fricatives]

Applies at stem level

Inflectional vs. derivational morphemes

Learned words

Class 3 strong verbs (past tense)

Mad, bad, glad

<table>
<thead>
<tr>
<th></th>
<th>Philly</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>Ran</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>Mad</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>Aspirin</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>Caraffe</td>
<td>tense</td>
<td>lax</td>
</tr>
</tbody>
</table>

The similarity between Philly and Nasal

Philly: Tensing of /æ/ before anterior, tautosyllabic [nasals, voiceless fricatives]

Nasal: Tensing of /æ/ before [nasals]

<table>
<thead>
<tr>
<th>Condition</th>
<th>Example</th>
<th>Philly</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ant. tautosyll. Voiceless Fric</td>
<td>pass</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>MBG exceptions</td>
<td>mad, bad, glad</td>
<td>tense</td>
<td>lax</td>
</tr>
<tr>
<td>Anterior tautosyll. nasals</td>
<td>man, ham</td>
<td>tense</td>
<td>tense</td>
</tr>
<tr>
<td>Anterior heterosyll. nasals</td>
<td>hammer, manage</td>
<td>lax</td>
<td>tense</td>
</tr>
<tr>
<td>Posterior nasals</td>
<td>hang, bank</td>
<td>lax</td>
<td>tense</td>
</tr>
<tr>
<td>Nasal exceptions</td>
<td>ran, and</td>
<td>lax</td>
<td>tense</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>cat</td>
<td>lax</td>
<td>lax</td>
</tr>
</tbody>
</table>

Yang’s Productivity Model

T ≤ N / \ln(N)

Tolerance Principle: A productive rule can handle N/\ln(N) exceptions

Is the Nasal system a plausible rule, given Philly input?

<table>
<thead>
<tr>
<th>Token (Philly)</th>
<th>Expectation (Nasal)</th>
<th>Exception?</th>
</tr>
</thead>
<tbody>
<tr>
<td>mæn</td>
<td>mæn</td>
<td>no</td>
</tr>
<tr>
<td>caet</td>
<td>caet</td>
<td>no</td>
</tr>
<tr>
<td>bæd</td>
<td>bæd</td>
<td>yes</td>
</tr>
</tbody>
</table>

T = total number of exceptions
N = total number of /æ/ words
Applying Tolerance Principle
CHILDES database (MacWhinney, 2000)

Applying Tolerance Principle: most frequent words

Productivity Wrap Up

Grammar Competition
**Philly and Nasal in competition**

**Yang’s Grammar Competition Model**

Fitness (G) = proportion of unambiguously 'G' clauses it generates out of all the clauses it generates. If Fitness(G1) > Fitness(G2), G1 wins.

V2 and SVO competing

<table>
<thead>
<tr>
<th>Ambiguous</th>
<th>SVO</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2 Advantage</td>
<td>XVSO, OVS</td>
</tr>
<tr>
<td>SVO Advantage</td>
<td>XSVO, XIVO</td>
</tr>
</tbody>
</table>

**The Challenge in Applying Competition to Phonology**

<table>
<thead>
<tr>
<th>Strings</th>
<th>Fitness(G) = proportion unambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambiguous</td>
<td>h[ǣ]m, c[æ]t</td>
</tr>
<tr>
<td>Nasal Advantage</td>
<td>h[ǣ]mm, h[ǣ]ng, c[æ]st, b[æ]d</td>
</tr>
<tr>
<td>Philly Advantage</td>
<td>h[æ]mmmer, h[æ]ng, c[ǣ]st, b[ǣ]d</td>
</tr>
</tbody>
</table>

van der Feest & Fikkert (2015) found children detected default-for-marked errors, but not marked-for-default.

Noisy Harmonic Grammars

Philly data

training

Noisy Harmonic Grammar

Philly data

testing

Philly Grammar

Philly grammar accuracy on Philly data

Nasal data

training

Noisy Harmonic Grammar

Nasal data

testing

Nasal Grammar

Nasal grammar accuracy on Philly data

Constraint Set =

\*æ
\*ǣ
\*æ
\*σ
\*æ
…
\*σ
\*æ
\*σ
…

10 chains, 9,000 training iterations

Harmonic Grammar Results

Conclusions
Conclusions