For a sensible approach to the analysis of child phonological data

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Child language seems weird (but is it, really?..)

- Several processes observed in child language are not attested in adult languages; e.g.
  - Major PoA consonant harmony (duck > ‘guck’)
  - Reduplication (again > ‘ge ge ge ge ge ge...’)
- Analyzing these processes is rather challenging:
  - Some look at the statistical properties of the input (e.g. Levelt, Demuth, Lló, Kehoe)
  - Some investigate the issues from a formal perspective (e.g. Bernhardt, Stemberger, Dinnesen, Gierut, Goud, Rose, Freitas, Pater, Flkert, Levelt, ...)
  - Some think that we simply shouldn’t bother (esp. Hale & Reiss 1998)

Can any of these approaches (or lack thereof) be validated?

An example: the statistical approach

Statistical approaches: Foundational work

- Infant speech perception:
  - Statistical and probabilistic approaches provide appealing / convincing explanations for:
    - Discrimination of sound sequences
    - Perception and development of ling. categories
  - Development of the mental lexicon
    (Work by, e.g. Aslin, Gerken, Jusczyk, Maye, Morgan, Newport, Saffran, T ees, Werker, ...)
  - Development of word categories
    (e.g. Curtin, Werker)

Statistical approaches: Predictions

- The order of acquisition of syllable types, word shapes, phones, etc. correspond to their frequencies in the ambient language:
  - Most frequent units acquired first
  - Least frequent units acquired later
  - Units with comparable frequencies acquired during the same period
The development sequences correspond to the frequencies observed in the language Variation between groups A and B: syllable types with comparable frequencies

CV > CVC > CV > VC > CCV

Their conclusion: acquisition paths can be predicted through input frequency from ambient language

Questions

Does the frequency approach make any better predictions than more traditional approaches based on complexity (e.g. of phonological representations)?

Order of acquisition predicted by complexity:
Less complex >> more complex

In most cases, predictions are identical:
Complexity and frequency are in correlation (Less complex = more frequent = acquired early)

In the larger context...

Emerging processes:
- Consonant harmony (e.g. *duck > [gak])
- Velar fronting (e.g. *kick > [tik])
- Segmental substitution (e.g. *fit > [stɪ])
- Syllable truncation (e.g. *elephant > [ɪfə])
- Syllable reduplication (e.g. *ami > [mim])
- ...

Why do children produce patterns that cannot be directly induced by statistics of the input, or even predicted by phonological theory in general?

Frequency versus complexity

Back to groups A and B in Dutch data:
- Group A: Final CC sequences before initial ones:
  - CVCC >> VCC >> CCV >> GCVC
- Group B: Initial CC sequences before final ones:
  - CCV >> GCVC >> CVCC >> VCC
- Non-attested patterns (there are 22 of these):
  * CVCC >> CCV >> VCC >> CCVC;
  * CCV >> GCVC >> GCVC >> VCC;
  (i.e. all cases where #CC and CC# are mixed)

However:
The non-occurrence of these unattested patterns is predicted by a complexity-based approach.

Frequency versus complexity

Complexity-based approach:
- The structures are independent
  - Finnish, Klamath: CVCC; but not *CCVC
  - Mazateco, Sedang: CCV; but not *CVCV
- Groups A and B in Dutch (again!):
  - Group A: Final CC sequences before initial ones:
    - CVCC >> VCC >> CCV >> GCVC
  - Group B: Initial CC sequences before final ones:
    - CCV >> GCVC >> CVCC >> VCC
  - Group A: final structure acquired first
  - Group B: initial structure acquired first
  - Conclusion: only possible grammars are attested
**General approach**

- The learning path is governed by the child's **grammatical analysis** of his/her language
- Intuition expressed in the acquisition literature of the 1970s and 1980s (e.g., Goad & Ingram 1987)
- Approach explicit in work on distributional learning (e.g., Pinker, Slobin, ...)
- Also e.g. Dresher and v.d. Hulst on learnability
- The child's productions are **influenced by both grammatical and non-grammatical factors**
- Non-grammatical factors can also influence productions independently of child's analysis

**Methodological implications**

- Consider a wide variety of cross-linguistic child production data in their larger context
- Interpret these data based on:
  - Property of the input (ambient language)
  - Its phonetics and phonology
  - Other factors such as input frequency
  - Morpho-syntax
  - Derivations, inflections, word order, systems
- Larger context (social, pragmatic, ...)

**Some examples and illustrations**
Perceptual effects

- Erroneous representations due to incorrect perception of speech input (Smith 1973)
- puzzle /pʊzəl/ → [pʊzəl] -- /z/ → [d]
- puddle /pʊdəl/ → [pʊdəl] -- /d/ → [g] (*[d])

- If the child can produce [d] in puzzle, then the non-production of [d] in puddle cannot be caused by a grammatical problem
- The word puddle is represented with a /g/ in the child’s mind ⇒ there is no real ‘process’ involved (Braine 1976, Macken 1980)

Merger of acoustically-similar sounds

- Acquisition of the /θ/ ~ /ð/ contrast in English:
  
  - /θ/ → [f] (e.g. fin → [fin])
  - /ð/ → [f] (e.g. thin → [fin])

- /θ/ and /ð/ are acoustically extremely similar and often confused at the perceptual level (e.g. Levitt et al. 1987; Borden et al. 2004)
- If the child perceives and represents /θ/ as [f], then there is no way that thin will be produced as such

Articulatory effects: vocal tract

- Adult forms and proportions are attained between ages 6 and 10 (Crelin 1987; Ménard 2002)

- The tongue is a unique muscle in the human body
- Muscular hydrostat
- Two functional sections (root, tip)
- Full motor control for tongue shape is acquired fairly late in development (e.g. Kent 1992)
- Fine contrasts (e.g. [θ ~ θ]) may be compromised
- Tongue movements in early speech are ballistic (lack refined control), especially in strong articulations (e.g. Studdert-Kennedy & Goodell 1992)
- Lingual contrasts may be affected by position

Positional velar fronting

- ‘Strong’ positions (e.g. initial, stressed): k/g → t/d
  - cake: [t]ake
  - cookie: [t]ookie

- ‘Weak’ positions (e.g. medial unstr’d; final): OK
  - cake: ca[k]e
  - cookie: coo[k]ie

‘Take and tookie’
‘Sagwa is a tat’
Positional stopping

'Strong' positions (e.g. initial, stressed): continuant ➔ stop

\begin{align*}
\text{before} & \quad \text{be[p]ore} \\
\text{casino} & \quad \text{ca[t]ino} \\
\text{sun} & \quad \text{[t]un} \\
\text{person} & \quad \text{per[s]on} \\
\text{miss} & \quad \text{mi[s]} \\
\text{cave} & \quad \text{ca[v]e}
\end{align*}


'Weak' positions (e.g. medial unstr’d; final): OK

\begin{align*}
\text{be} & \quad \text{f} \quad \text{or} \quad \text{be}\[p]\text{ore} \\
\text{casino} & \quad \text{ca[t]ino} \\
\text{sun} & \quad \text{[t]un} \\
\text{person} & \quad \text{per[s]on} \\
\text{miss} & \quad \text{mi[s]} \\
\text{cave} & \quad \text{ca[v]e}
\end{align*}

\text{Acoustic correlates (e.g. PVF)}

\text{Strong consonantal positions}

\text{Weak consonantal positions}

\text{t}^\text{th} \text{ et k } \& \text{ t}^\text{h} \text{ A k i:}

* Positional stopping = same contextualization

What type of analysis should we favour?

- Descriptive constraints? (e.g. Dinnsen 2007)
  - *#K/, *#S
  - What does this do beyond data description?...
- Representational analyses?
- Prosodic domains? (e.g. Chiat 1989; Rvachew & Andrews 2002; Marshall & Chiat 2003)
  - Positional effects related to syllable or foot structure
  - Certainly on the right track:
  - Relationship to prosodic (stress) structure
  - Grammatically-conditioned output effect
  - Or maybe we’re facing another conspiracy...

Hypothesis (Inkelas and Rose 2008)

- The child perceives the grammatical contrast between strong and weak consonants
- The immature shape of the vocal tract and the imperfect control of the tongue prevent an accurate rendition of this contrast, such that:
  - Extended contact of the tongue body on the palate brings closure into front area of the palate
  - At release, the consonant sounds like a [t, d]
- Conclusions:
  - The child is phonetically inaccurate; but...
  - The child is grammatically accurate

Further proof of grammaticality: Positional lateral neutralization

- Different process; same contextualization
- Target /l/:
  - Pronounced as [j] in strong positions
  - Pronounced as [w] in weak positions
- This pattern cannot be driven by lingual articulations only
- Cannot be fully explained by adult distributions of ‘dark’ versus ‘clear’ /l/
- The patterns follows the same contextualization as positional velar fronting

Speech patterns (prosodically strong positions)

- Word-initial primary-stressed syllable onset
  - [gamp] ‘jamp’ 1;10.0
  - [lokp jok [jok jop]] ‘Looks like a Lincoln log!’ 2;9.9
- Word-initial un unstressed
  - [jivan] ‘Livan’ 2;8.19
- Word-medial primary-stressed syllable onset
  - [hajow] ‘hauo’ 1;10.0
  - [sajow] ‘stouo’ 2;3.29
- Word-medial secondary stressed syllable
  - [gwej jaka] ‘Goldilocks’ 2;4.2
  - [pajd jok] ‘Padlocks’ 2;4.9
Speech patterns
(prosodically weak positions)

- Intervocalic unstressed syllable onset
  - [hæw*əˈka] 'helicopter' 1;11.10
  - [əwəˈdəra] 'alligator' 2;1.10

- Word-medial coda
  - [nɔʊ mɪ] 'hold me' 1;10.25
  - [biˈwda] 'Hilda' 1;11.10

- Word-final
  - [bejju] 'bagel' 1;9.24
  - [f.ˌw] 'fell' 2;0.19

The discrepancy between PLN and the distribution of /l/ in English

<table>
<thead>
<tr>
<th>Word-initial</th>
<th>Unstressed medial onset</th>
<th>Stressed medial onset</th>
<th>Coda, word-final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>Lightest ([l]) ← → Darkest ([r])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E [j] [w] [j] [w]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contexts for: [velar fronting] vs [no velar fronting]

Conclusion:
The child grammaticalized two pronunciation rules (for velar and laterals) based on the same prosodic categories

Discussion

Summary

- Mono-factorial approaches to child language:
  - Do not provide many useful explanations
  - Sometimes complicate the explanations of observed phenomena
  - An understanding of developmental production patterns requires a multi-faceted analysis incorporating:
    - Perceptual factors
    - Articulatory effects
    - Grammatical organization
    - These components interact with one another

Some further questions

- What should analyses of child language phonological patterns really give us?
  - A grammar in the traditional sense of the term?
  - Insight into a more general system?
- Should constraints that represent physiological or motor issues be part of the grammar at all?
  - Cf. Pater's (1997) child-specific constraints
- The answer to this question should probably be NO, if we want a theory of grammar
- This calls for a more modular system with interacting parts and interfaces between them

If all this makes sense...

... we have to maintain a formal distinction between phonetics and phonology

- Phonology: Representations, Constraints
- Phonetics: Rules of phonetic implementation
Conclusion

- Child language is entirely compatible with current theoretical issues that pertain to phonetics and phonology as a system of constraint interaction.
- The peculiarities of child language offer a nice workbench for the elaboration and testing of current formal models.
- This work raises fundamental questions about the very definition of what should be our object of study and how we should approach these objects, both empirically and formally.

Thanks for your attention!

Feedback? Questions? PDF version? yrose@mun.ca