

*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...')
- Analyzing these processes is rather challenging:
 - Some look at the statistical properties of the input (e.g. Levelt, Demuth, Lleó, Kehoe)
 - Some investigate the issues from a formal perspective (e.g. Bernhardt, Stemberger, Dinnsen, Gierut, Goad, Rose, Freitas, Pater, Fikkert, Levelt, ...)
 - Some think that we simply shouldn't bother (esp. Hale & Reiss 1998)

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

**An example: the statistical
approach**

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**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, Tees, Werker, ...)
- (Other factors such as segmental, co-articulatory and supra-segmental information also play a role in language learning) (e.g. Curtin, Werker)

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**Statistical approaches:
Some proposals**

- **Child early productions:**
 - **Levelt, Schiller & Levelt (2000):**
The order of acquisition of syllable types in young Dutch learners corresponds to the relative frequency of these syllable types in the ambient language
 - **Demuth & Johnson (2003):**
Syllable truncations resulting in CV forms in French correlate with the high frequency of CV syllables in this language

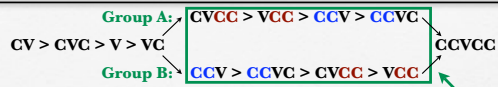
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Statistical approaches: Predictions

- 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**

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Levelt, Schiller & Levelt (2000)



- The development sequences correspond to the frequencies observed in the language
 - **Variation** between groups A and B: syllable types with **comparable frequencies**
- CV > CVC > V > VC > [CVCC ≈ CCVC ≈ CCV ≈ VCC] > CCVCC

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

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Questions

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Frequency versus complexity

- 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**)

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Frequency versus complexity

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

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Frequency versus complexity

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

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In the larger context...

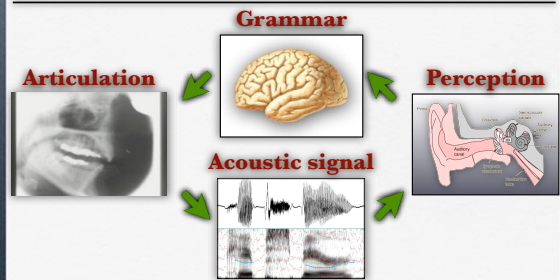
- Emerging processes:
 - Consonant harmony (e.g. *duck* > [gʌk])
 - Velar fronting (e.g. *kick* > [tik])
 - Segmental substitution (e.g. *fit* > [sit])
 - Syllable truncation (e.g. *elephant* > [ifa])
 - Syllable reduplication (e.g. *ami* > [mimi])
 - ...
- **Why do children produce patterns that cannot be directly induced by statistics of the input, or even predicted by phonological theory in general?**

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Proposal

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The spoken chain



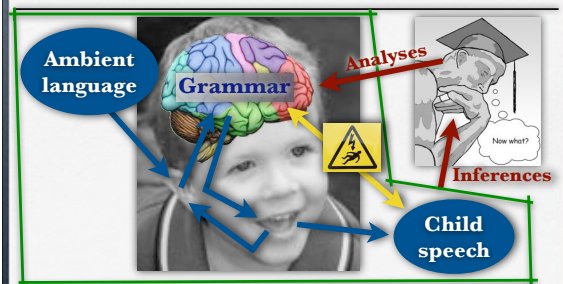
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General approach

- 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

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What kinds of factors?



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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
 - **Phonetics (perception, articulation)**
 - **Phonology (representations, categories)**
 - Morpho-syntax
 - Derivations, inflections, word order, systems
 - Larger context (social, pragmatic, ...)

Today's focus:

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Some examples and illustrations

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Perceptual effects

- Erroneous representations due to incorrect perception of speech input (Smith 1973)
 - *puzzle* /pʌzəl/ → [pʌdəl] -- /z/ → [d]
 - *puddle* /pʌdəl/ → [pʌgəl] -- /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)

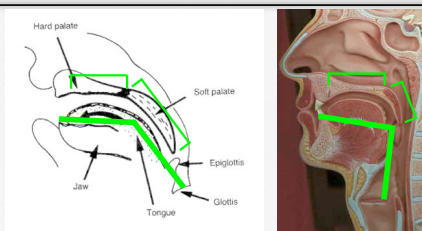
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Perceptual effects

- Merger of acoustically-similar sounds
 - Acquisition of the /θ/ ~ /f/ contrast in English:
 - /f/ → [f] (e.g. *fin* → [fɪn])
 - /θ/ → [f] (e.g. *thin* → [fɪn])
 - /θ/ and /f/ 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

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Articulatory effects: vocal tract



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

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Articulatory effects: motor control

- The tongue is a unique muscle in the human body
 - Muscular hydrostat
 - Two functional sections (root, tip)
- Motor control is imperfect in young children
 - Full motor control for tongue shape is acquired fairly late in development (e.g. Kent 1992)
 - Fine contrasts (e.g. [θ ~ s]) 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

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Conspiracy between perception and articulatory limitations

- 'Chain shift' phenomena: problematic for strictly grammatical approaches to productions (Hale & Reiss 1998; Bernhardt & Stemberger 1998)
 - /θ/ → [f] (*thick* /θɪk/ → [fɪk])
 - /s/ → [θ] (*sick* /sɪk/ → [θɪk])
- Why not /θ/ → [θ] if [θ] is possible in outputs?
- Explanation:
 - /θ/ → [f]: perceptual effect
 - Thus: [θ] = [f] in mental representations
 - /s/ → [θ]: frontal lisp-like articulatory problem

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Positional velar fronting

‘Strong’ positions (e.g. initial, stressed): k/g → t/d	<i>cake</i>	[t]ake
	<i>cookie</i>	[t]ookie
‘Weak’ positions (e.g. medial unstr’d; final): OK	<i>cake</i>	ca[k]e
	<i>cookie</i>	coo[k]ie

‘Take and tookie’
‘Sagwa is a tat’

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Positional stopping

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

<i>before</i>	be[p]ore
<i>casino</i>	ca[t]ino
<i>sun</i>	[t]un

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

<i>person</i>	per[s]on
<i>miss</i>	mi[s]
<i>cave</i>	ca[v]e

(Chiat 1989; Rvachew & Andrews 2002, Marshall & Chiat 2003)

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Acoustic correlates (e.g. PVF)

* Positional stopping = same contextualization

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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...

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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

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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

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Speech patterns (prosodically strong positions)

- Word-initial primary-stressed syllable onset

[jæmp]	'lamp'	1;10.0
[jɔks jɔk ə jɪŋkən jɔg]	'Looks like a Lincoln log'	2;9.9
- Word-initial unstressed

[jli:vən]	'Livan'	2;8.19
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- Word-medial primary-stressed syllable onset

[hə'jɔw]	'hello'	1;10.0
[vəjə'jɪn]	'violin'	2;5.29
- Word-medial secondary stressed syllable

[gɔwji:jɔks]	'Goldilocks'	2;4.2
[pæd jɔk]	'Padlocks'	2;4.9

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Speech patterns (prosodically weak positions)

- Intervocalic unstressed syllable onset

[hæwətʰækə]	'helicopter'	1;11.10
[æwədəɾə]	'alligator'	2;1.18
- Word-medial coda

[mow mi]	'hold me'	1;10.25
[hiwðə]	'Hilda'	1;11.10
- Word-final

[bejgu]	'bagel'	1;9.24
[fɛw]	'fell'	2;0.19

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

	Word-initial	Unstressed medial onset	Stressed medial onset	Coda, word-final
Adult	Lightest ([l]) ← → Darkest ([ɫ])			
E	[j]	[w]	[j]	[w]

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

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Discussion

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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

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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

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If all this makes sense...

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

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    graph TD
      Phonology[Phonology] <--> Phonetics[Phonetics]
      Phonology --- P1[• Representations]
      Phonology --- P2[• Constraints]
      Phonetics --- P3[• Rules of phonetic implementation]
      Phonetics --> Output["[Output]"]
  
```

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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

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*Thanks for your
attention!*

Feedback?

Questions?

PDF version?

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