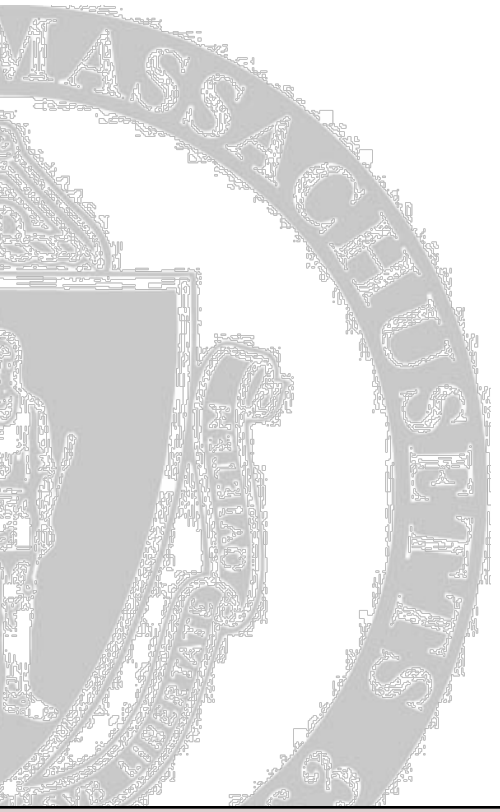
UMassAmherst

Child phonology as gradual constraint reranking



Joe Pater

Guest lecture in Ling 397

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Introduction

- Children's early productions are phonologically simple (examples of differences from adult pronunciations?)
- We'll talk about how this can be understood as an initial ranking of Markedness over Faithfulness constraints in Optimality Theory
- We'll also talk about how acquisition can then be understood as the gradual reranking of constraints
- Allows for effects of the frequency of structures on acquisition order, within limits imposed by UG

Acknowledgement

- The contents of this lecture are taken quite directly from an article by our colleague Gaja Jarosz:

  Implicational Markedness and Frequency in Constraint-Based Computational Models of Phonological Learning. In Journal of Child Language 2010 37(3), Special Issue on Computational models of child language learning, 565-606.

  http://pantheon.yale.edu/~gjs42/files/2010_JCL.pdf

Markedness and faithfulness constraints

- In Optimality Theory (OT), a linguistic system consists of a ranking of a universal set of constraints.
- For example, NoCoda is satisfied by open syllables

  [bæt] *violates NoCoda*

  [bæ] *satisfies NoCoda*

- NoCoda is a Markedness constraint; these state preferences for simple, or unmarked structures.
- *What are some other Markedness constraints we might want for child speech?*

Introduction

- Other Markedness constraints we'll be discussing today:

ONSET – No vowel-initial syllables.
NOCODA – No consonant-final syllables.
*COMPLEXONSET – No syllable-initial consonant clusters.
*COMPLEXCODA – No syllable-final consonant clusters.

Introduction

- Faithfulness constraints require that the pronunciation match the stored lexical representation
- For child phonology, we usually assume that children have relatively accurate lexical representations, and that deviations from adult forms are due to the activity of a production grammar (lots to discuss here!)
- We'll just be using one Faithfulness constraint (others…)

MAX – No deletion.

Introduction

- NoCoda >> Max (>> means "is ranked above")

  /bæt/ → [bæ]

- Max >> NoCoda

  /bæt/ → [bæt]

- What happens if all our Markedness constraints rank above Faithfulness? The reverse?

ONSET – No vowel-initial syllables.
NOCODA – No consonant-final syllables.
*COMPLEXONSET – No syllable-initial consonant clusters.
*COMPLEXCODA – No syllable-final consonant clusters.

Introduction

- The "syllable template" produced by M >> F:

  CV

- The "syllable template" produced by F >> M:

  (C)(C)V(C)(C)

- What about this ranking?

  *ComplexCoda >> Max >> Other M

- And this one?

  NoCoda, Onset, *ComplexOnset >> Max >> *ComplexCoda

Introduction

- What is the constraint ranking that gives us this syllable template?

  VC

- Two implicational universals:

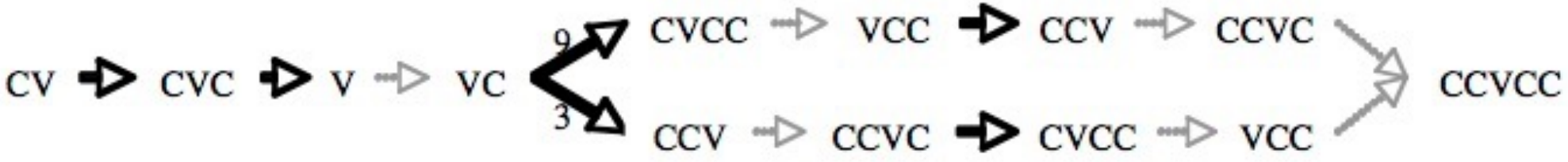
  "If a language has syllables with codas, it also has syllables without codas"

  "If a language has syllables without onsets, it also has syllables with onsets"

- What are some other implicational universals that we get from this constraint set?

The Dutch learning path and frequency

- Dutch children have been shown to follow the following learning paths:



- In what order are they "demoting" the markedness constraints?

The Dutch learning path and frequency

- Frequencies of different syllable types:

TABLE I. *Relative frequencies of syllable types in Dutch*

CV	CVC	CVCC	V	VC	VCC	CCV	CCVC	CCVCC
44·8%	32·1%	3·3%	3·9%	12·0%	0·4%	1·4%	2·0%	0·3%

- Let's work out the frequencies with which our 4 markedness constraints are violated.
- How does that relate to the order in which the Markedness constraints are demoted?

A Gradual Learning Algorithm

- One way to model this is to put constraints on a numerical scale and to have them gradually reranked
- Initial ranking M >> F

Markedness	100
Faithfulness	0

- Every time the learner encounters a word requiring a different ranking of the constraints, it moves them a little bit in the right direction

A Gradual Learning Algorithm

- Child's initial grammar has NoCoda >> Max

  /bæt/ → [bæ]

- A piece of evidence for the reverse ranking Max >> NoCoda

  /bæt/ → [bæt]

- Initial numerical ranking:

  NoCoda 100, Max 0

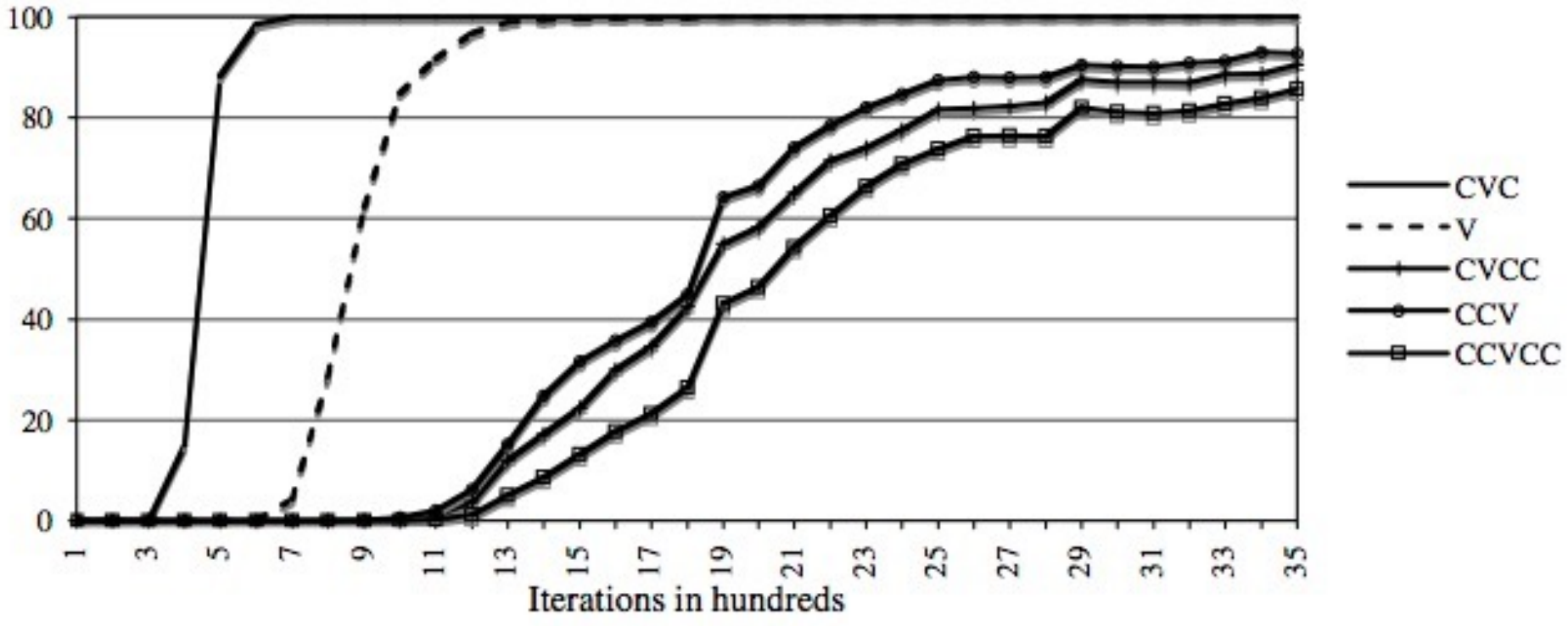
- Ranking after update (learning rate 0.1):

  NoCoda 99.9, Max 0.1

- How many updates will it take to get Max >> NoCoda?

A Gradual Learning Algorithm

- Here is a typical result for when we run the GLA on Dutch



A Gradual Learning Algorithm

- Different runs yield different results for complex codas and complex onsets (Jarosz p. 595):

  Running the simulation 10,000 times for 20,000 iterations (a point at which learning is essentially complete) reveals that 63.1% of the runs result in a slight preference for complex codas, 27.8% with slight preference for complex onsets, and 9% result in a tied ranking value for the two corresponding markedness constraints.

A Gradual Learning Algorithm

- If a language has different frequencies of syllable types, a different acquisition order is predicted

TABLE 1. *Relative frequencies of syllable types in Dutch*

CV	CVC	CVCC	V	VC	VCC	CCV	CCVC	CCVCC
44·8%	32·1%	3·3%	3·9%	12·0%	0·4%	1·4%	2·0%	0·3%

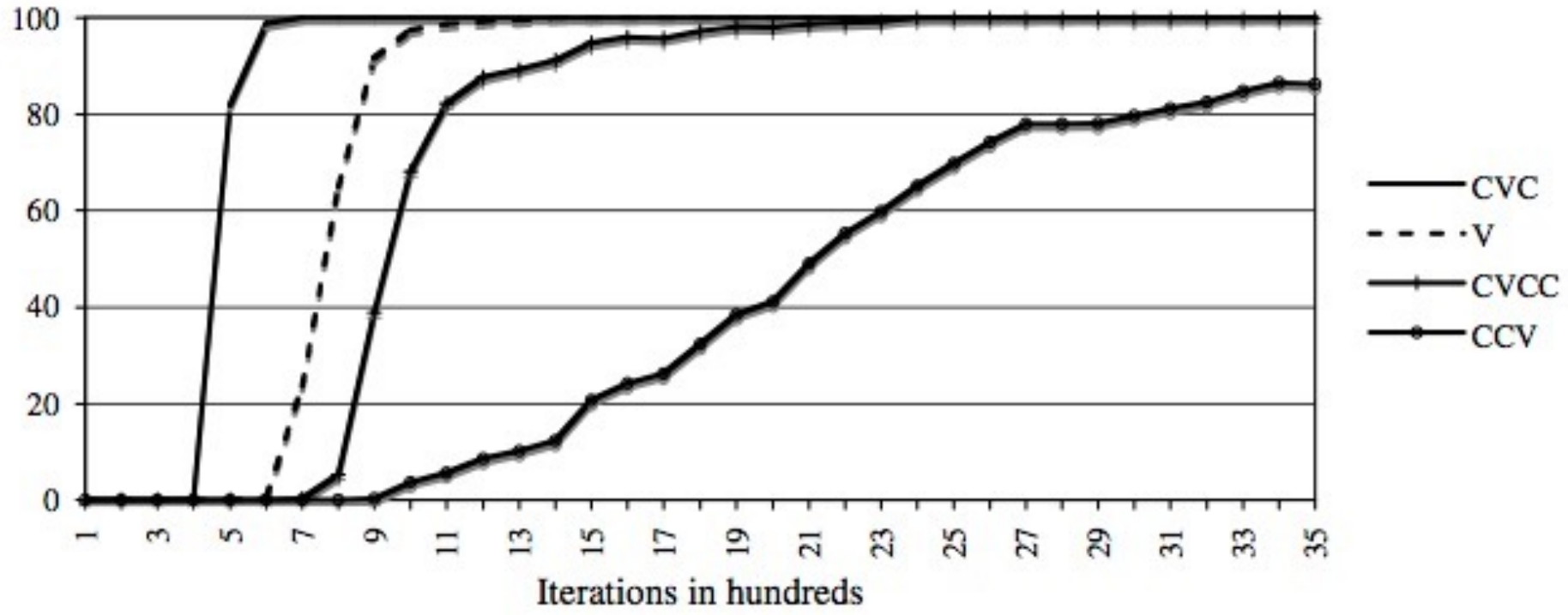
TABLE 5. *Relative frequencies of syllable types in English*

CV	CVC	CVCC	V	VC	VCC	CCV	CCVC	CCVCC
24·4%	40·5%	10·1%	4·7%	13·0%	3·5%	0·9%	2·2%	0·6%

- What's different in English?

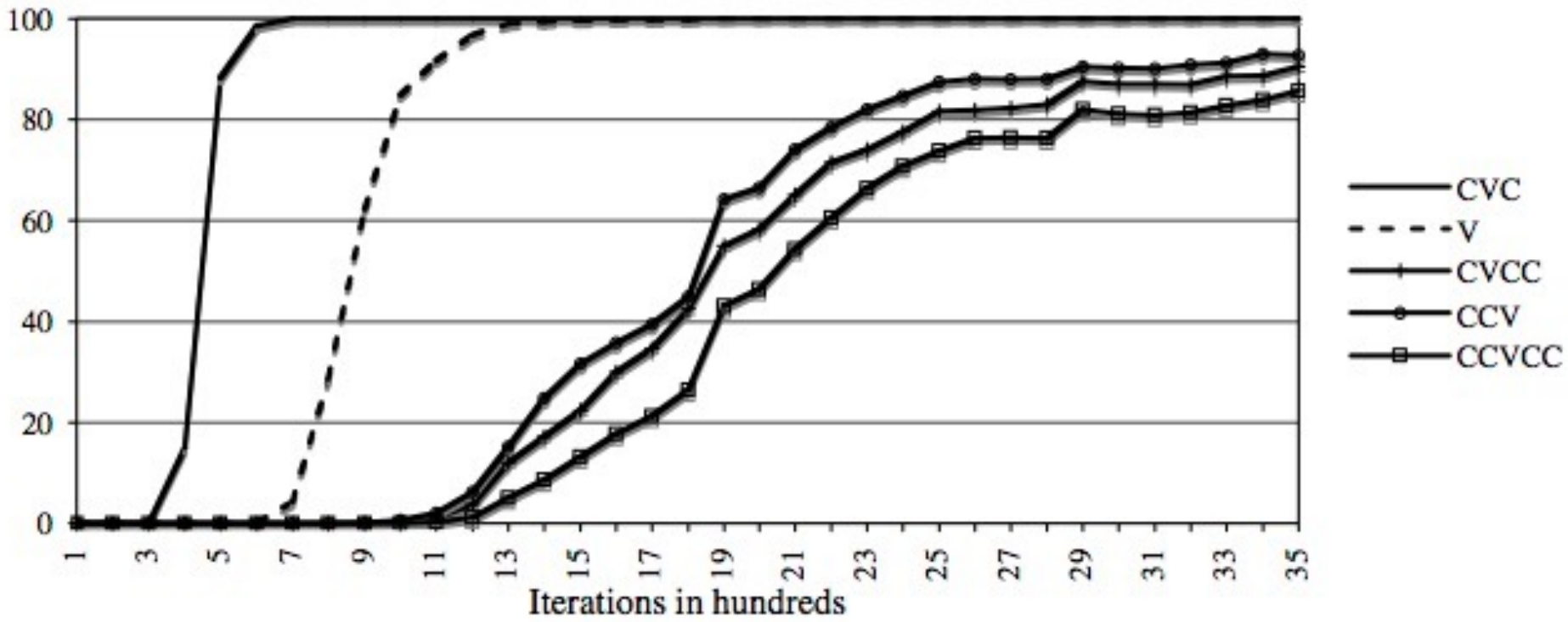
A Gradual Learning Algorithm

- A typical GLA run for English



A Gradual Learning Algorithm

- Dutch again

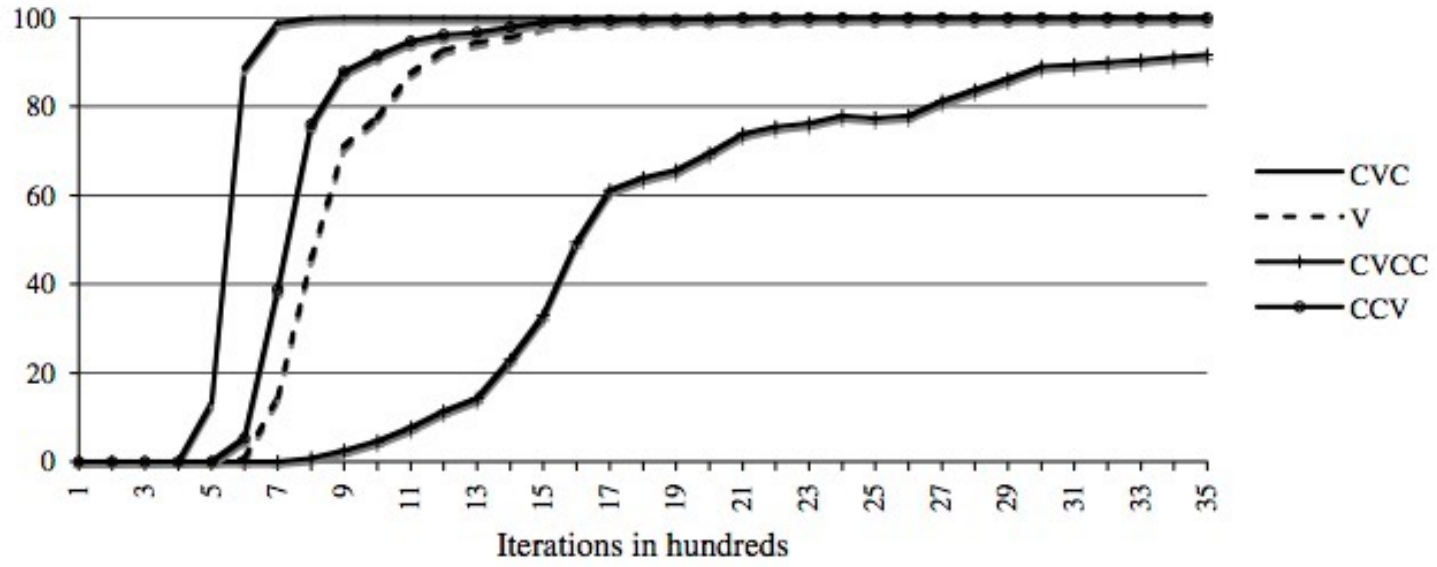


A Gradual Learning Algorithm

- Polish GLA run and statistics:

TABLE 6. *Relative frequencies of syllable types in Polish*

CV	CVC	CVCC	V	VC	VCC	CCV	CCVC	CCVCC
50·3%	20·9%	3·3%	8·5%	3·5%	0·6%	9·6%	4·0%	0·6%



A Gradual Learning Algorithm

- English does indeed have earlier acquisition of coda clusters (see p. 578 of Jarosz paper)
- And in Polish, there is earlier acquisition of onset than coda clusters (Jarosz p.c.). See this paper for more details

  Submitted. Gaja Jarosz, Shira Calamaro, and Jason Zentz. Input Frequency and the Acquisition of Syllable Structure in Polish.

  http://people.umass.edu/jarosz/jarosz_etal_submitted.pdf