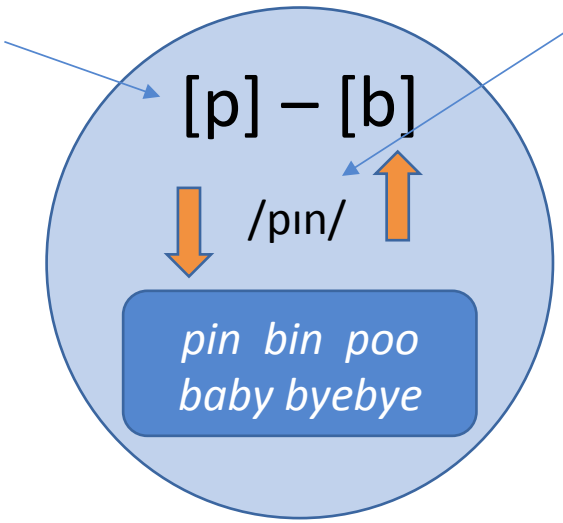
Lecture 3: How do lexical factors affect phonological development?

Mits Ota
University of Edinburgh

Summer School of Linguistics, 2019
mits-ota.github.io/SSoL2019.html

Last time

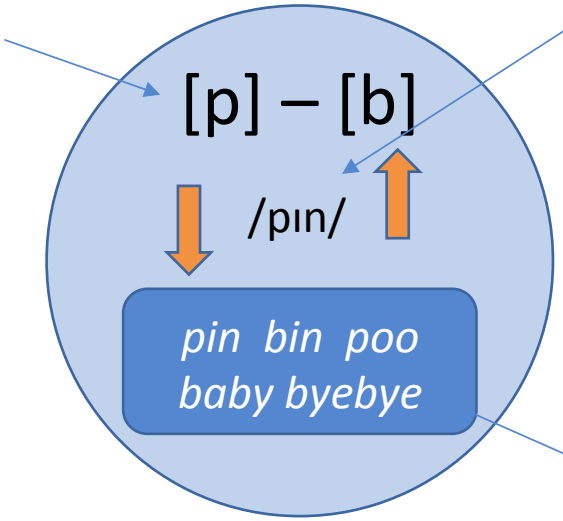
Can sounds be learned independent of words?



How do phonological representations develop?

This lecture

Can sounds be learned independent of words?



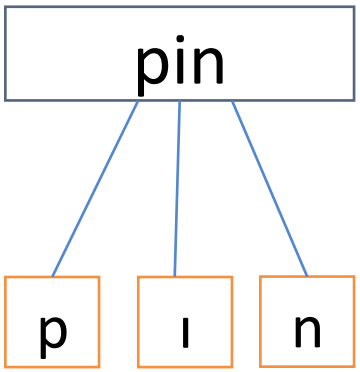
How do phonological representations develop?

How do lexical factors affect phonological development?

mits-ota.github.io/SSoL2019.html

What if duality of patterning is maintained during the development of words and sounds?

Morphemes/words



Limitless supply of meaningful units

Phonemes

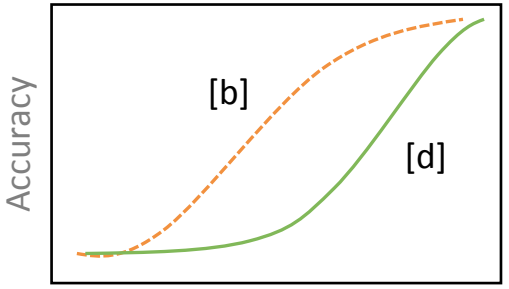
Finite set of meaningless units

We expect learning of sounds to be independent of the composition of the lexicon

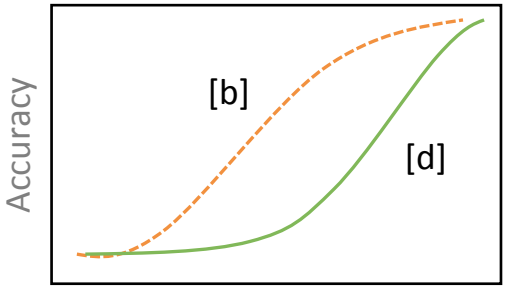
Words learned or exposed to

Development of sound production

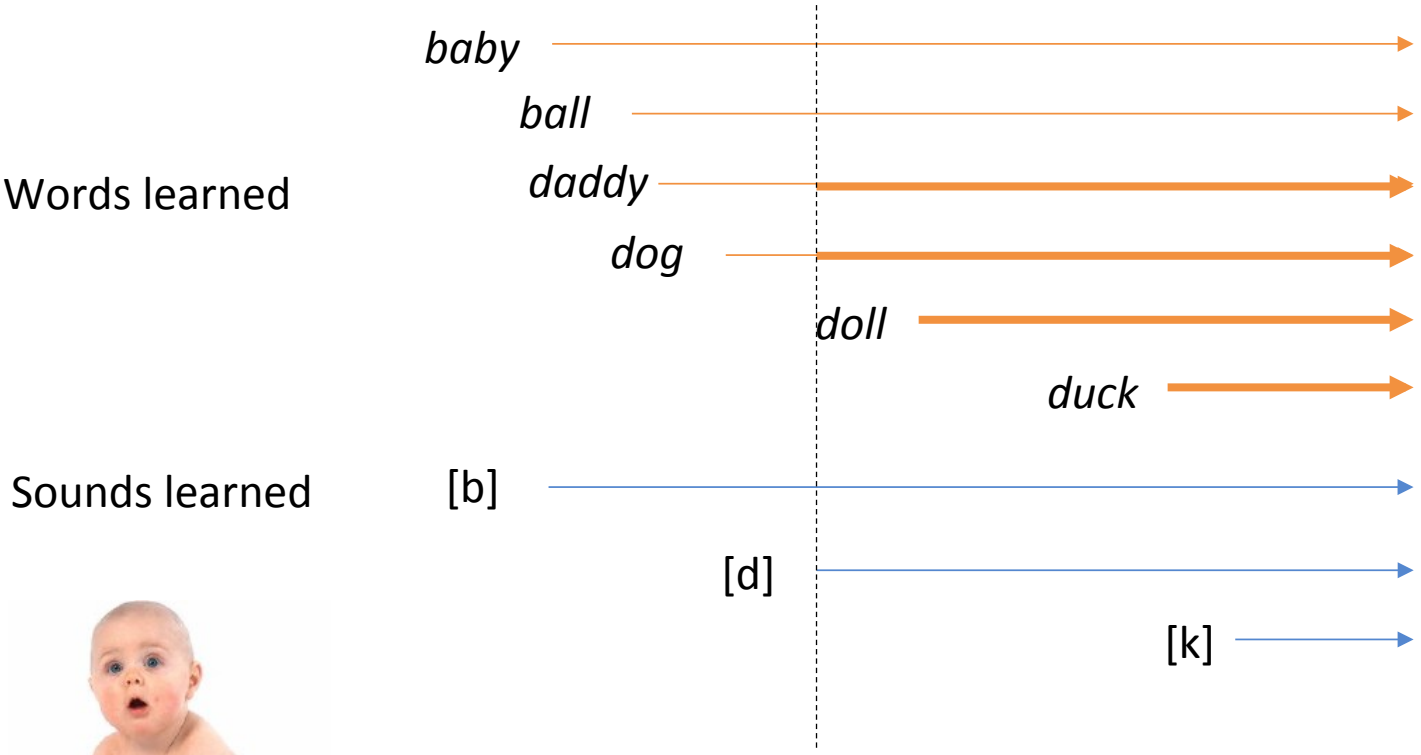
baby ball bottle bird bubbles
daddy dog duck
down dummy doll



bear book balloon
banana baby ball
bottle bird bubbles
daddy dog



We expect learning of sounds to occur across individual words



Time when [d] should be produced accurately in all words

Part 1

Does the composition of the lexicon affect phonological development?

Infants' perception is sensitive to phonotactic probabilities in the lexicon

Phonotactic probability	High	Low
Stimuli	[ʧʌn]	[jʌʃ]
	[taɪs]	[ʃaɪb]
	[kik]	[giθ]
	[vet]	[θeʤ]
	[mɚn]	[ʧɚg]
Mean summed biphone prob.	0.068	0.015

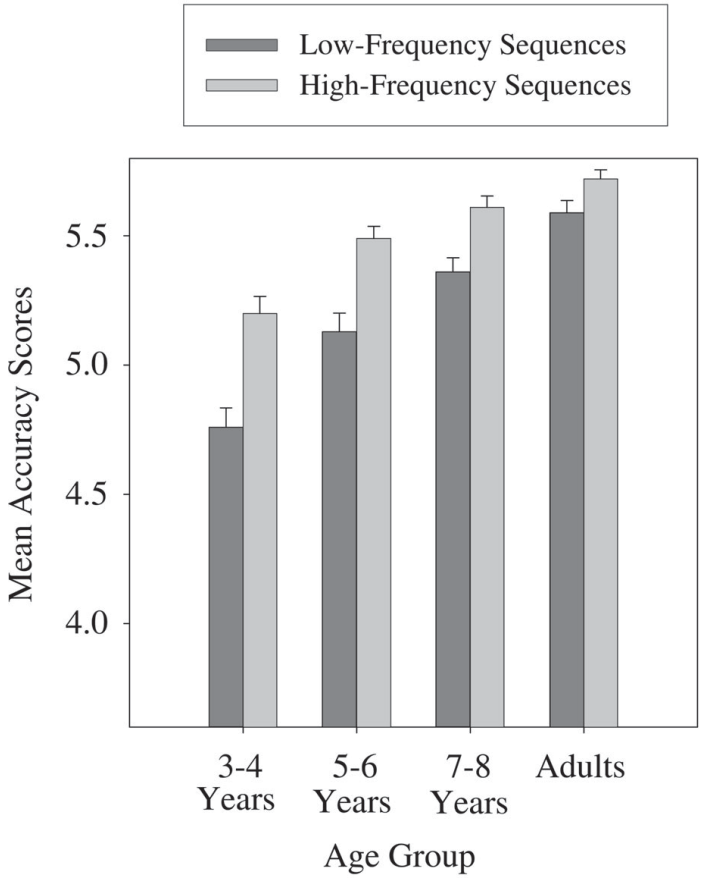
English-learning 9-month-olds, but not 6-month-olds, listen longer to non-sense syllables with high probabilities (Jusczyk, Luce, & Charles-Luce, 1994)

Toddlers' production is sensitive to phonotactic probabilities in the lexicon

Phonotactic probability		Response type									
		Correct		Incorrect		No coda		No response		Real word	
Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
tʃʌd	gɛd	7	11	16	8	1	1	2	0	3	9
pʌl	gɛl	3	13	9	2	13	4	0	1	4	9
dʒʌs	tɛs	13	16	4	4	0	0	10	8	2	1
θæg	sɪg	7	14	20	9	1	2	0	0	1	4
zɛv	dɪv	5	5	14	11	2	0	8	10	0	3
ʃʌŋ	bɪŋ	6	11	10	9	3	0	8	6	2	3
gim	bom	8	3	7	6	2	1	1	1	11	18
von	nin	6	14	7	1	3	1	0	0	13	13
dʒɔɪs	fɑɪs	17	18	4	4	2	1	1	3	5	3
lɔɪn	rɑɪn	5	8	3	2	1	4	9	10	11	5
mɔɪd	nɑɪd	8	9	7	7	1	3	12	9	1	1
Total		85	122	101	63	29	17	51	48	53	69

Non-word repetition by 18-to-24-month-old English learners (Zamuner, Gerken, & Hammond, 2004)

This pattern continues into adulthood!



Edwards, Beckman, & Munson (2004)

But maybe this is a reflection of universal markedness effects?

- Universal markedness: Some sounds and sound patterns are inherently more marked (≈ 'more difficult to perceive/ produce/learn') than others. Prediction: Unmarked sounds and sound patterns are learned before marked ones.
- Language-specific input: Some sounds and sound patterns occur more frequently than others in the linguistic input. Prediction: Frequently heard sounds and sound patterns are learned before infrequent ones.

Universal markedness prediction for the production of coda consonants

Typological evidence shows that:

- Coronals (e.g., /t/, /s/, /l/, /n/) are less marked than labials (e.g., /p/, /f/) or dorsals (e.g., /k/, /g/) as codas (Paradis & Prunet, 1991).
- Sonorants (e.g., /l/, /n/) are less marked than obstruents (e.g., /t/, /s/) as codas (Clement, 1990).

Learning prediction: Children will produce coronal codas before labial or dorsal codas, and sonorant codas before obstruent codas.

Language-specific input prediction for the production of coda consonants

- Input frequency estimates for English coda consonants based on CHILDES data: t > r > n > d > z > k > s > l > m > v > ʃ > g > p > θ > ŋ > ʧ > f > ʤ > b > ʒ, ð
- Learning prediction: Children will produce frequent codas before infrequent ones.

Production data have a better fit with the language-specific input prediction (Zamuner, Gerken, & Hammond, 2005)

- Children's order of production for English codas (any production): t > n > k > d, m > ʔ > p > ʧ, l > b, f, ɸ, ŋ, r, s
- Children's order of production for English codas (only target production): k > t > n > d, s > b, f, l, m, ŋ, p, r, z
- No systematic differences between coronals vs. labial/ dorsal or between obstruents vs. sonorant.
- Actual order correlates with language-specific input order: *r* = .51 (any production) or *r*. = .59 (only target production)

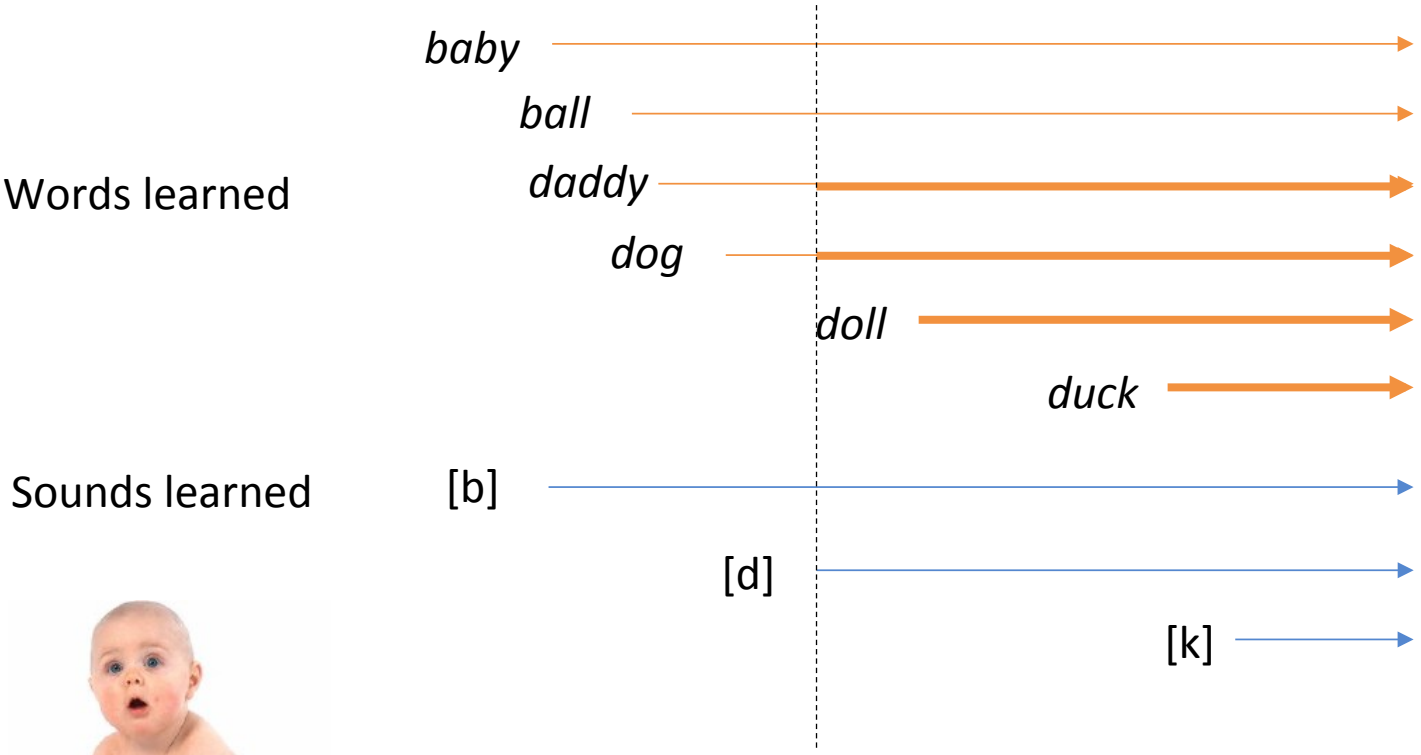
Summary

- Phonological development is not independent of the composition of the lexicon.
- Both perception and production are sensitive to phonotactic probabilities.
- The effects cannot be reduced to universal markedness.

Part 2

Does phonological development occur across individual words?

We expect learning of sounds to occur across individual words



Time when [d] should be produced accurately in all words

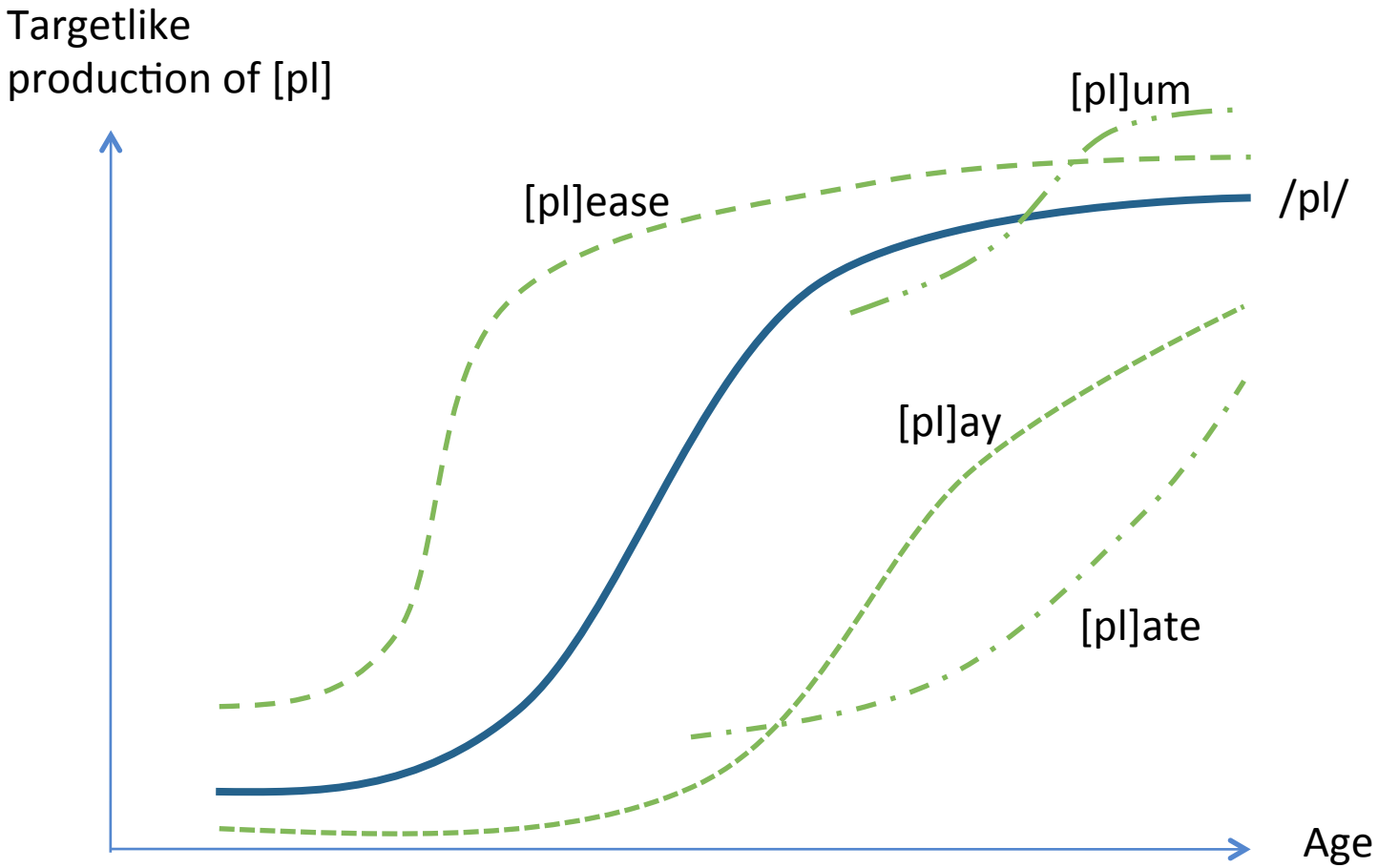
But phonological development is lexically variable

Production of [b] by 'T' (11-14 months) (Ferguson & Farwell, 1975)

- *ball* [b]
- *bounce* [b]
- *blanket* [b]
- *baby* [b] ~ [β]
- *book* [b] ~ ∅
- *bye-bye* [b] ~ [p^h]

See also Berg, 1995; Menn & Matthei, 1992; Schwartz et al, 1980; Sosa & Stoel-Gammon, 2006

So accurate production of sounds and sound patterns can be different across words



Sounds or words?

Are the basic units of acquisition in production development sounds (or sound patterns) or words?

Why are some sound patterns acquired in certain words first?

Speech production of older children (5+ years) is conditioned by lexical factors

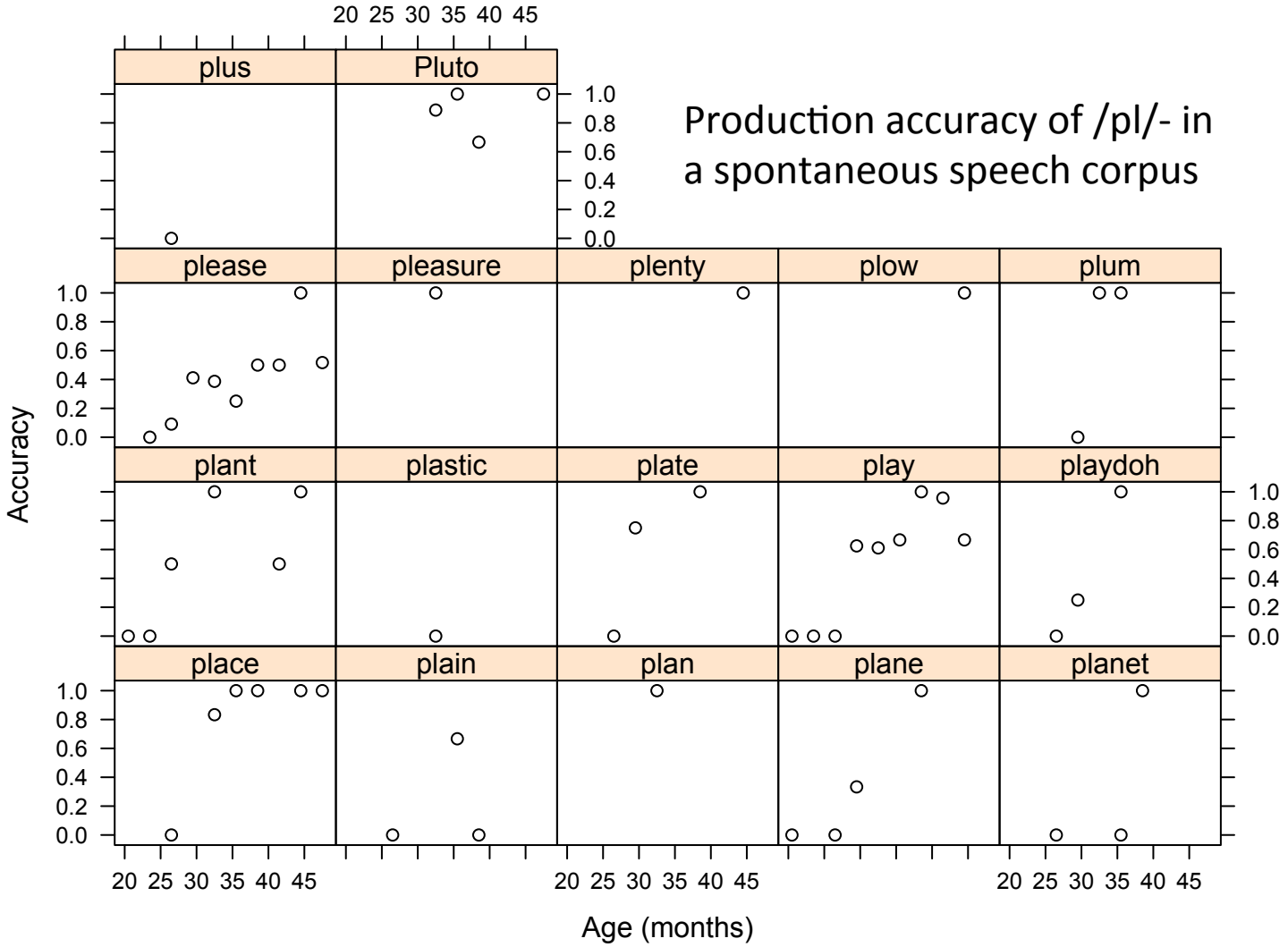
Sounds and sound patterns are more accurately produced in:

- Words learned earlier (Age-of-acquisition, or AoA; Garlock Walley, & Metsala, 2001)
- Words with few similar items in the lexicon, i.e., in sparse neighborhoods (phonological neighborhood density or PND; Garlock et al., 2001)
- Frequent words (Leonard & Ritterman, 1971; but see Moore et al, 1976 and Garlock et al., 2001 for null results)

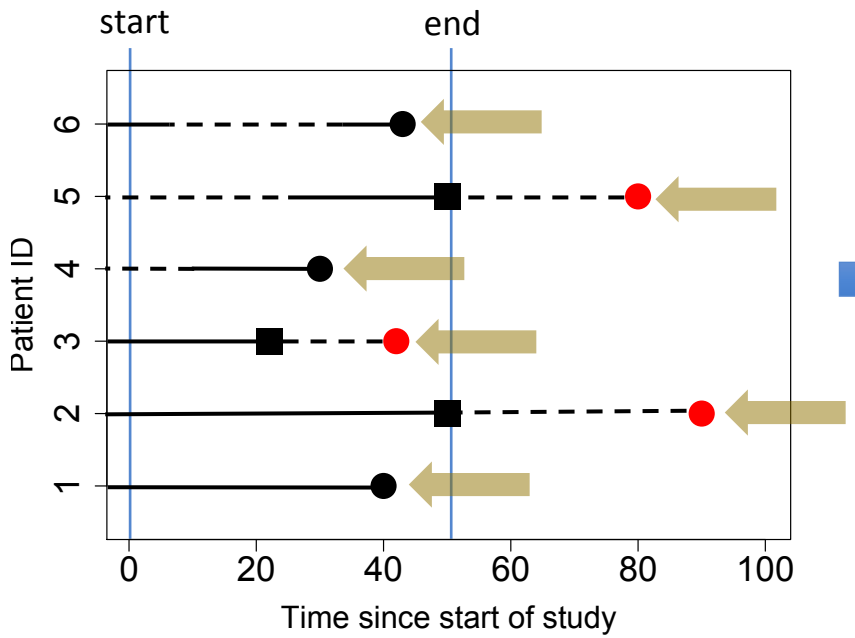
It's difficult to extend this investigation to younger children because ...

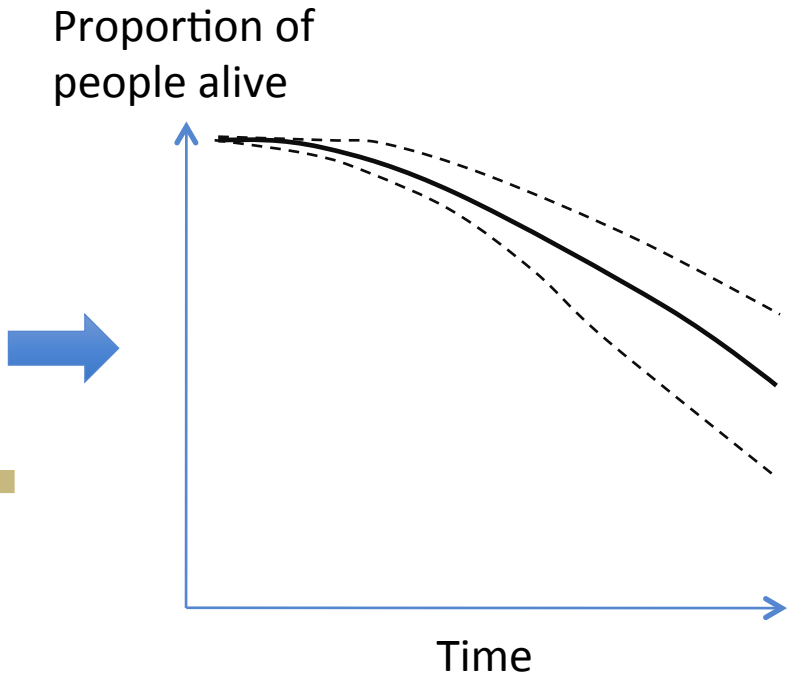
- Constraints on experimental design (cf. Sosa & Stoel-Gammon, 2006)
  - Small lexicon
  - Individual differences in lexical knowledge
- Longitudinal analysis of spontaneous production?
  - Confounds: AoA ~ PND ~ word length ~ frequency
  - Also: Input frequency ~ production frequency ~ sampling frequency
  - Sampling sparsity

Spontaneous production data have lots of holes



Methodological solution: Survival analysis

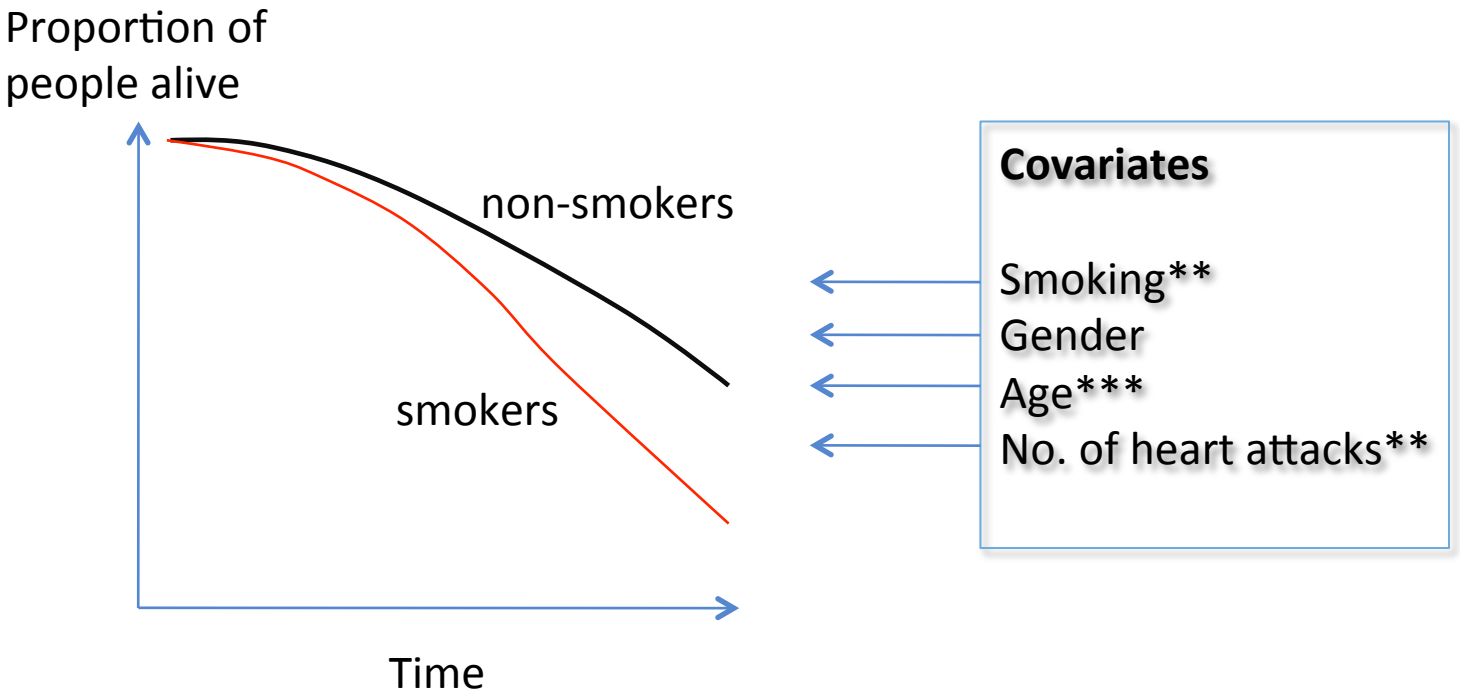




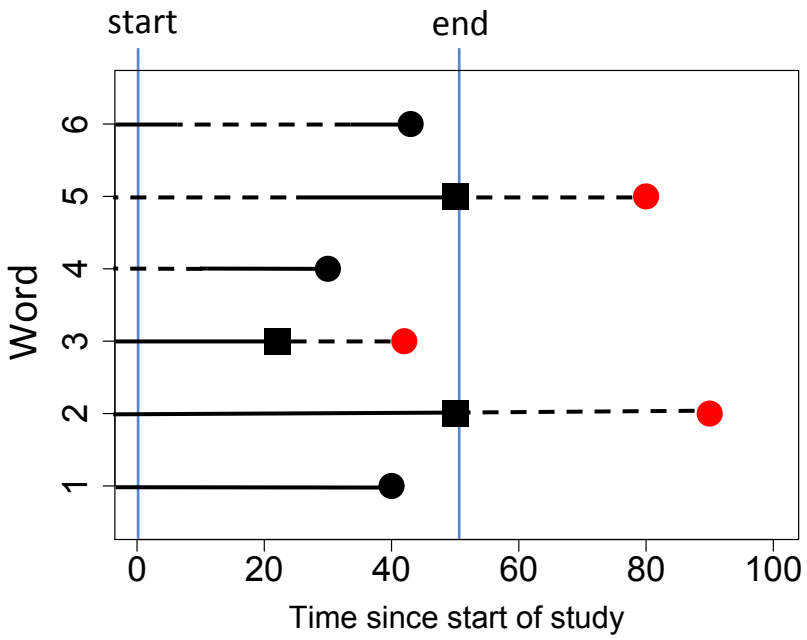
●= Death (observed)
●= Death (unobserved)
■ = Last confirmation

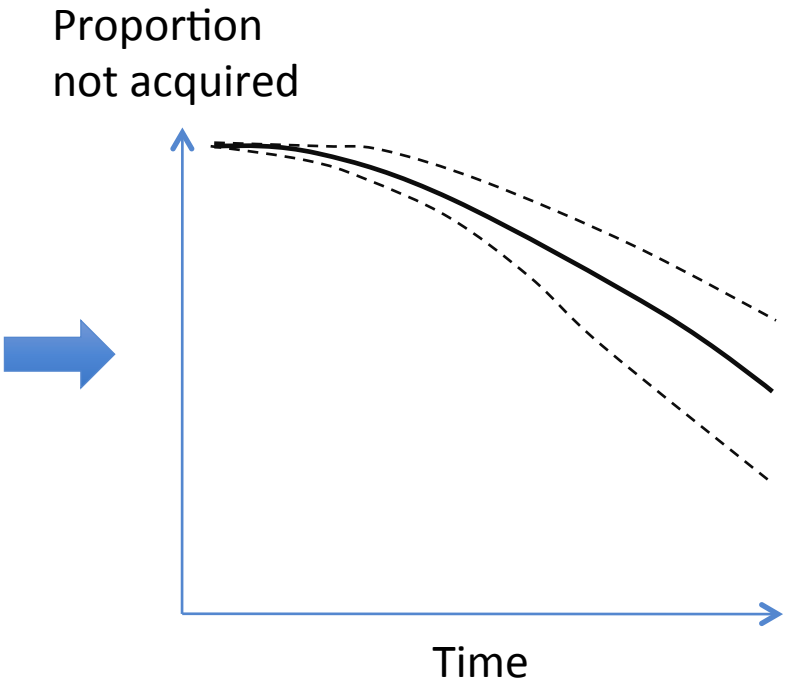
A survival curve for heart transplant patients (critical event = death)

Methodological solution: Cox regression



Application of survival analysis to phonological production

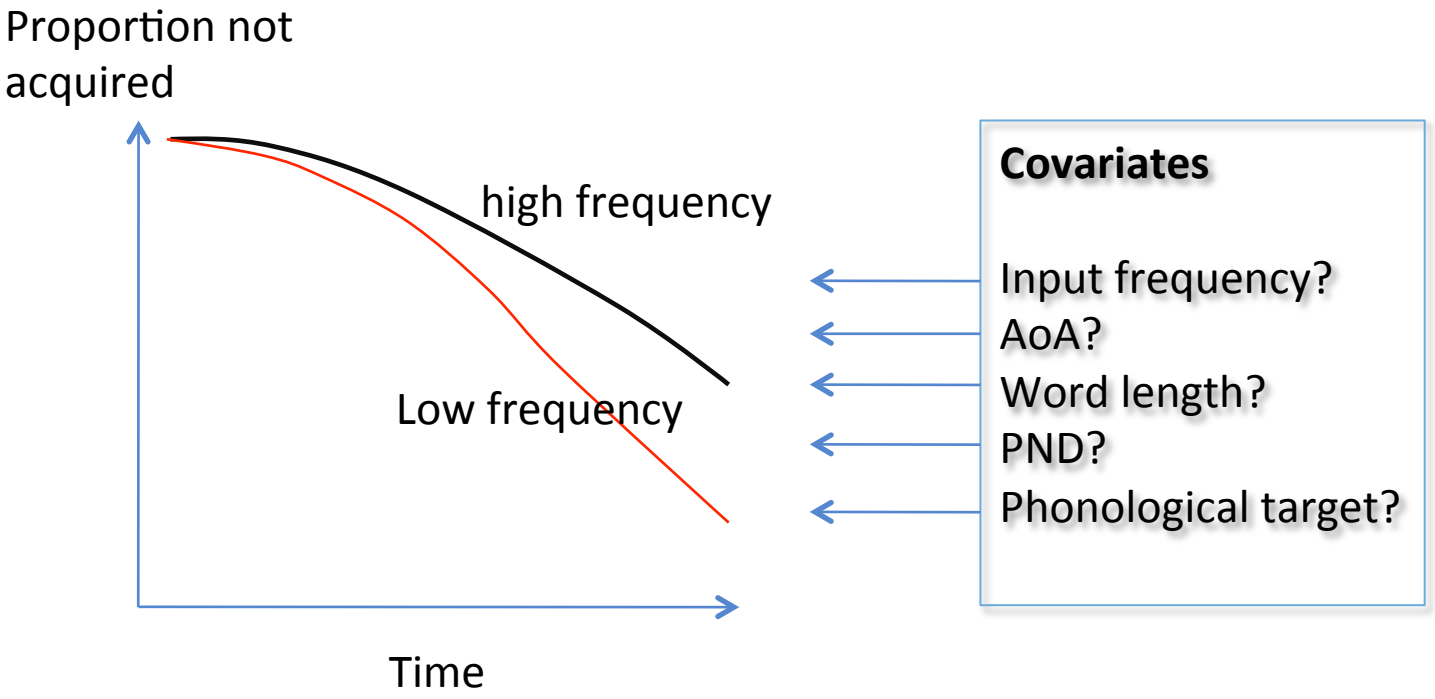




●= Accuracy ≥ 80% (observed)
●= Accuracy ≥ 80% (unobserved)
■ = Last obs of accuracy < 80%

A 'survival curve' for words with an initial cluster (critical event = acquisition)

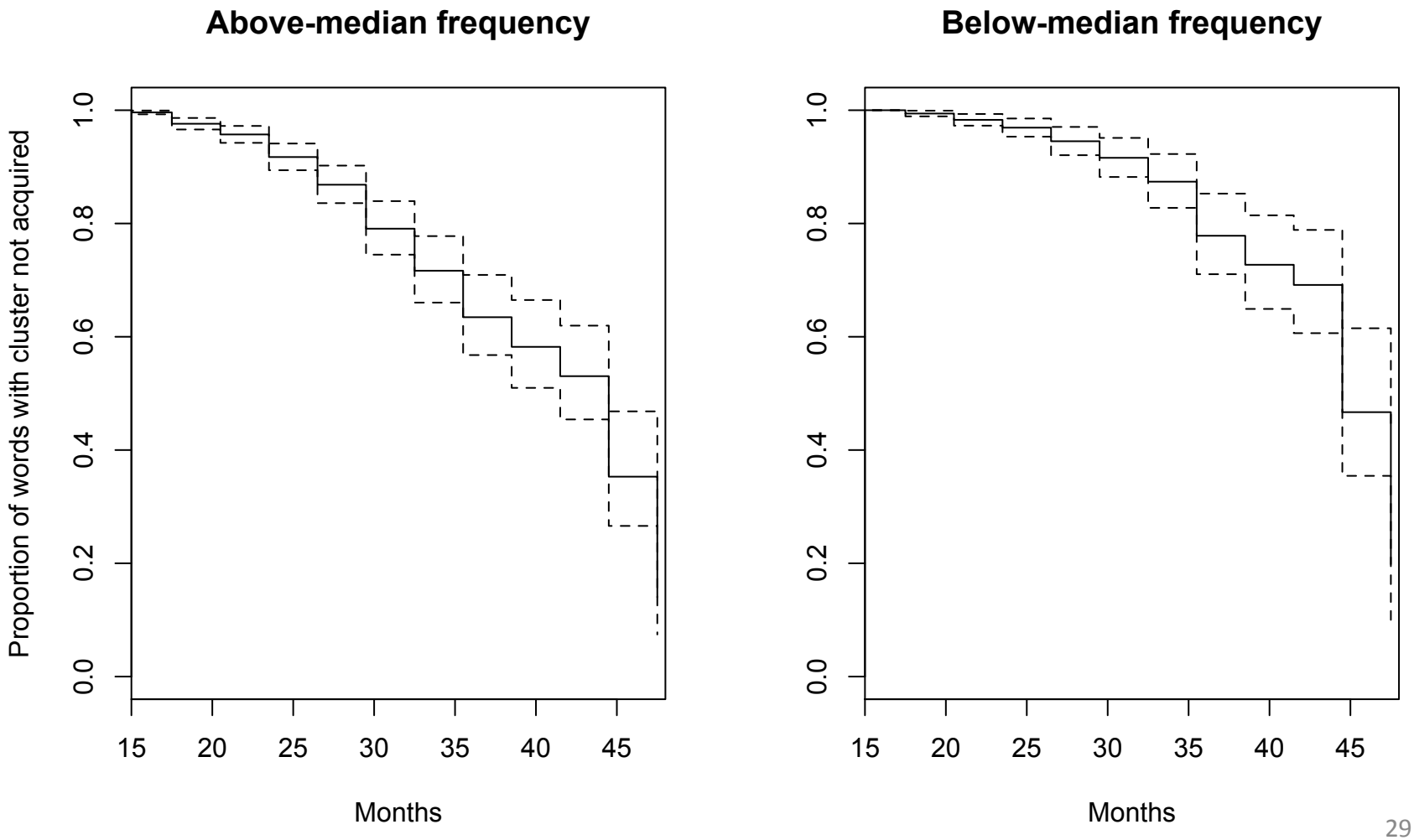
Application of survival analysis to phonological production



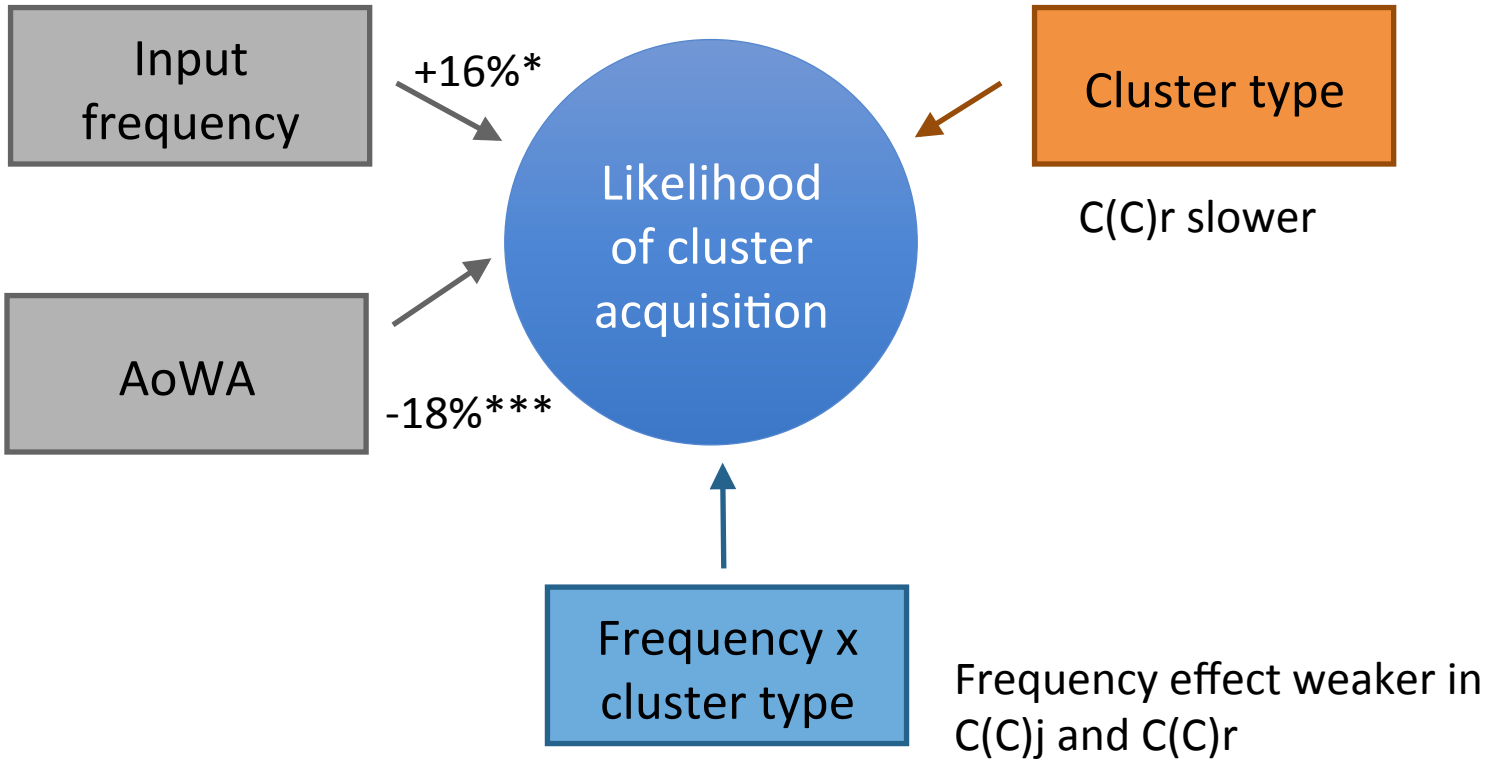
A survival analysis of initial consonant clusters in English (Ota & Green, 2013)

- Longitudinal spontaneous speech data from the Providence Corpus (Demuth, Culbertson & Alter, 2006).
- Age of children: 11 months – 4 years
- Age of cluster acquisition: First 3-month bin with production accuracy above 80%
- Phonological variables: Cluster type (C(C)l: *pl, sl, spl* ..., C(C)r: *pr, tr, spr* ..., SN: *sm, sn* ... SP: *st, sp, sk*), Cluster size: CC vs CCC, Word size (number of phonemes)
- Lexical variables: Input frequency, output frequency, AoA, PND

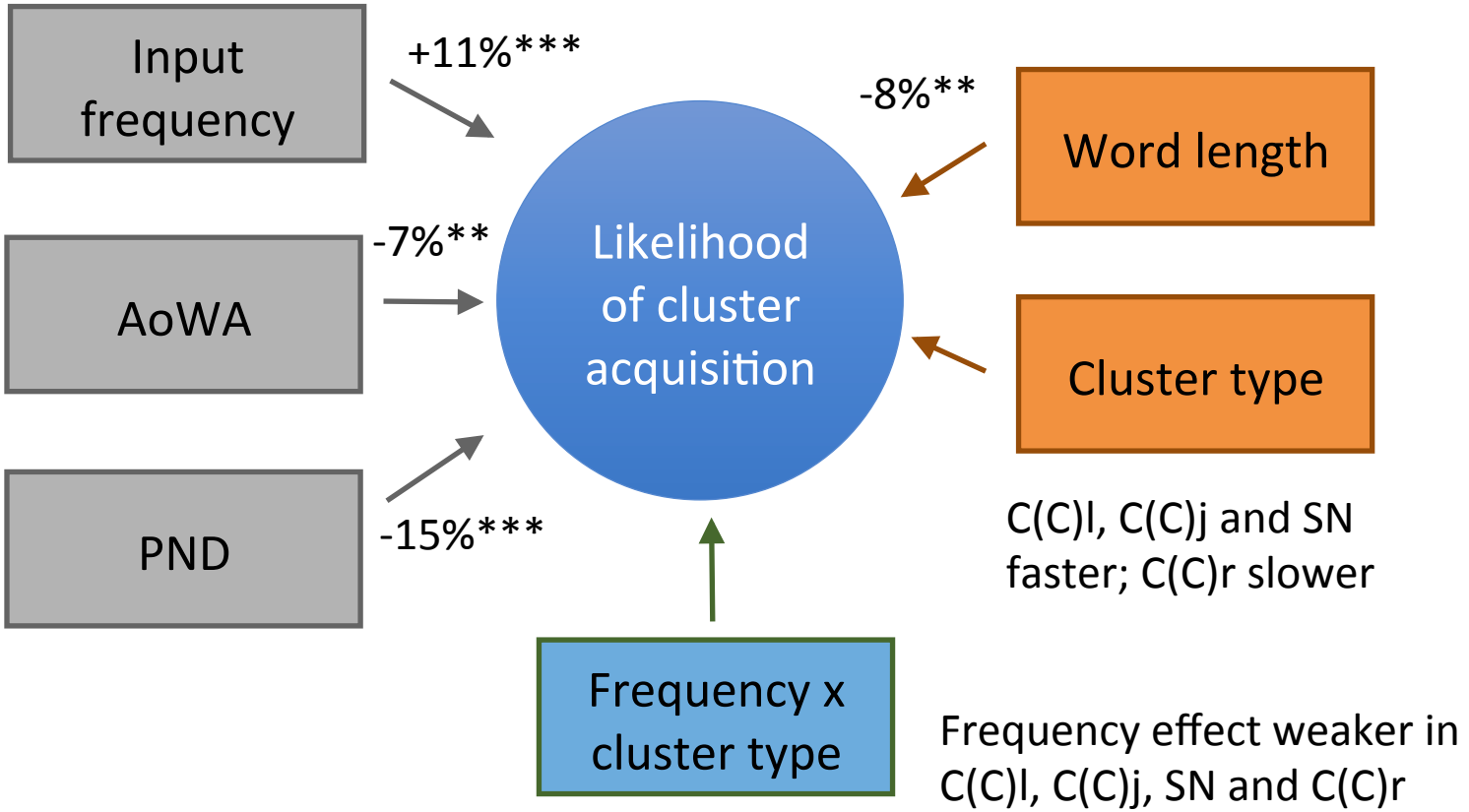
Frequency effects on survival curve



Cox regression: Words learned before 2

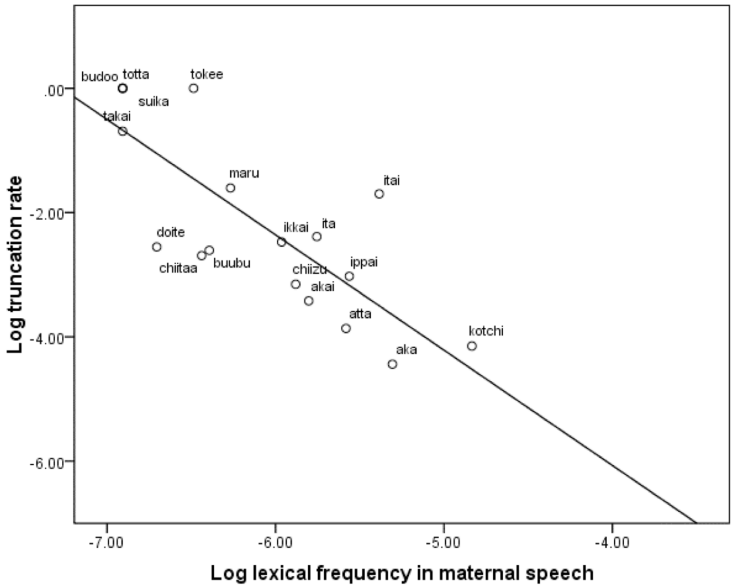


Cox regression: Words learned after 2

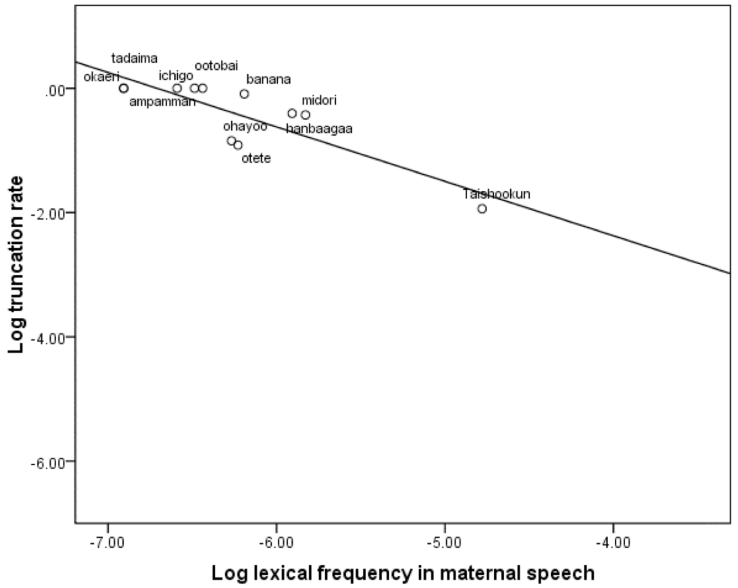


Another example: Word truncation (syllable omission) in Japanese (Ota, 2006)

Tai's truncation: 17-21 months (e.g., *midori* 'green' -> [mido])



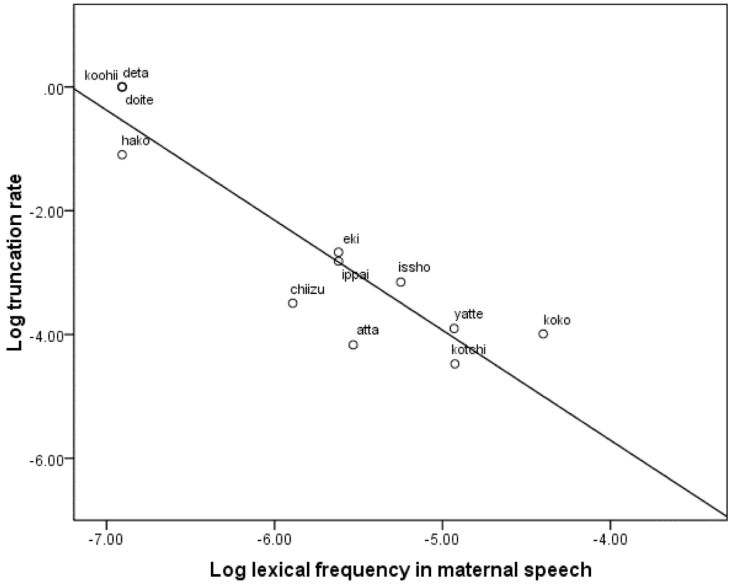
Disyllabic targets



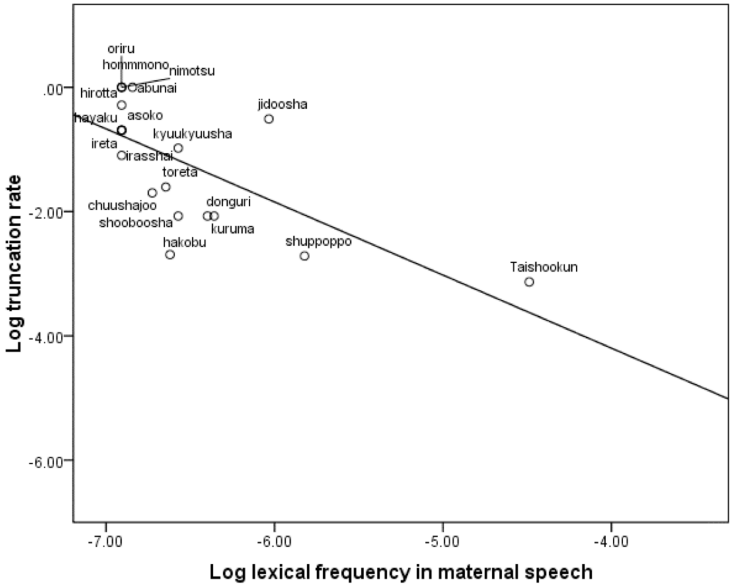
Trisyllabic targets

Another example: Word truncation (syllable omission) in Japanese (Ota, 2006)

Tai's truncation: 20-22 months



Disyllabic targets



Trisyllabic targets

Why do lexical factors affect phonological production?

- Exposure improves fidelity of representations (AoA, input frequency)
- 'Practice makes perfect' (output frequency)
- Having too many similar sounding words can interfere with production? (PND)
- But there are also genuine phonological effects:
  - Shorter words are easier to produce
  - Some clusters are inherently more difficult to produce

- **Words are important units in the development of phonological production (but so are sounds and sound patterns).**

Summary

- The composition of the lexicon affects phonological development. Young children are sensitive to phonotactic probabilities.
- Certain aspects of phonological development (e.g., accuracy of production) are lexically variable. The sources of the variability include lexical frequency, age of acquisition (of words) and phonological neighborhood density.
- Words are important units of phonological development.