

Cognateness, frequency, and vocabulary size

An interactive account of bilingual lexical acquisition

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Word acquisition

- Word learning is **challenging**: variability, ambiguity
- Earliest evidence of word acquisition: **6 months** of age
- **Bilingual word acquisition** is more complex: more than one word-form per referent (*gos* → DOG ← *perro*)
- Do bilinguals fall behind? **Mixed evidence** across language pairs: English–French, Catalan–Spanish, etc.

Jusczyk and Aslin (1995), Bergelson and Swingley (2012), Hoff et al. (2012)

Linguistic distance

Bilingual toddlers learning two languages that share more **cognates** show larger vocabulary sizes

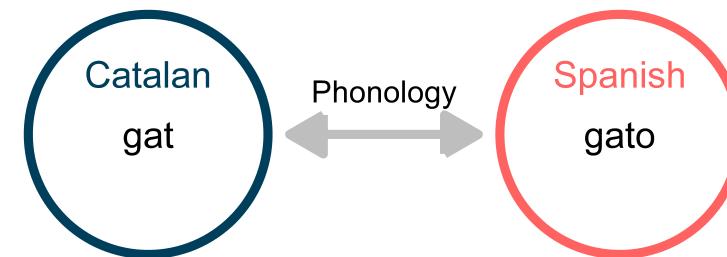
Cognates	<i>Cognate</i>	<i>Non-cognate</i>
Form-similar translation equivalents (TEs)	[cat] /'gat-'ga.to/	[dog] /'gos-'pe.ro/

Cognates are acquired **earlier** than non-cognates. Why?

Floccia et al. (2018), Mitchell, Tsui, and Byers-Heinlein (2022), Bosch and Ramon-Casas (2014), Bilson et al. (2015)

Parallel activation: candidate mechanism?

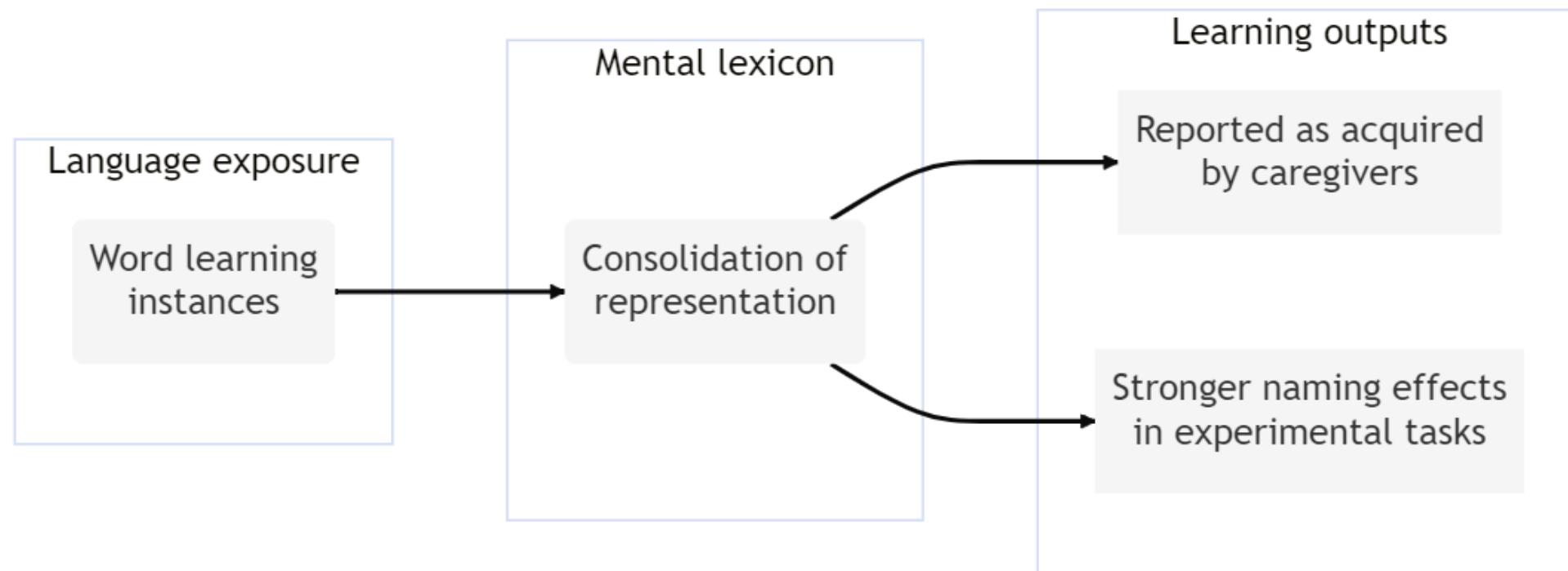
- Lexical access is **language non-selective**: both languages are co-activated, even in monolingual situations
- Cross-language activation across translation equivalents
- **Dissociation** between models of bilingual word *processing* and *word acquisition*



Spivey and Marian (1999), Costa, Caramazza, and Sebastian-Galles (2000)

Accumulator models

Word acquisition as a **continuous process of lexical consolidation**: accumulation of word **learning instances**



Hidaka (2013), Mollica and Piantadosi (2017)

Simulating bilingual word acquisition

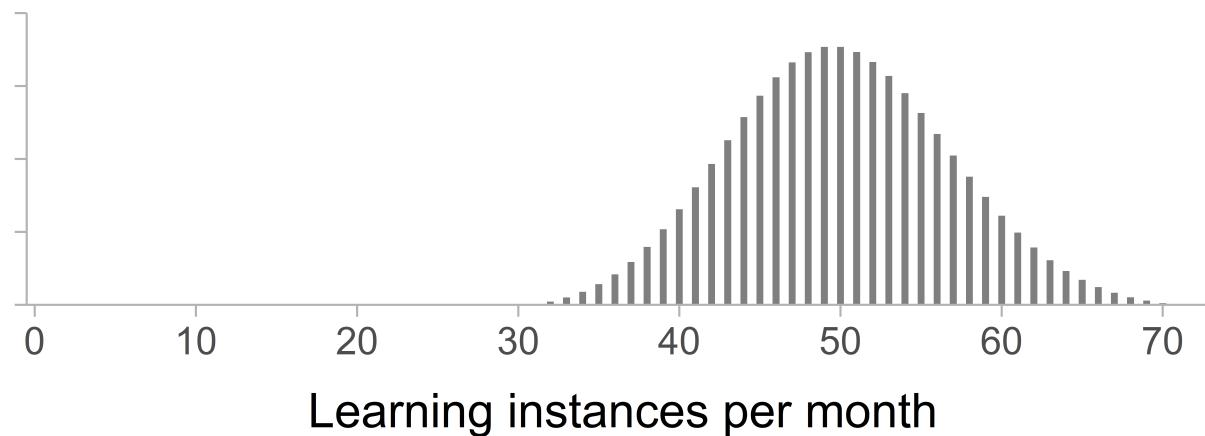
For participant i and word j :

$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j \cdot \text{Exposure}_i$$

$$\text{Frequency}_j \sim \text{Poisson}(\lambda)$$

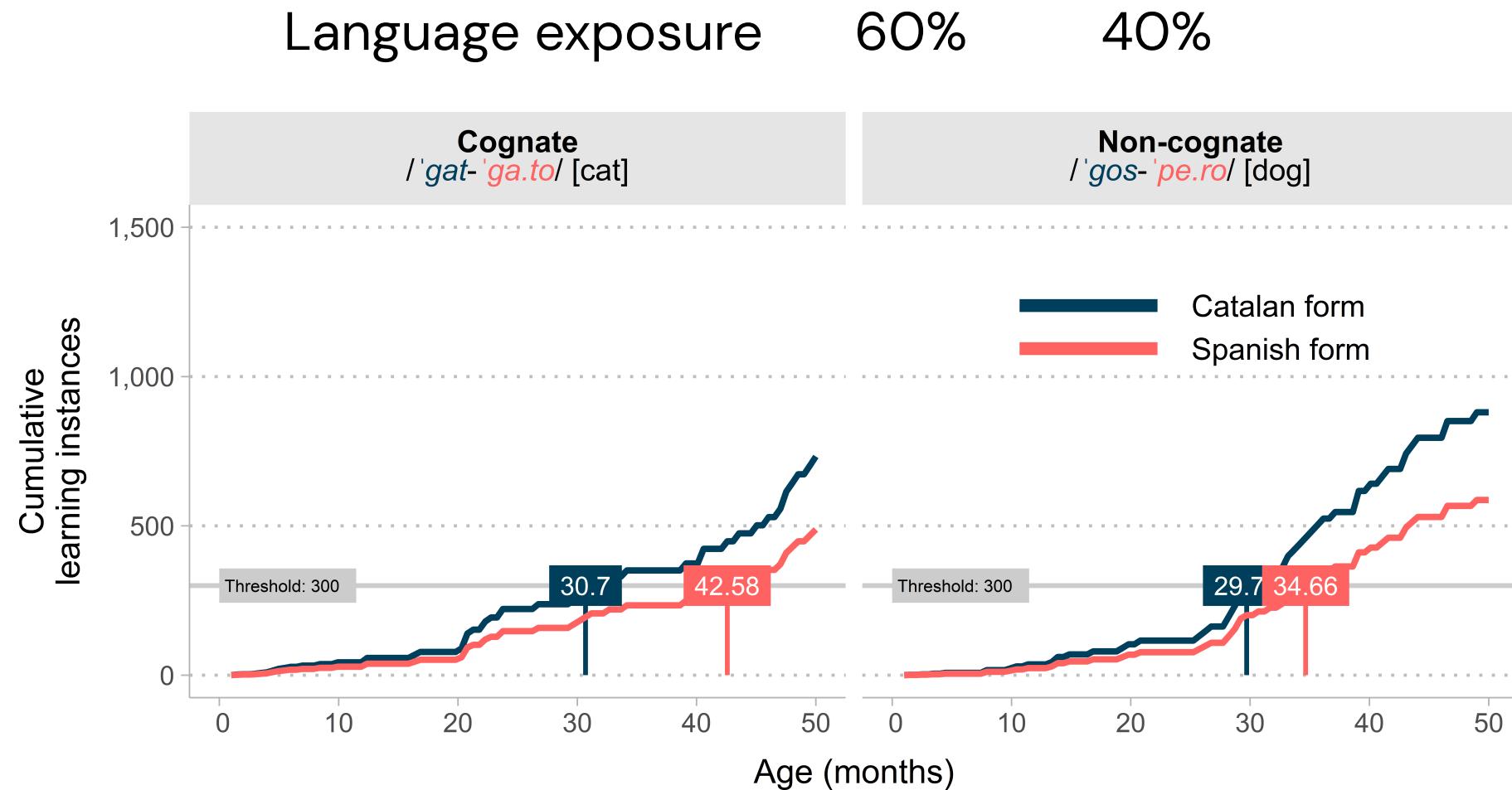
For simulations: $\lambda = 50$

Frequency per month $\sim \text{Poisson}(50)$

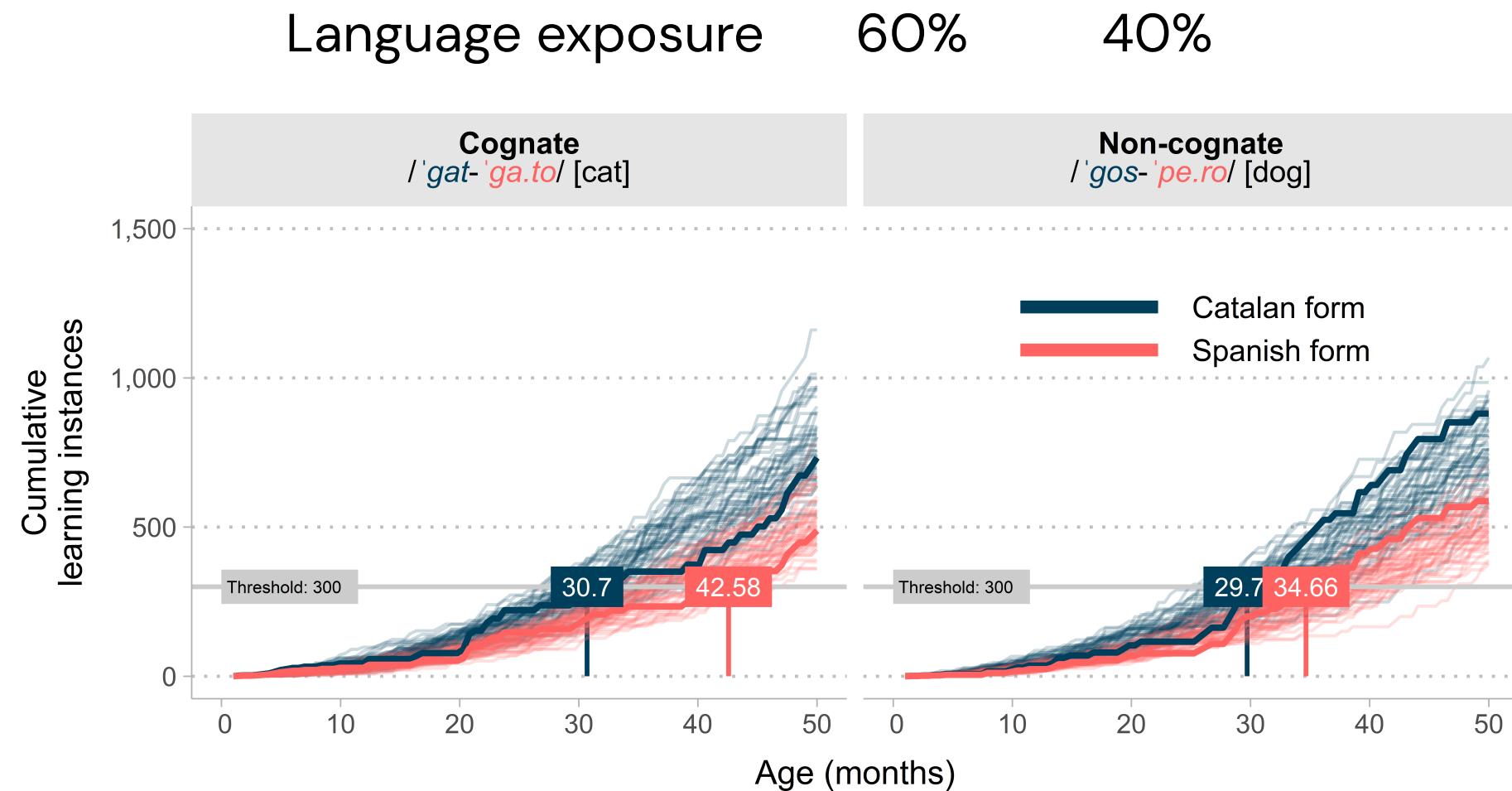


Simulation 1: no parallel activation

Catalan Spanish



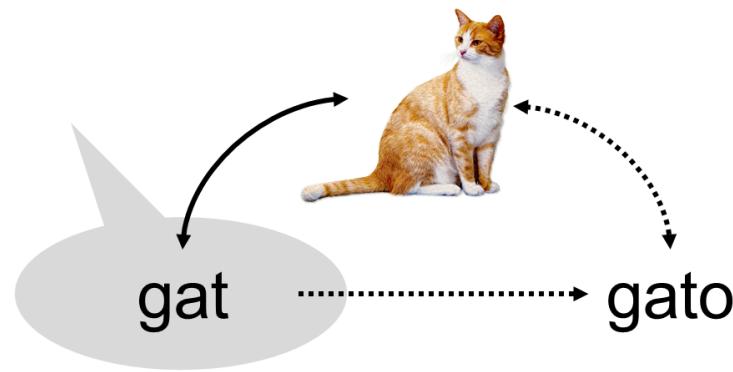
Catalan Spanish



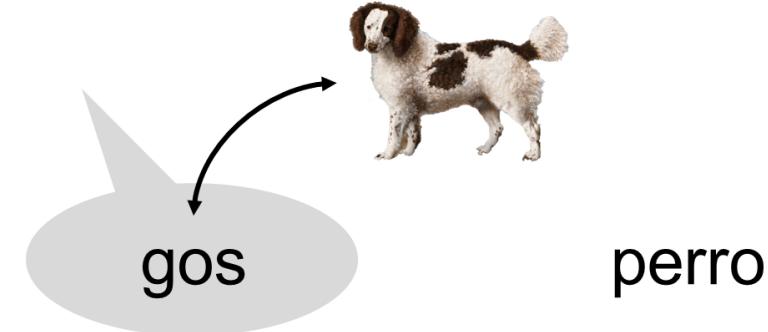
Simulation 2: parallel activation

Parallel activation hypothesis

Word-representations receive learning instances from their translations. This increment in learning instances is proportional to form-similarity (**cognateness**).

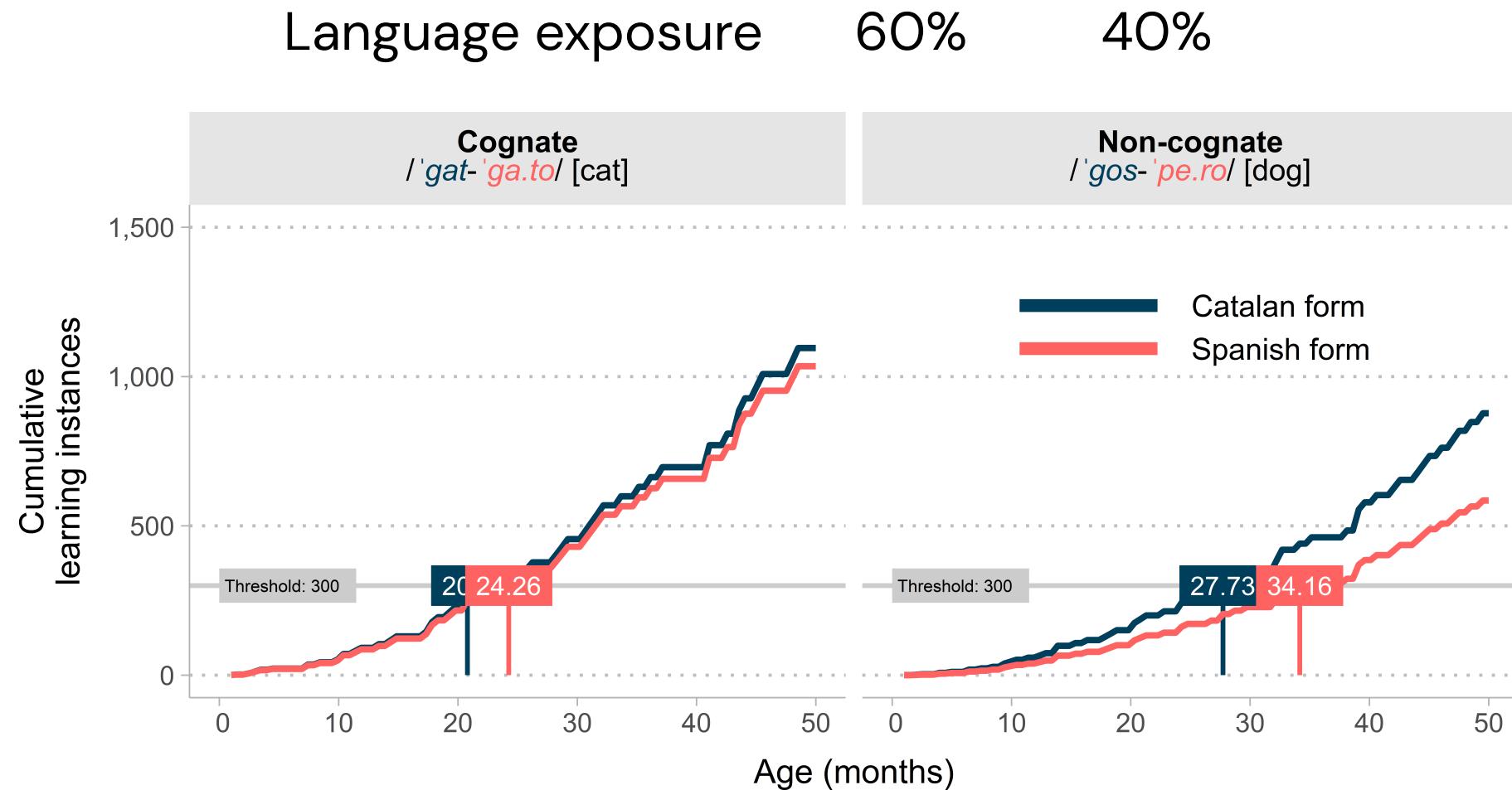


Cognate

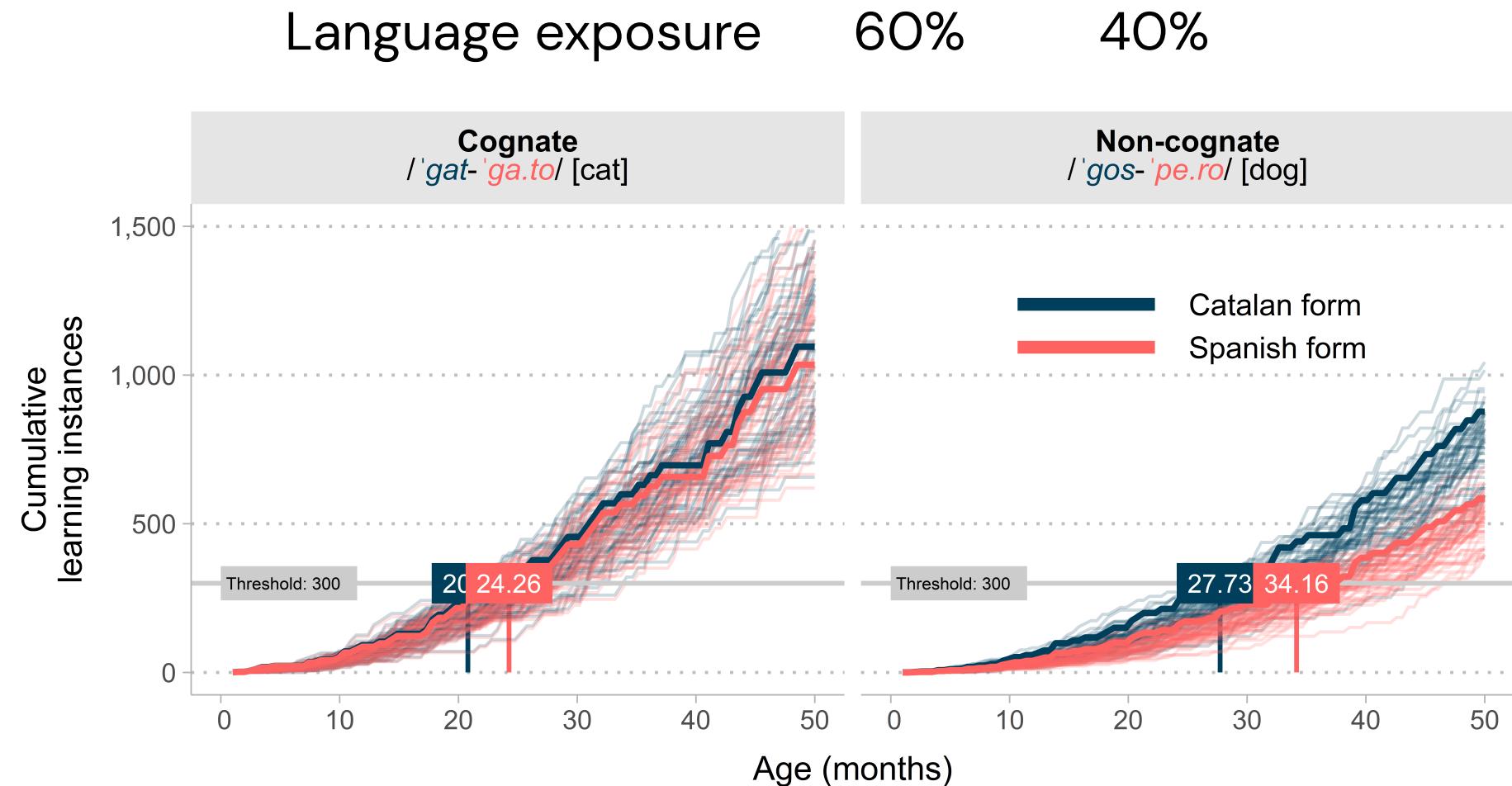


Non-cognate

Catalan Spanish



Catalan Spanish



Testing hypotheses

Data collection

Questionnaire

Barcelona Vocabulary Questionnaire (BVQ)

- On-line, inspired by CDI
- 1,600 words: 800 Catalan and 800 Spanish (sub-lists of 500 words)
- Short-listed 302 (noun) translation pairs

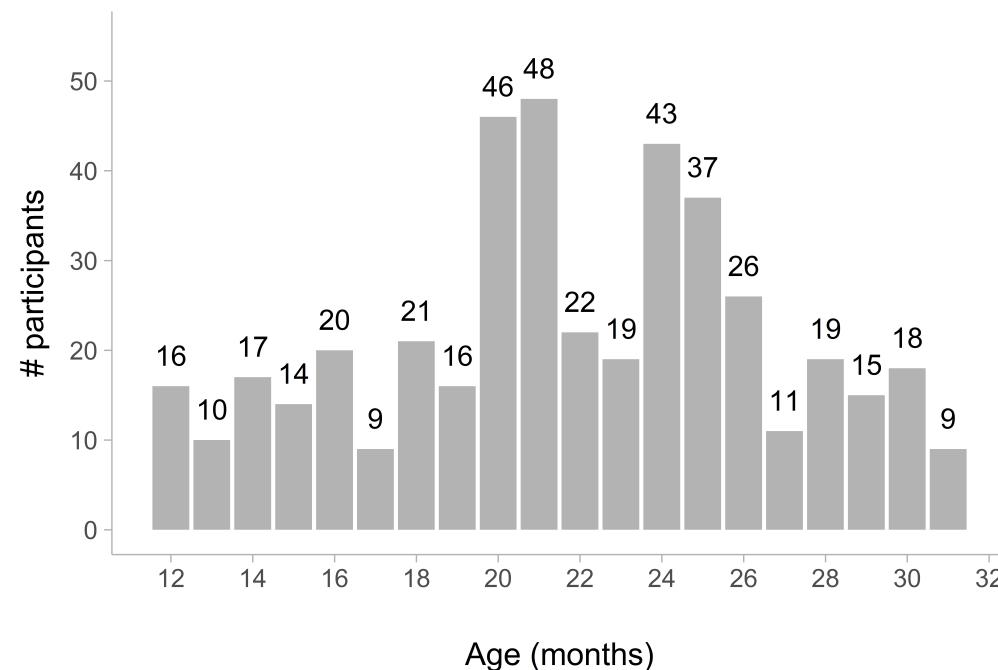


	Understands	Understands & Says
chair	[x]	[]
table	[]	[]
...	[]	[x]

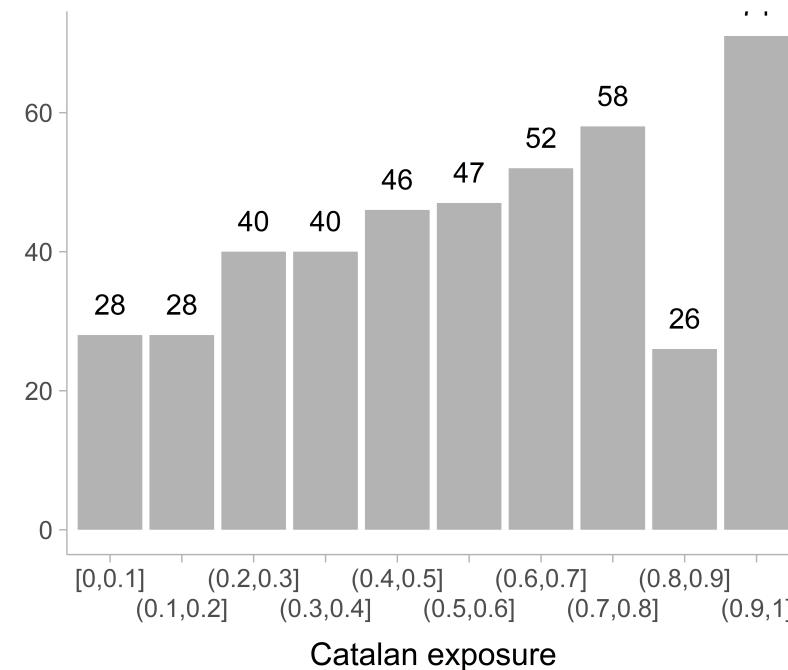
Fenson et al. (1994)

Participants

138,078 item responses
from 366 Catalan-
Spanish bilinguals



	1 time	2 times	3 times	4 times
	312	42	8	4



Testing hypotheses

Modelling and statistical inference

Model

Multilevel, ordinal regression model:

- *No < Understands < Understands and Says*

Bayesian ([brms](#)/Stan): probability of parameter values

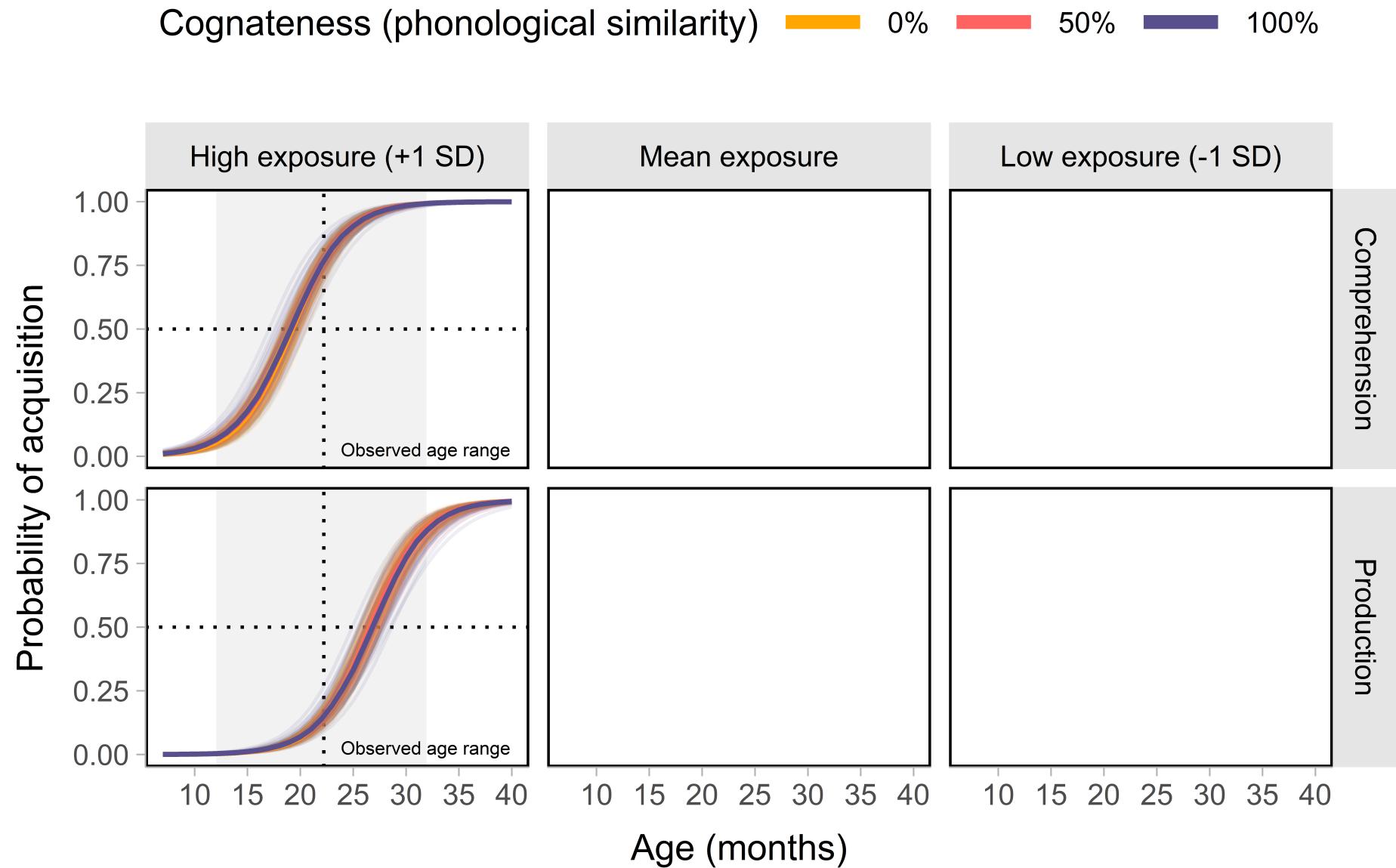
$$P(\text{model}|\text{data}) \propto P(\text{data}|\text{model}) \times P(\text{model})$$

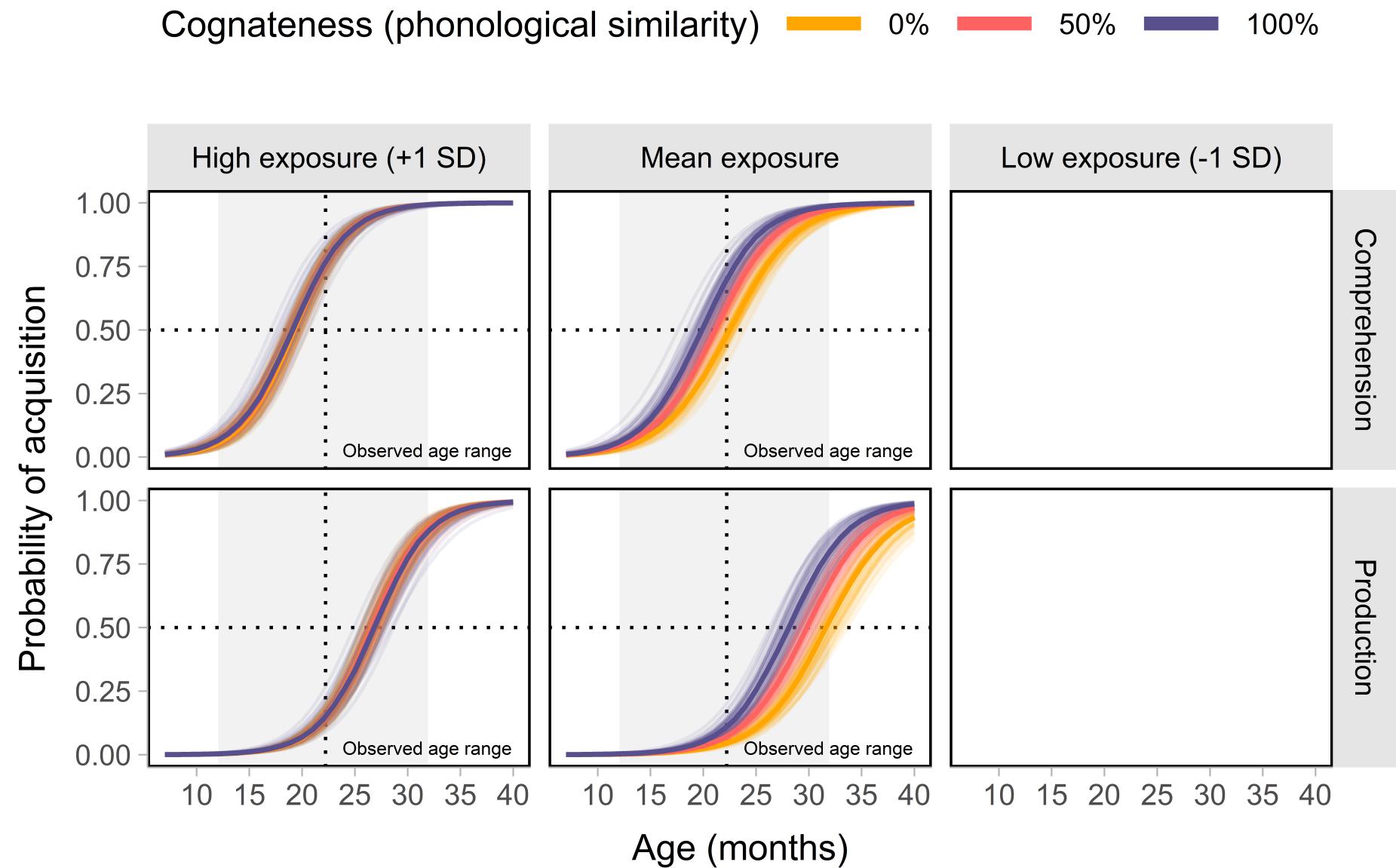
Predictors

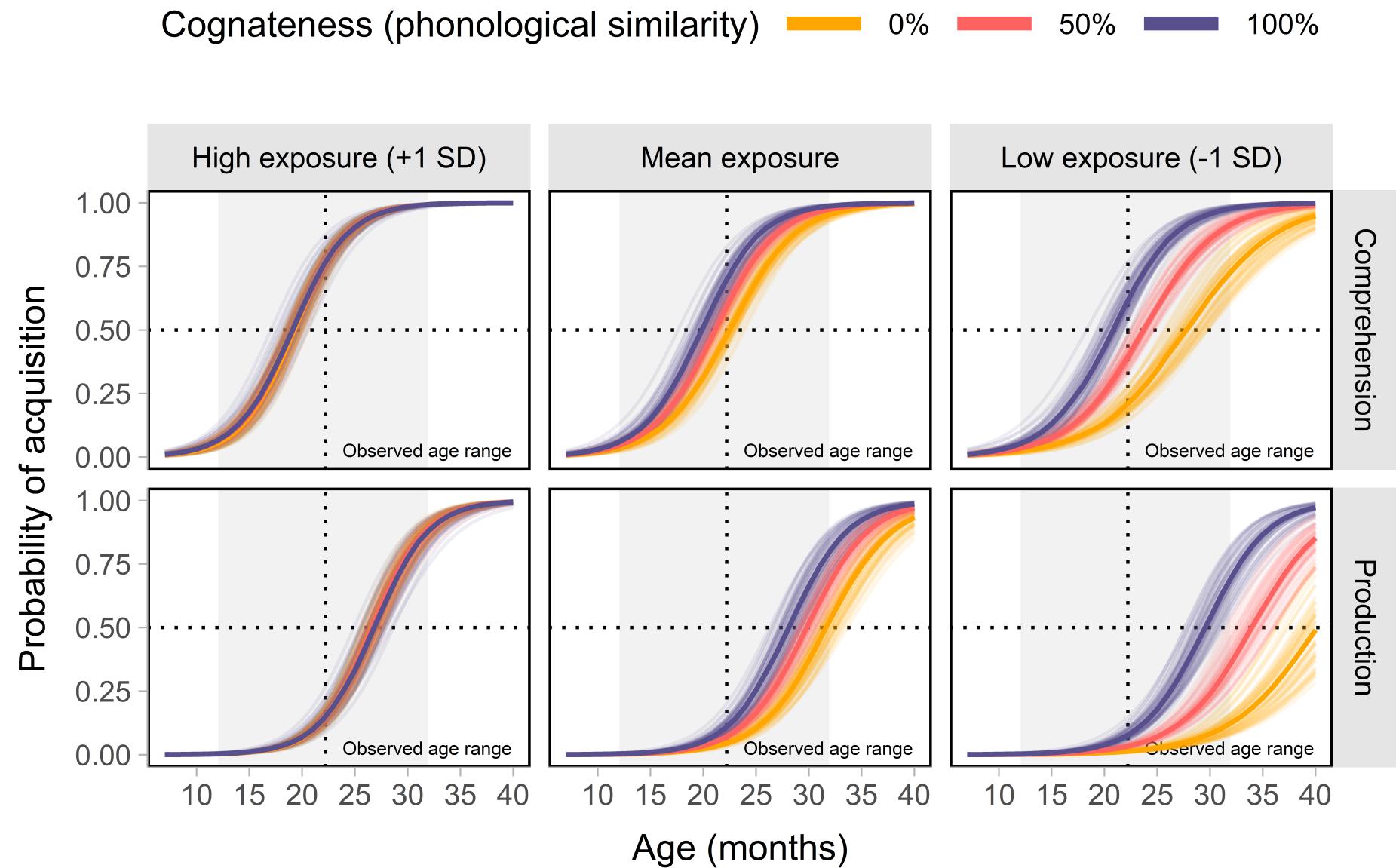
- **Age**
- **Length:** number of phonemes in word-form
- **Exposure:** lexical frequency \times language exposure
- **Cognateness:** Levenshtein similarity between a word-form and its translation

Two-way and three-way **interactions** between age, exposure, and cognateness

Predictor	Estimate	95% HDI	p(HO)
Intercepts			
Comprehension and Production	0.438	[-0.5, 0.5]	0.088
Comprehension	0.936	[2.44, 0.95]	0.000
Slopes			
Age (+1 SD, 4.87, months)	0.405	[1.43, 0.45]	0.000
Exposure (+1 SD, 1.81)	0.233	[0.8, 0.27]	0.000
Cognateness (+1 SD, 0.26)	0.058	[0.06, 0.1]	0.037
Length (+1 SD, 1.56 phonemes)	-0.062	[-0.35, -0.04]	0.000
Age × Exposure	0.071	[0.16, 0.1]	0.000
Age × Cognateness	0.014	[0, 0.03]	0.985
Exposure × Cognateness	-0.057	[-0.28, -0.05]	0.000
Age × Exposure × Cognateness	-0.018	[-0.11, -0.01]	0.975







Discussion

- Cognateness facilitates word acquisition
- Only **low-exposure** words benefit from their cognate status: less dominant language receives more facilitation
- Parallel activation as mechanism that boosts lexical consolidation: increment in **cumulative learning instances**
- Next steps: word-learning, formalisation

Thanks!

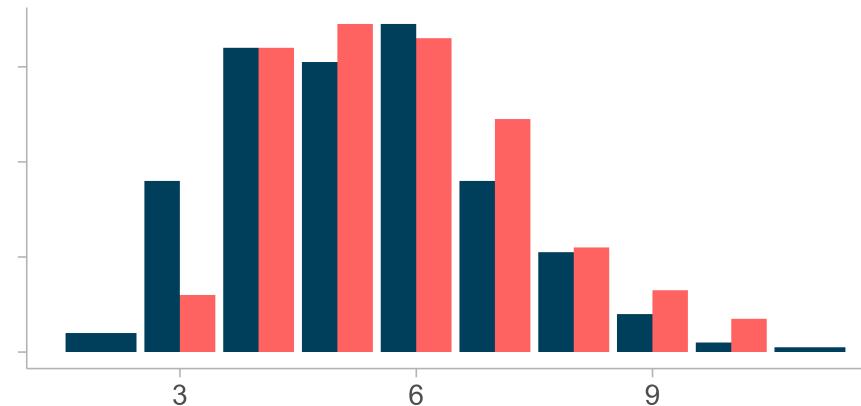


Appendix

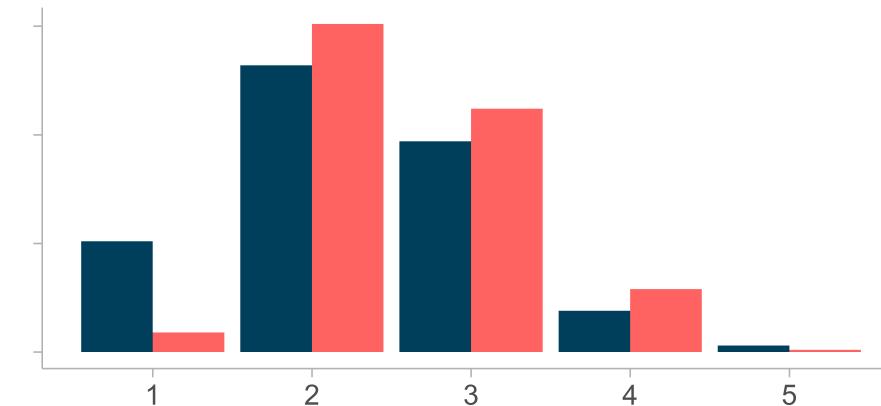
Item properties

Number of phonemes

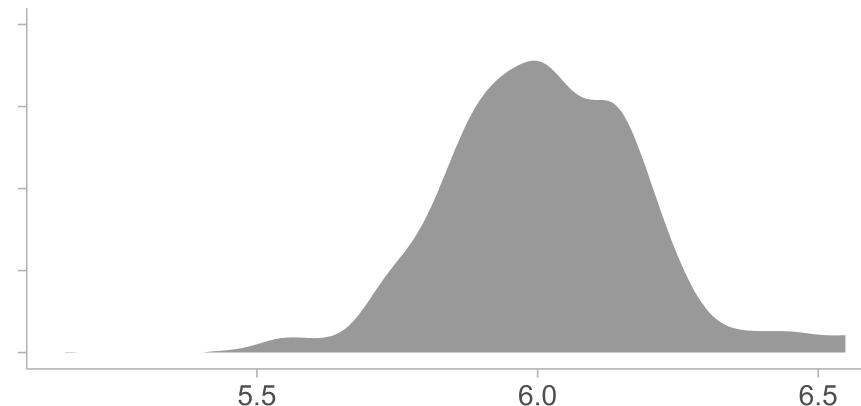
Language █ Catalan █ Spanish



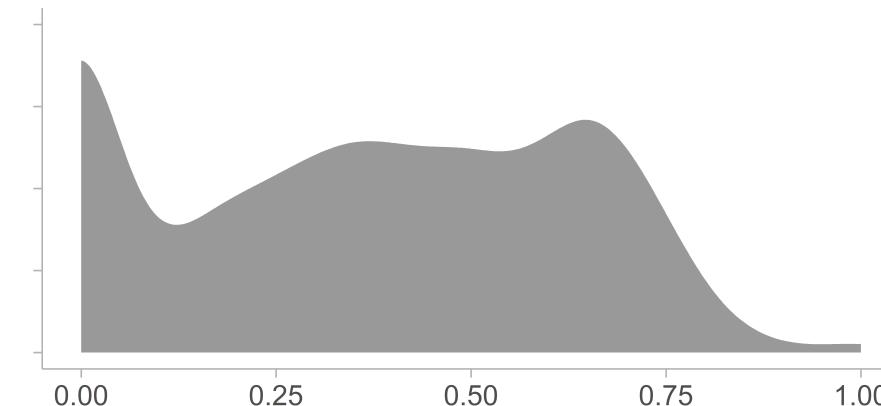
Number of syllables



Lexical frequency



Phonological similarity



Levenshtein similarity

Levenshtein distance: number of edits for two character strings to become identical

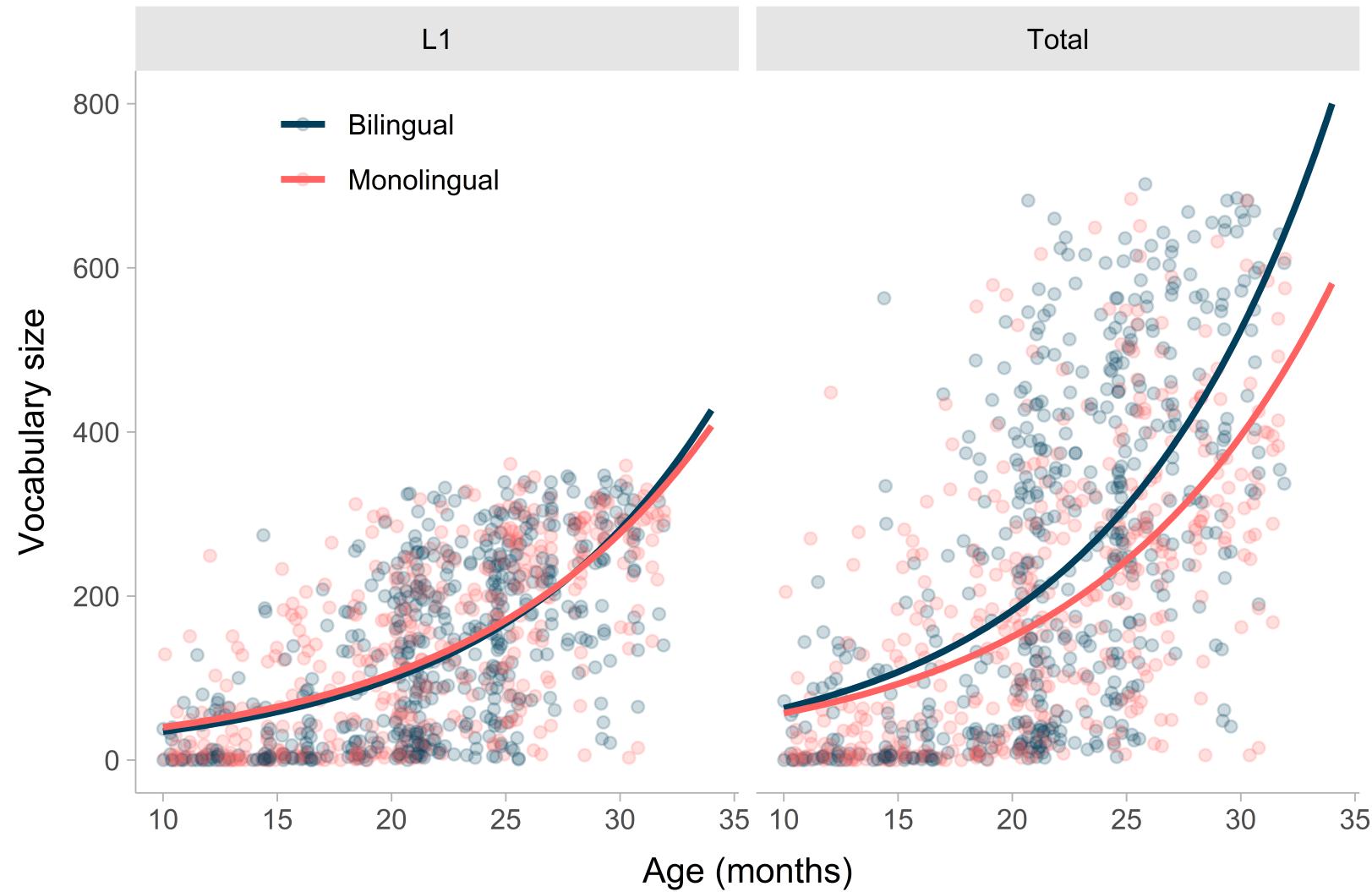
	Orthography	Phonology	String
Catalan	<i>porta</i>	/'pɔr.tə/	pɔrtə
Spanish	<i>puerta</i>	/'pwer.ta/	pweṛta

Levenshtein similarity

$$1 - \frac{lev(A, B)}{Max(length(A), length(B))}$$

Catalan	Spanish	Levenshtein
porta (/'pɔr.tə/)	puerta (/ˈpwεr.ta/)	0.50 (3)
taula (/taw.lə/)	mesa* (/ˈmesa/)	0.00 (5)
cotxe (/kɔ.tʃə/)	coche (/kɔtʃe/)	0.40 (3)
...

Vocabulary



Simulation: monolinguals

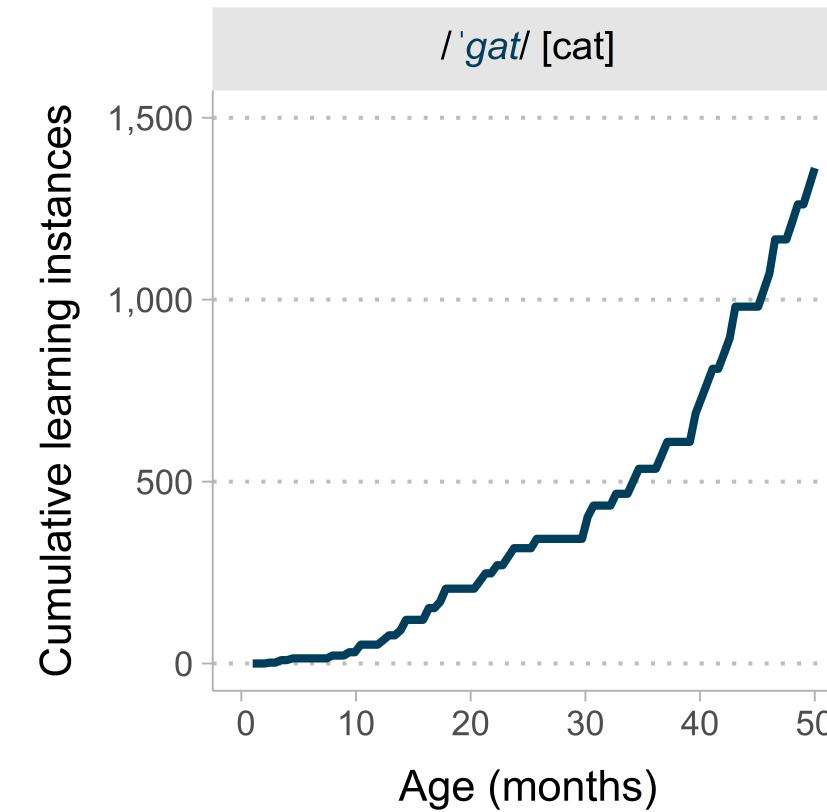
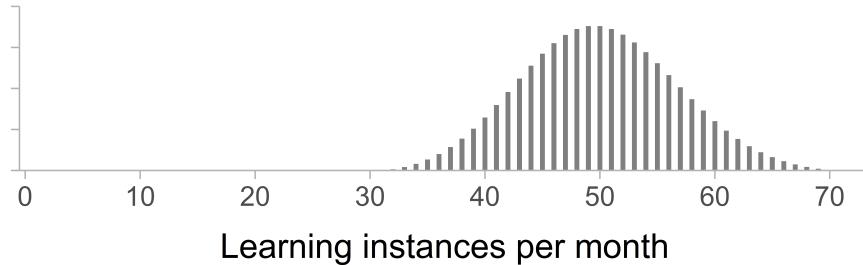
For participant i and word j :

$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j$$

$$\text{Frequency}_j \sim \text{Poisson}(\lambda)$$

For simulations: $\lambda = 50$

Frequency per month
(Poisson distribution)



For participant i and word j :

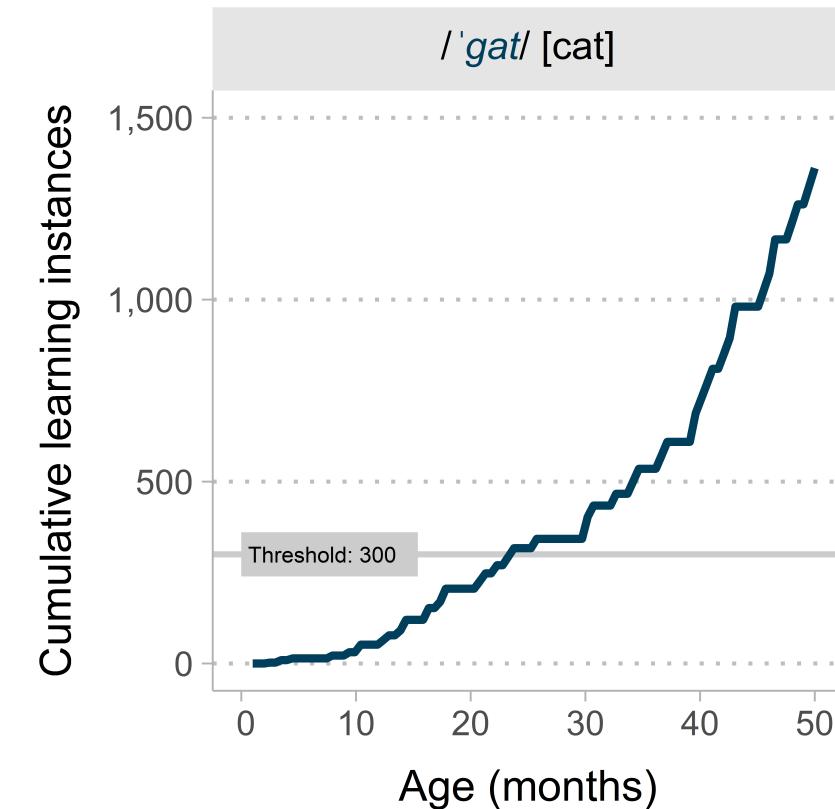
$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j$$

$$\text{Frequency}_j \sim \text{Poisson}(\lambda)$$

For simulations:

$$\lambda = 50$$

$$\text{Threshold} = 300$$



For participant i and word j :

$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j$$

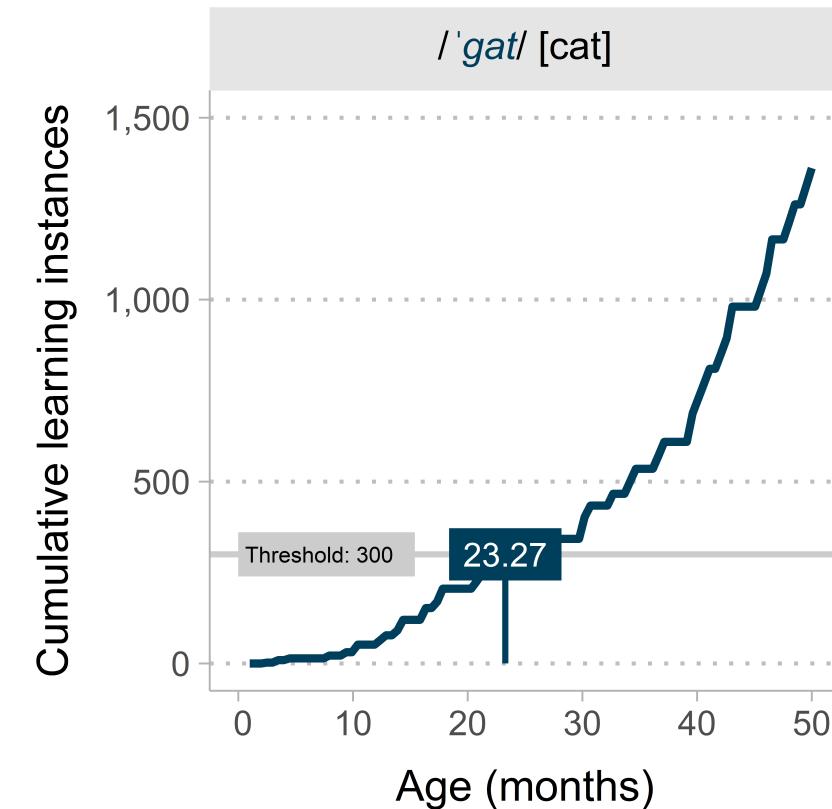
$$\text{Frequency}_j \sim \text{Poisson}(\lambda)$$

For simulations:

$$\lambda = 50$$

$$\text{Threshold} = 300$$

$$\text{Age of Acquisition}_{ij} = \text{Age}_i [\text{Threshold}]$$



For participant i and word j :

$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j$$

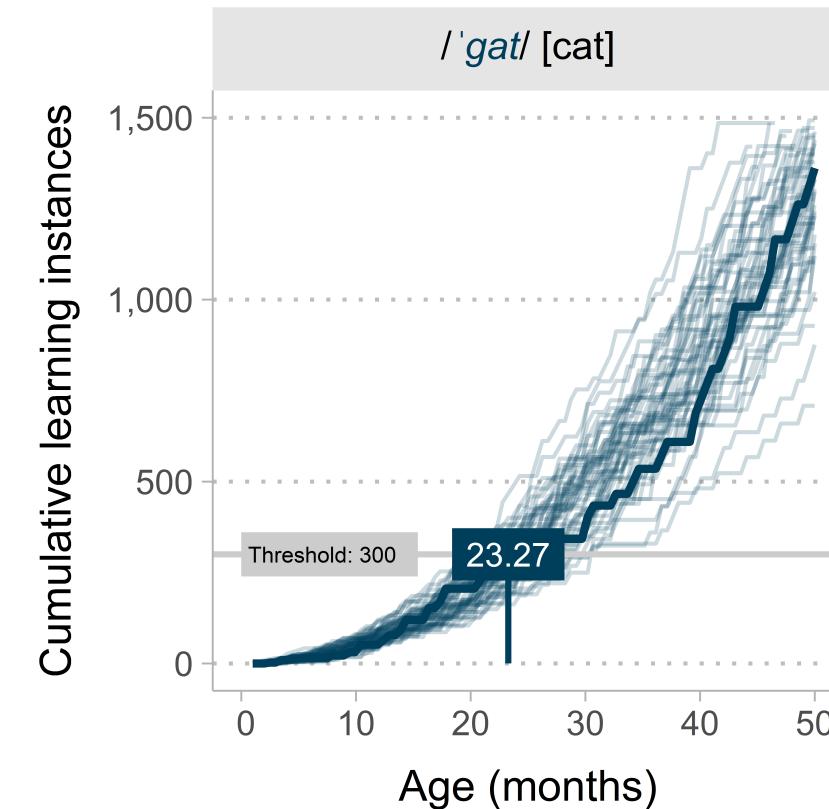
$$\text{Frequency}_j \sim \text{Poisson}(\lambda)$$

For simulations:

$$\lambda = 50$$

$$\text{Threshold} = 300$$

$$\text{Age of Acquisition}_{ij} = \text{Age}_i [\text{Threshold}]$$



Simulations: bilinguals

Including learning instances from **parallel activation**:

- **Hypothesis:** word-representations receive learning instances from their translations
- Proportional to the amount of form-similarity (**cognateness**)

Monolinguals:

$$\text{Learning instances}_{ij} = \text{Age}_i \cdot \text{Frequency}_j$$

Bilinguals:

$$\begin{aligned}\text{Learning instances}_{ij} = & \text{Age}_i \cdot \text{Frequency}_j \cdot \text{Exposure}_i + \\ & (\text{Cognateness}_j \cdot \text{Learning instances}_{ij'})\end{aligned}$$

References

- Bergelson, Elika, and Daniel Swingley. 2012. "At 6–9 Months, Human Infants Know the Meanings of Many Common Nouns." *Proceedings of the National Academy of Sciences* 109 (9): 3253–58. <https://doi.org/10.1073/pnas.1113380109>.
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