Children's production of determiners: a test case for innate syntactic categories?

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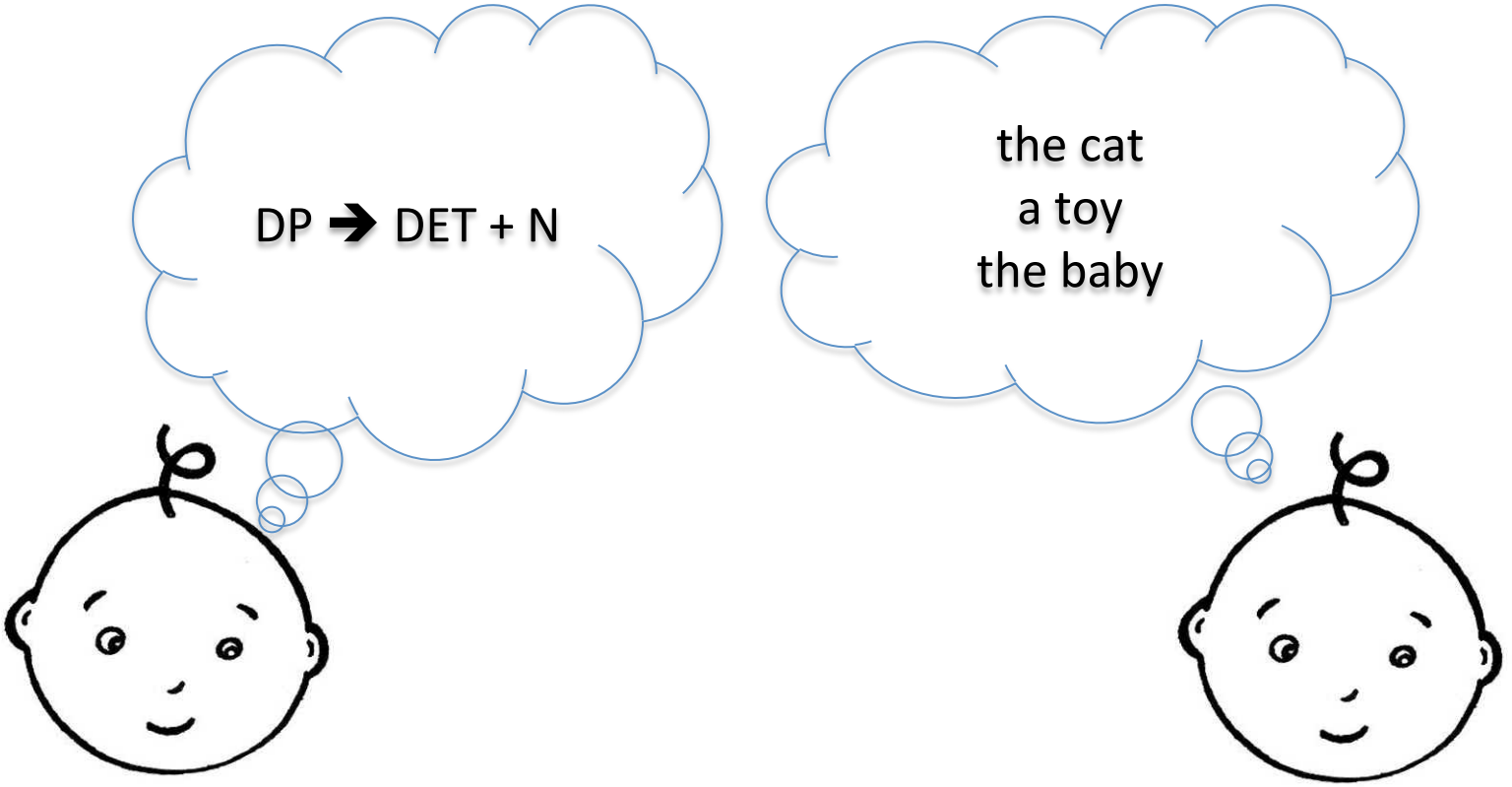
Evolutionary question

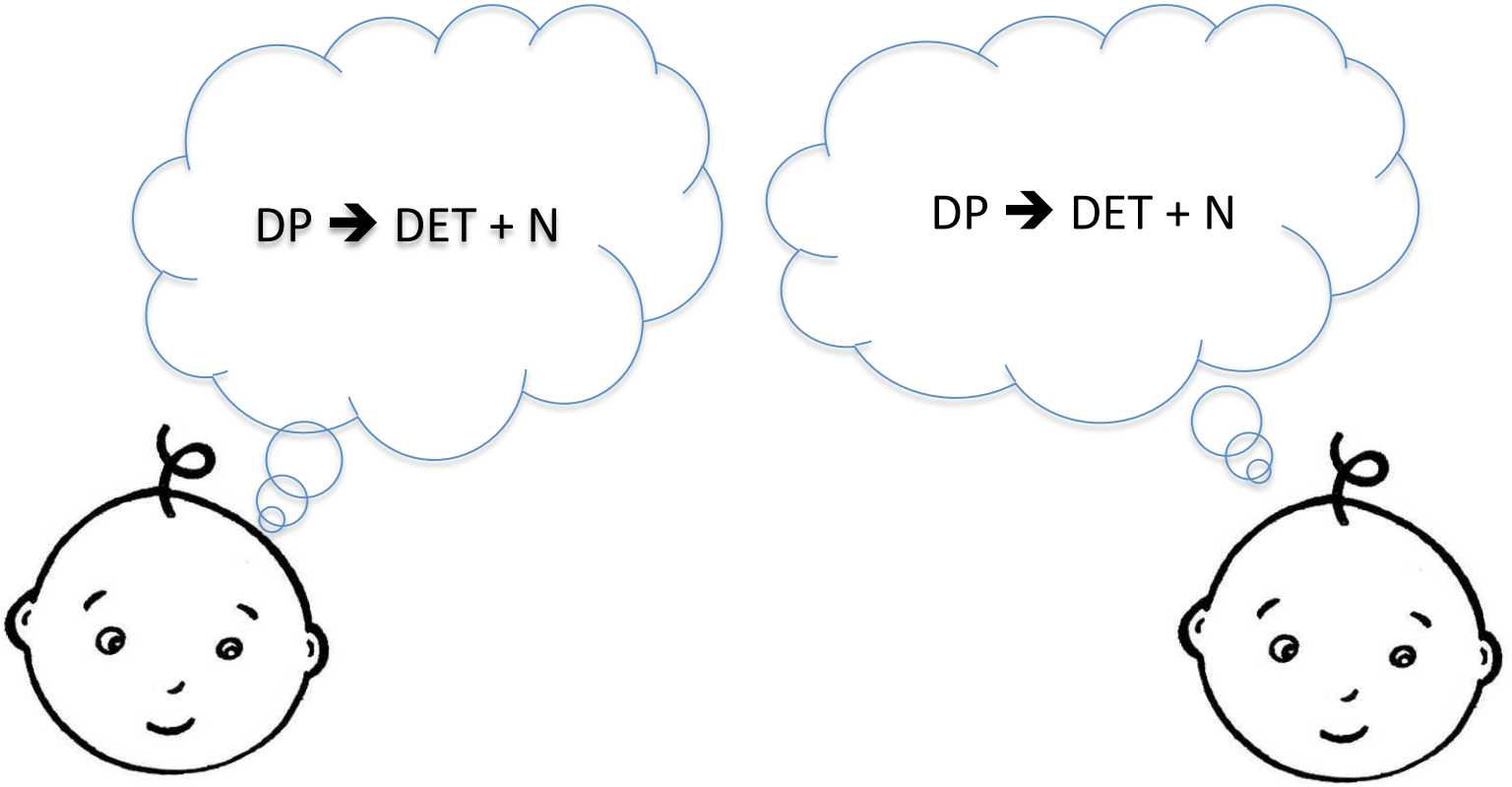
- What do humans bring to the task of acquiring language?
- What can we learn from children's early spontaneous productions?
- Ongoing debate: children's production of determiner+noun combinations

What do humans bring to the task of acquiring language?



Valian (1986); Pine & Lieven (1997); Valian, Solt & Stewart (2009); Yang (2013); Pine et al. (2013)

What do humans bring to the task of acquiring language?



Valian (1986); Pine & Lieven (1997); Valian, Solt & Stewart (2009); Yang (2013); Pine et al. (2013)

Overlap

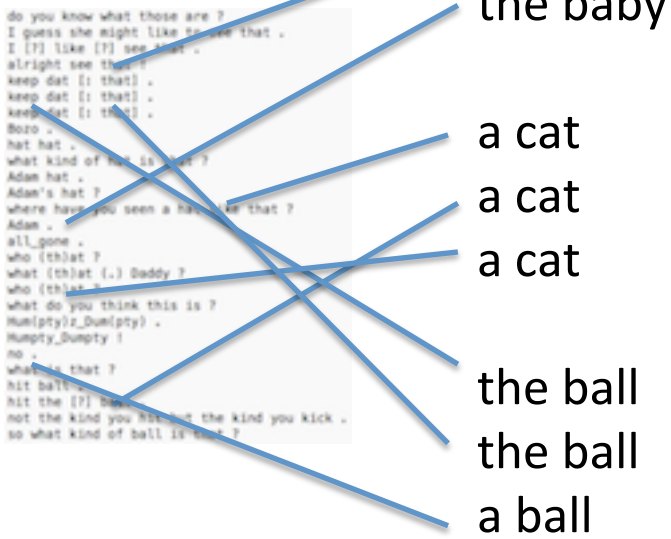
$$\frac{\text{\# of nouns used with both } \textbf{the} \text{ and } \textbf{a}}{\text{\# of nouns used with either } \textbf{the} \text{ or } \textbf{a}}$$


do you know what those are ?
I guess she might like to see that .
I [?] like [?] see that .
alright see that !
keep dat [: that] .
keep dat [: that] .
keep dat [: that] .
Bozo .
hat hat .
what kind of hat is that ?
Adam hat .
Adam's hat ?
where have you seen a hat like that ?
Adam .
all_gone .
who (th)at ?
what (th)at (.) Daddy ?
who (th)at ?
what do you think this is ?
Hum(pty)z_Dum(pty) .
Humpty_Dumpty !
no .
what is that ?
hit ball .
hit the [?] ball .
not the kind you hit but the kind you kick .
so what kind of ball is that ?

Pine & Lieven (1997)

Overlap

$$\frac{\text{\# of nouns used with both } \textbf{the} \text{ and } \textbf{a}}{\text{\# of nouns used with either } \textbf{the} \text{ or } \textbf{a}}$$



Pine & Lieven (1997)

Overlap

$$\frac{\text{\# of nouns used with both } \textbf{the} \text{ and } \textbf{a}}{\text{\# of nouns used with either } \textbf{the} \text{ or } \textbf{a}}$$

a baby
the baby

a cat
a cat
a cat

the ball
the ball
a ball

Pine & Lieven (1997)

Overlap

$$\frac{\text{\# of nouns used with both } \textbf{the} \text{ and } \textbf{a}}{\text{\# of nouns used with either } \textbf{the} \text{ or } \textbf{a}}$$

a baby
the baby

a cat
a cat
a cat

the ball
the ball
a ball

2/3 = **67%**

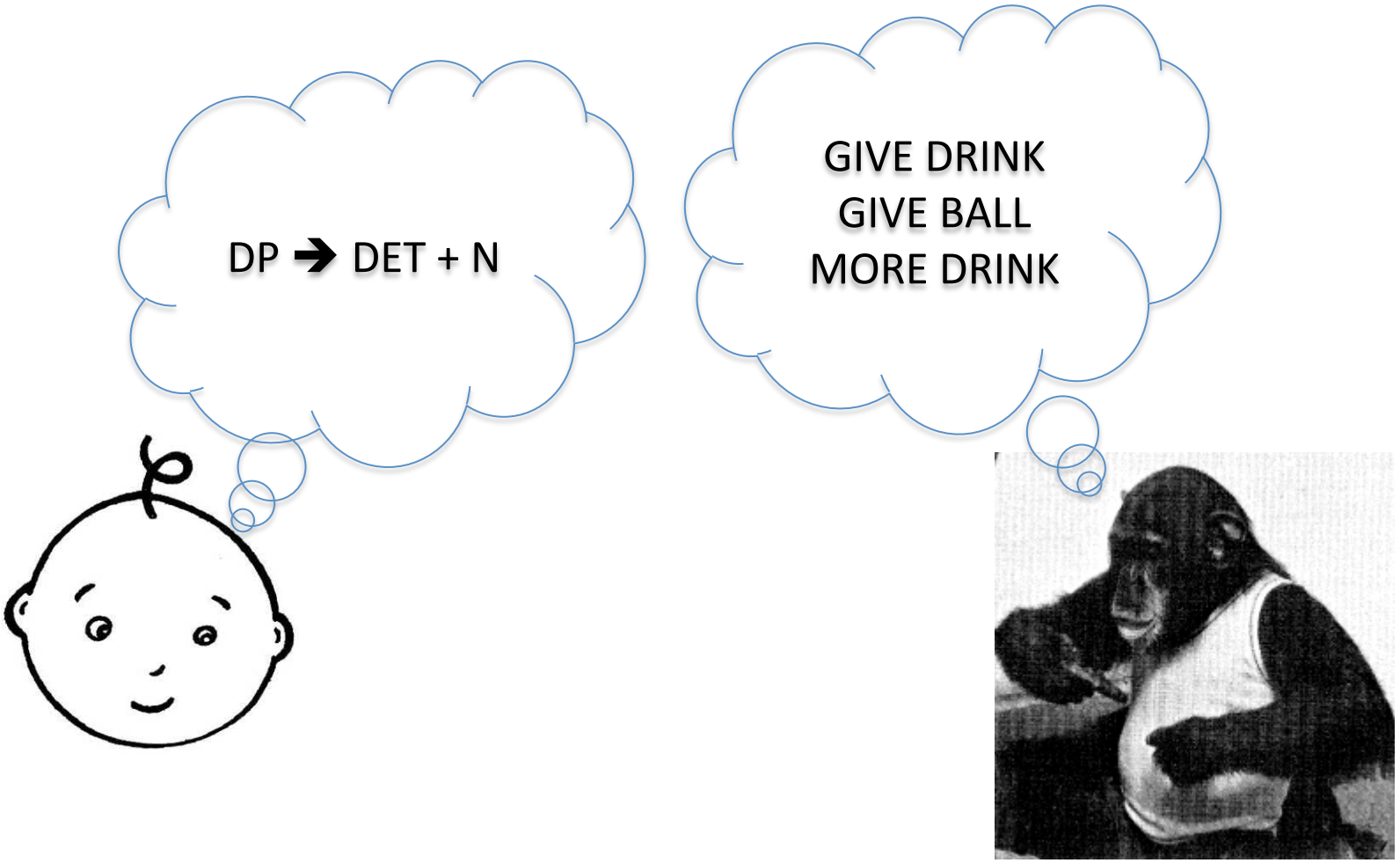
Pine & Lieven (1997)

Previous findings

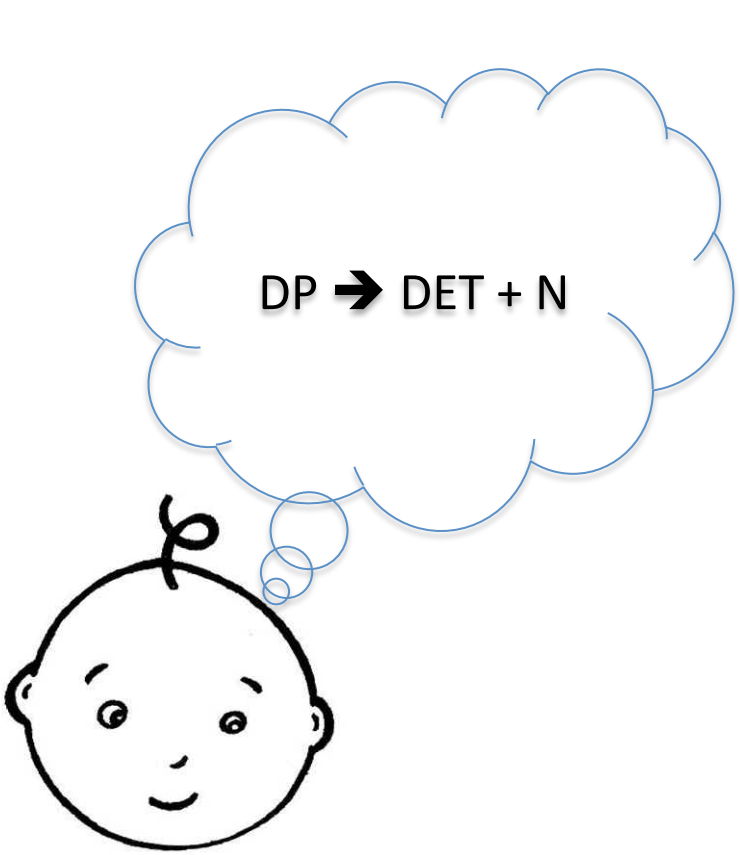
- Pine et al. (1997, 2013)
  - child overlap initially lower than parent overlap
  - children gradually abstract syntactic categories

- Valian et al. (2009, 2014)
  - child overlap no different from parent overlap
  - children have innate syntactic categories

Yang (2013)



Yang (2013)



Yang (2013)

- Overlap depends on noun frequency

a ball	a flower
the ball	a flower
the ball	
the ball	
a ball	
a ball	
the ball	
the ball	

- Determiners & nouns should freely combine within frequency constraints

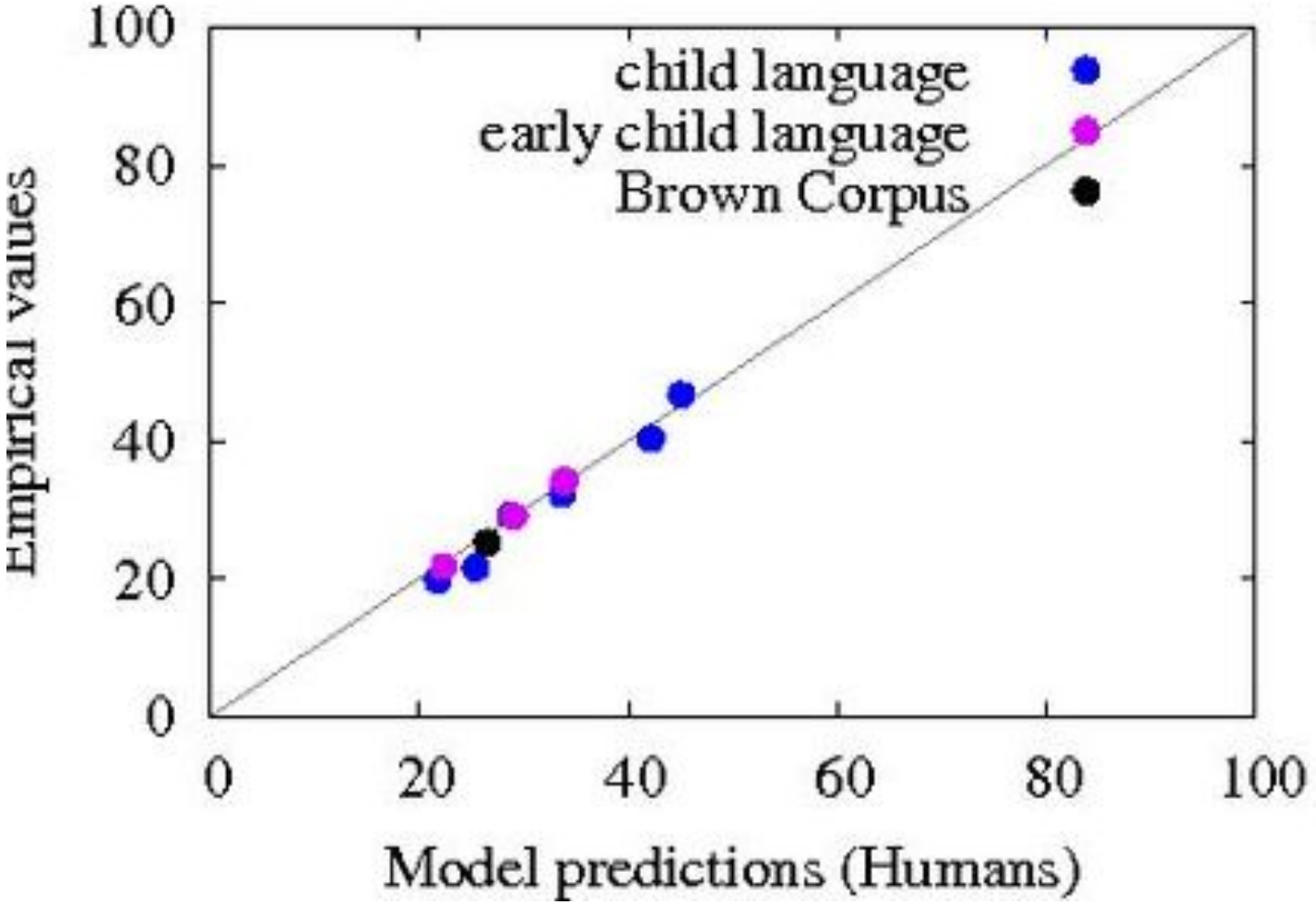
Yang (2013)'s model

- Predicts overlap from 3 main parameters:
  - Zipfian probability of each noun
  - Zipfian probability of each determiner
  - Sample size (number of det+noun pairs)

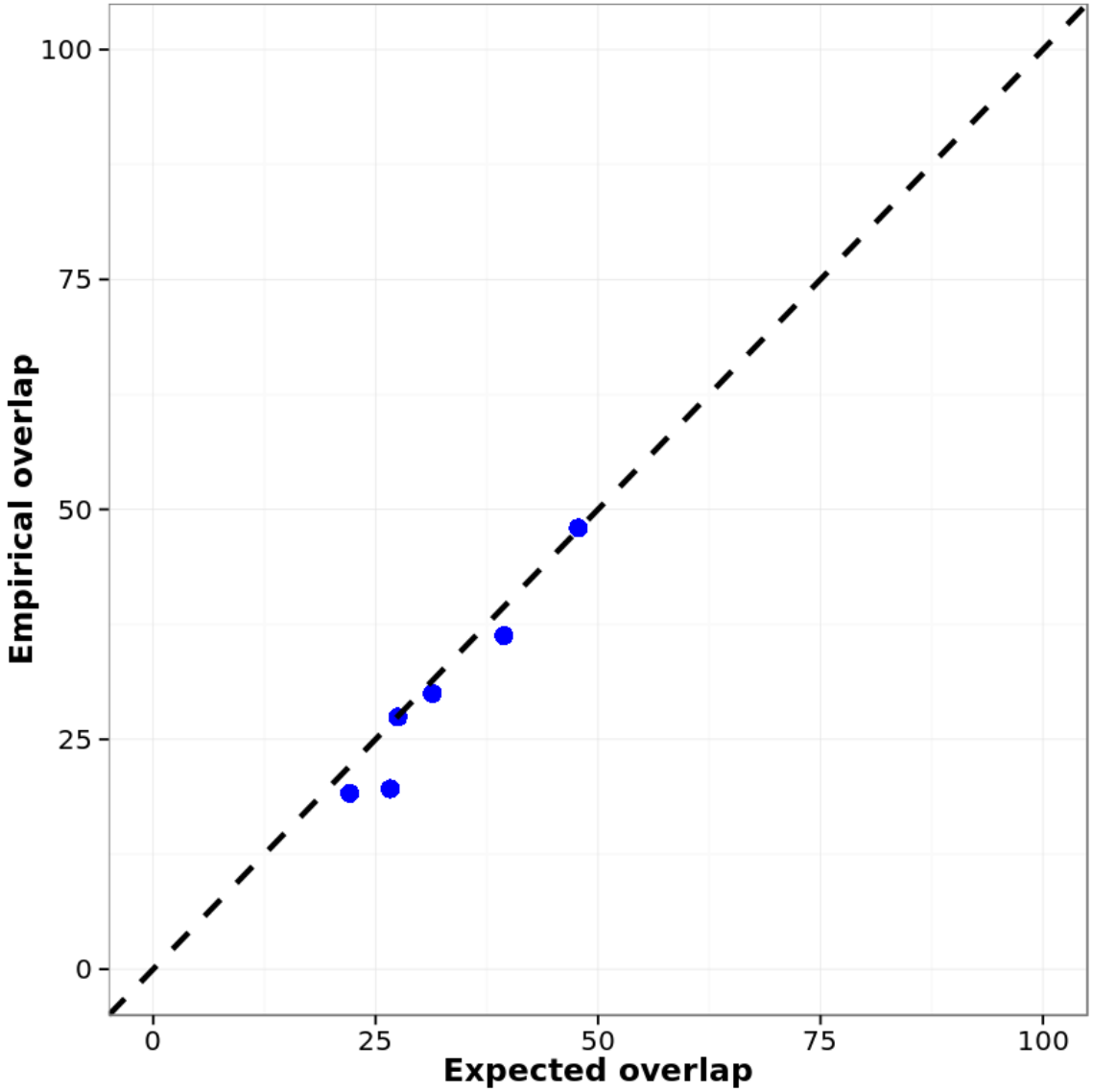
- Predicted & empirical overlap values for 6 children (1;1-5;1) from CHILDES

MacWhinney (2000); Zipf (1949)

Yang (2013) results



Child data: replication



Free combinations

Data

a baby
the baby

a cat
a cat
a cat

the ball
the ball
a ball

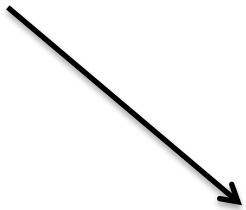
Free combinations

Data

a baby
the baby

a cat
a cat
a cat

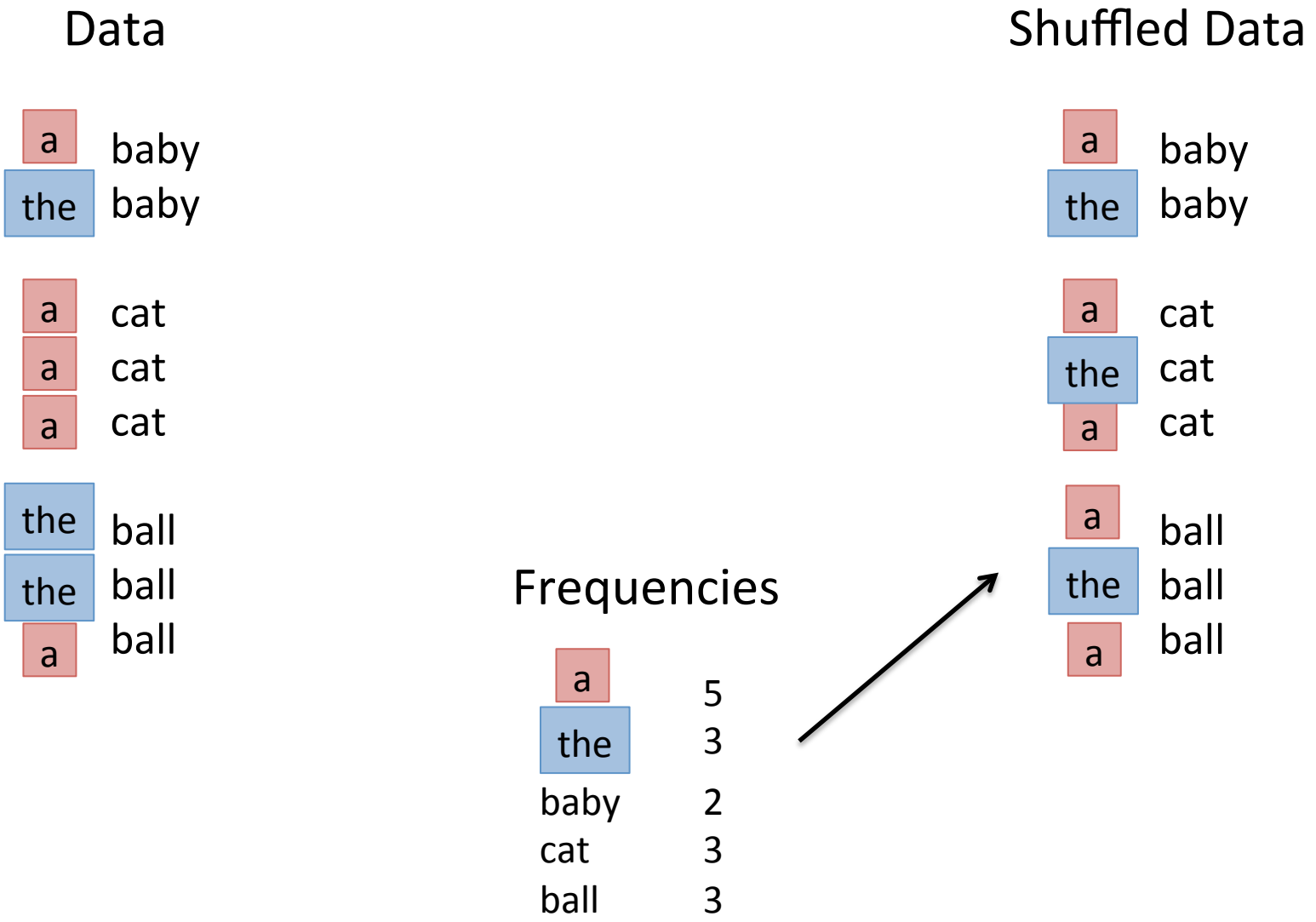
the ball
the ball
a ball



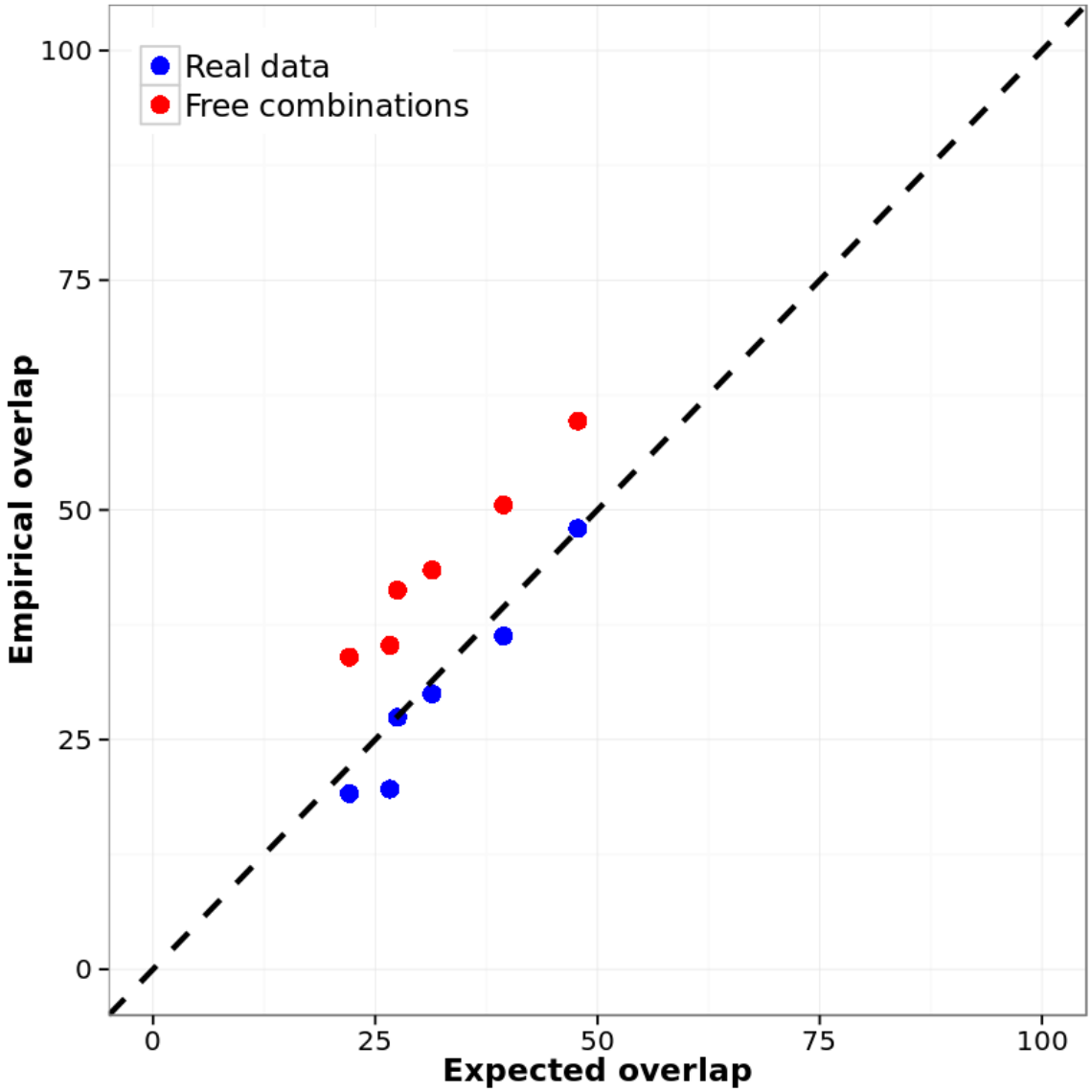
Frequencies

a	5
the	3
baby	2
cat	3
ball	3

Free combinations



Child data: free combinations



Child data: implications

- Model underestimates overlap under freely combinatorial rule

- This holds for simulated Zipfian samples

- Why does the model fit the real data?

Real data do not combine freely

a cookie
a cookie
a cookie
a cookie

Lana Dandan (Flickr)

the door
the door
the door
the door
the door
the door
the door
the door
the door
the door

Frederik Ranninger (Flickr)

Should a generativist theory predict free combinations?

- Children don't freely combine determiners and nouns
- And they shouldn't!
- Regularities in discourse context constrain combinations beyond marginal frequencies

Should a constructivist theory predict early constrained combinations?

- Children produce nouns alone before det +noun combinations (Clark, 2003)

- Evidence from input that 'the' and 'a' can combine with many nouns

- By the time children produce combinations, ample evidence from which to construct a rule

Other approaches

- Bayesian modelling (Meylan, Frank & Levy, 2013)
- Denser sampling e.g. Human Speechome Project (Roy et al., 2006)
- Experimental studies (Maratsos, 1974; Warden, 1976; Karmiloff-Smith, 1979)

More broadly

- Taking a broader perspective

- Determiners + nouns
  - Historical change
  - Invention without input

On the cultural level

- Rules change during transmission and interaction

DEMONSTRATIVE → the

NUMERAL → a

Greenberg (1978); Beckner & Bybee (2009); De Mulder & Carlier (2012); Smith, Fehér & Ritt (2014)

On the individual level

- A learner with no input still generates rules

[PENNY **point at penny]** point at self

[penny **that]** me

‘(You) (give) me **that penny**.’

David, homesigner

- Only after abstract noun category appears

Goldin-Meadow (2003); Hunsicker & Goldin-Meadow (2012)

Back to our original question

- What do humans bring to the task of acquiring language?
  - Propensity to infer (or create) combinatorial rules
  - Rules emerge via individual & historical reanalysis
- What can we learn from children's early spontaneous productions?
  - Different theories may not make different predictions
  - Combinations will be semantically constrained

Thanks!

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Code available at:
https://github.com/christos-c/noun-det-diversity

References

Goldin-Meadow, S. (2003). *The resilience of language.* New York: Psychology Press.

Hunsicker, D., & Goldin-Meadow, S. (2012). Hierarchical structure in a self-created communication system: Building nominal constituents in homesign. *Language*, *88*(4), 732–763.

Pine, J. M., & Lieven, E. V. M. (1997). Slot and frame patterns and the development of the determiner category. *Applied Psycholinguistics*, *18*(02), 123.

Pine, J. M., Freudenthal, D., Krajewski, G., & Gobet, F. (2013). Do young children have adult-like syntactic categories? Zipf's law and the case of the determiner. *Cognition*, *127*(3), 345–360.

Valian, V. (1986). Syntactic categories in the speech of young children. *Developmental Psychology*, *22*, 562-579.

Valian, V., Solt, S., & Stewart, J. (2009). Abstract categories or limited-scope formulae? The case of children's determiners. *Journal of Child Language*, *36*(4), 743–778.

Yang, C. (2013). Ontogeny and phylogeny of language. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(16), 6324–7e.

References (continued)

Greenberg, J. H. (1987). How does a language acquire gender markers? In Joseph H. Greenberg, Charles A. Ferguson, and Edith A. Moravcsik (eds), *Universals of Human Language*, vol. 3: *Word Structure*. Stanford, CA: Stanford University Press, 47–82.

Clark, E. V. (2003). *First language acquisition.* Cambridge: Cambridge University Press.

De Mulder, W., & Carlier, A. (2012). The grammaticalization of definite articles. In B. Heine & H. Narrog (Eds.), *The Oxford Handbook of Grammaticalization* (pp. 522–534). Oxford: Oxford University Press.

MacWhinney, B. (2000). *The CHILDES Project.* Mahwah, NJ: Lawrence Erlbaum.

Smith, K., Fehér, O., & Ritt, N. (2014). Eliminating unpredictable linguistic variation through interaction. In P. Bello, M. Guarini, M. McShane, & B. Scassellati (Eds.), *Proceedings of the 36th Annual Conference of the Cognitive Science Society* (pp. 1461–1466). Austin, TX: Cognitive Science Society.

Pictures: Lana Dandan https://www.flickr.com/photos/lanadandan/346204320/ and Frederik Ranninger https://www.flickr.com/photos/130218015@N02/16461029851/

Yang (2013) model

$$E_r = 1 - (1 - p_r)^S - \sum_{i=1}^{D} \left[(d_i p_r + 1 - p_r)^S - (1 - p_r)^S \right]$$

Probability noun not sampled

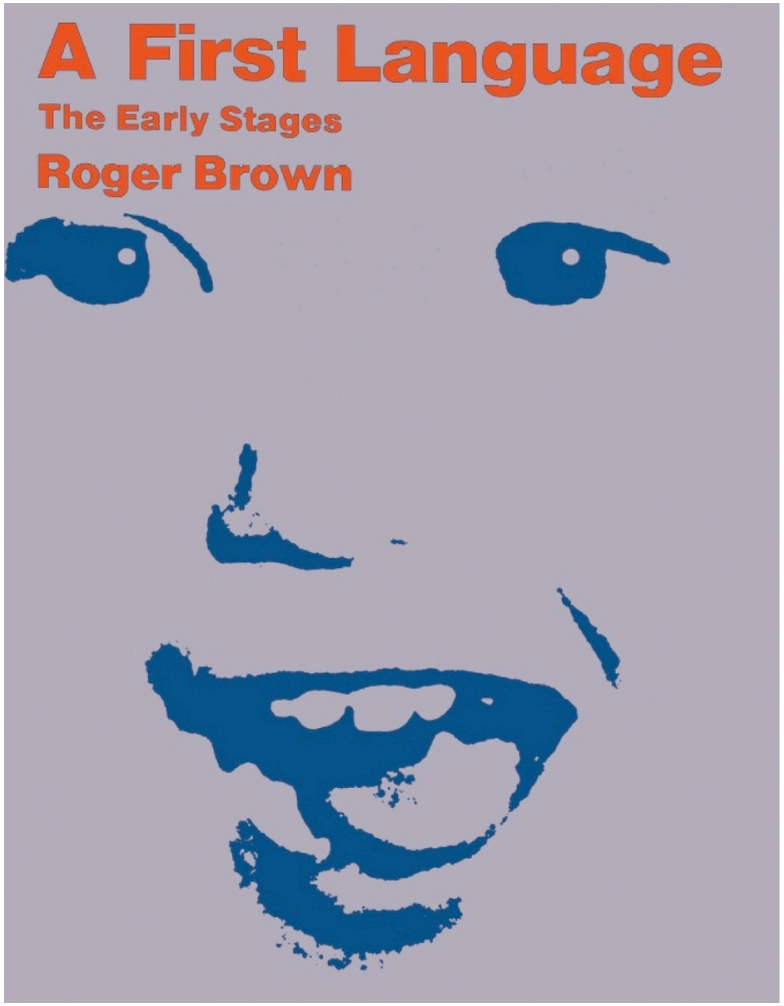
Probability noun sampled exclusively with one determiner

Simplified model

$$E_r = 1 - \sum_{i=1}^{D} d_i^{(p_r S)}$$

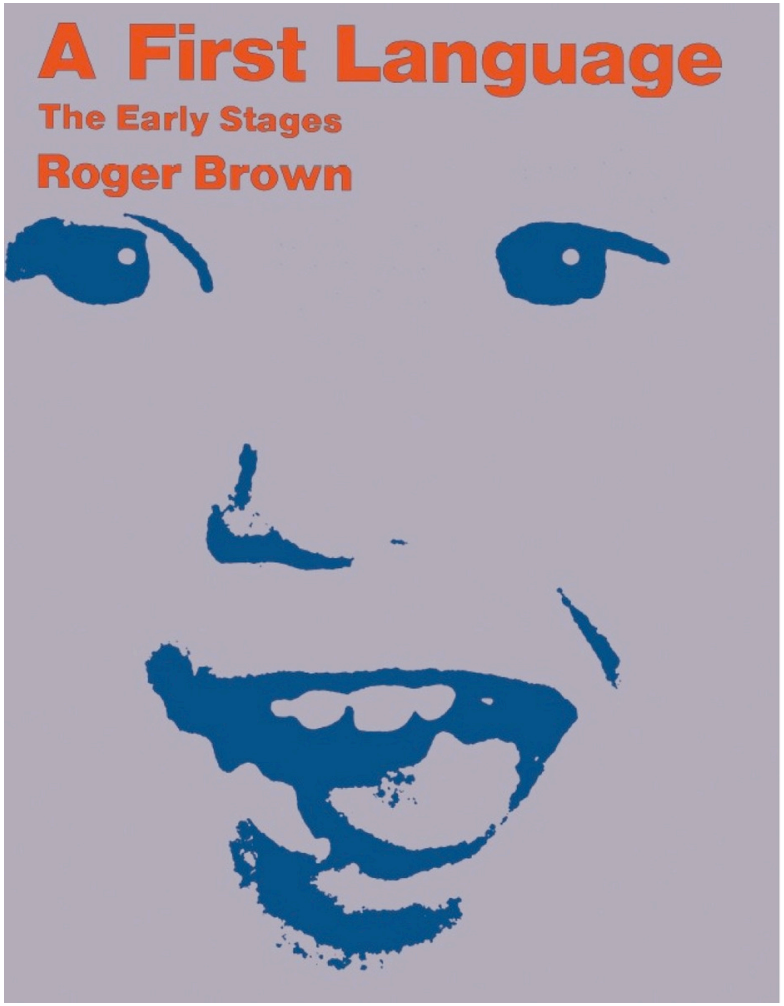
Probability noun sampled
exclusively with one determiner

Brown (1973)



- World knowledge
- Knowledge of what others know
- Understanding of connected discourse
- Part-whole entailment
- Fictitious/ hypothetical reference

Brown (1973)



SARAH: I want to open the door.
MOTHER: what door?

GLORIA: he's going on the fox's tail.
…
EVE: he on a fox's nose.

Free combination is not the goal

go to the kitchen and get me a cookie.

I'm going to have a bath.

answer the phone!

Free combination is not the goal

go to a kitchen and get me the cookie.

I'm going to have the bath.

answer a phone!

Nim

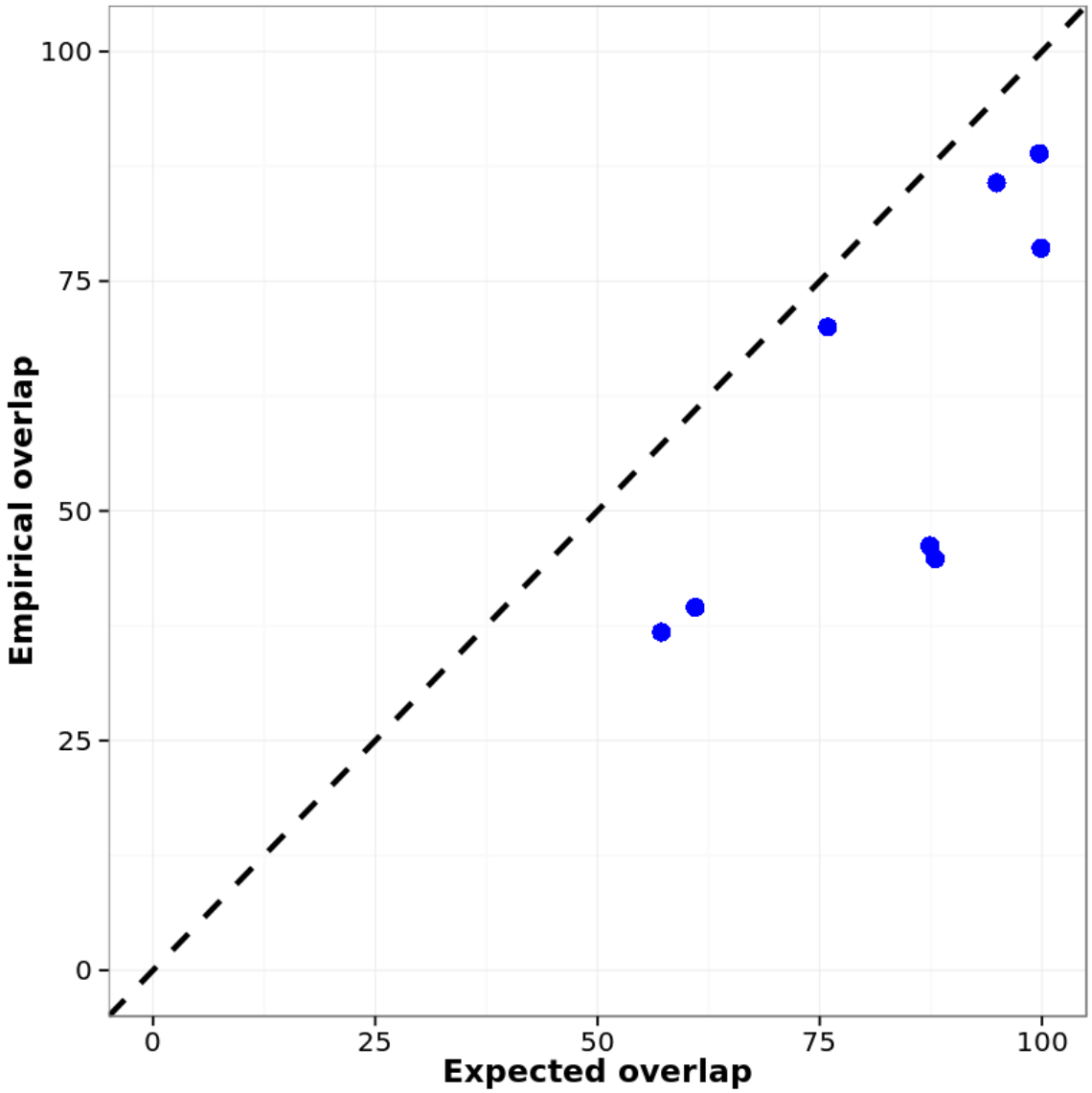
2-sign combinations

MORE Nim
MORE Nim
MORE Nim

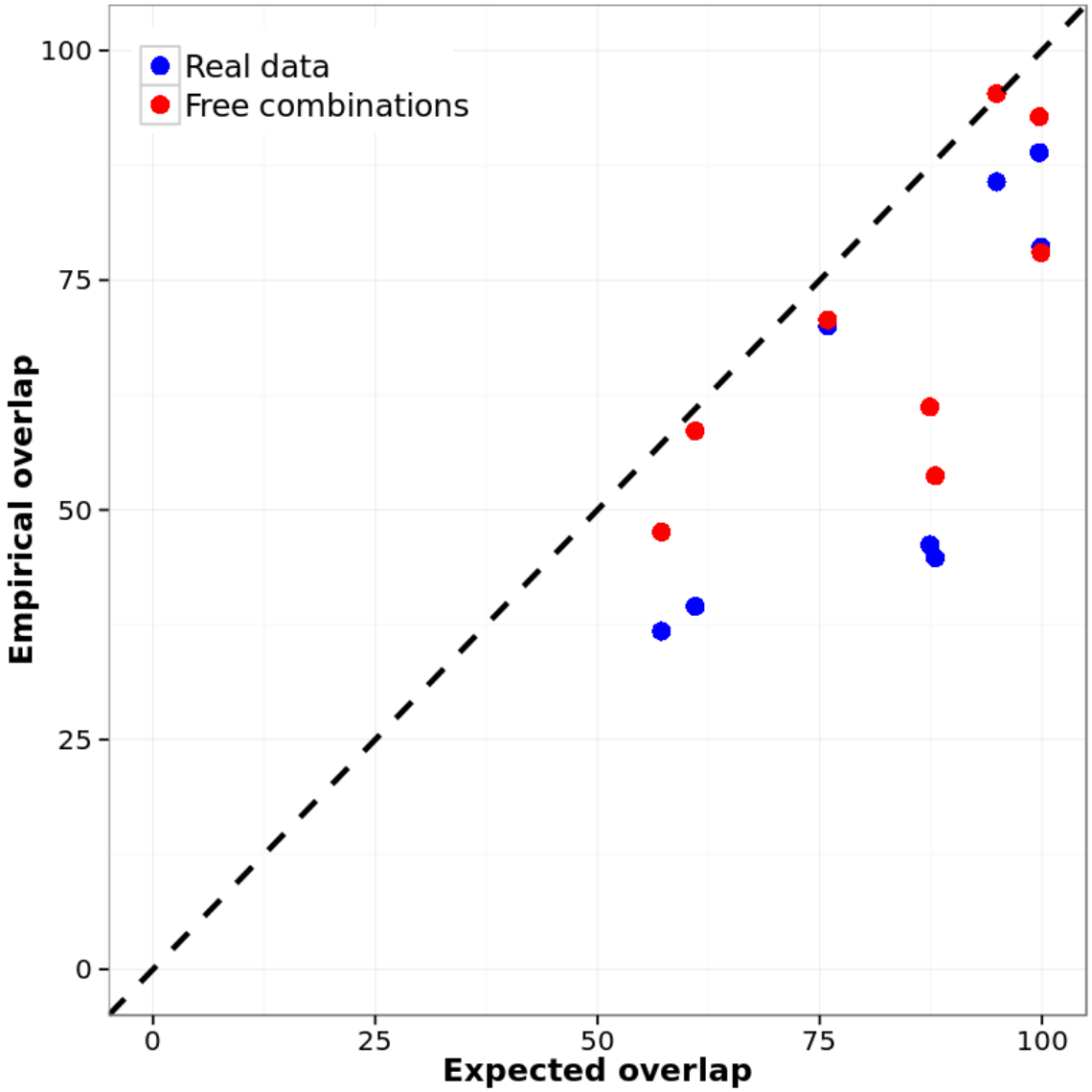
GIVE drink
GIVE drink
MORE drink
GIVE drink
MORE drink

Terrace (1979)

Nim: replication



Nim: free combinations



Nim: implications

- Model overestimates overlap under freely combinatorial rule

- Nim's sample not strictly Zipfian – low-ranked signs less frequent than predicted

- Nim data and child data not comparable using this model

Children

Peter 1;9.08 - 3;1.20

Adam 2;3.04 - 5;2.12

Sarah 2;3.05 - 5;1.06

Eve 1;6 - 2;3

Naomi 1;2.29 - 4;9.03

Nina 1;11.16 - 3;3.21