The everyday statistics of objects and their names: How word learning gets its start

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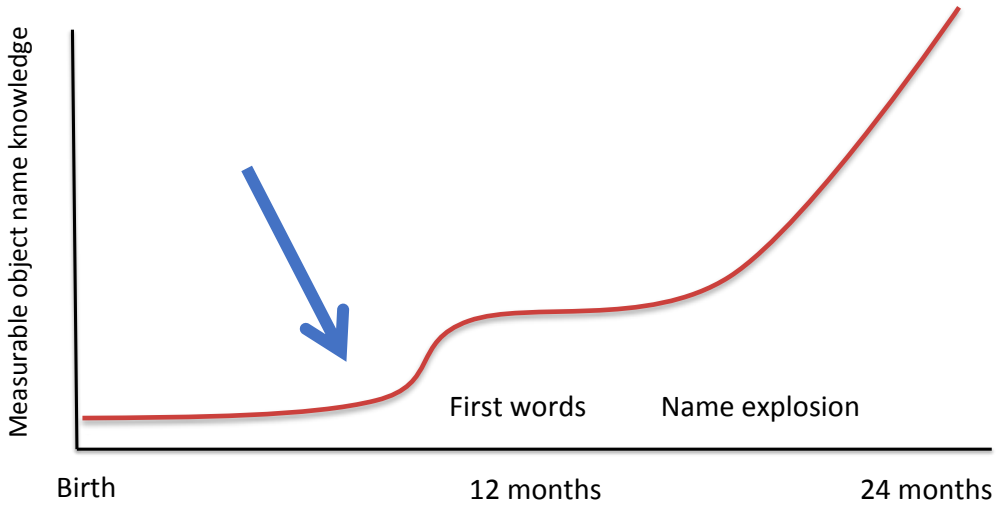
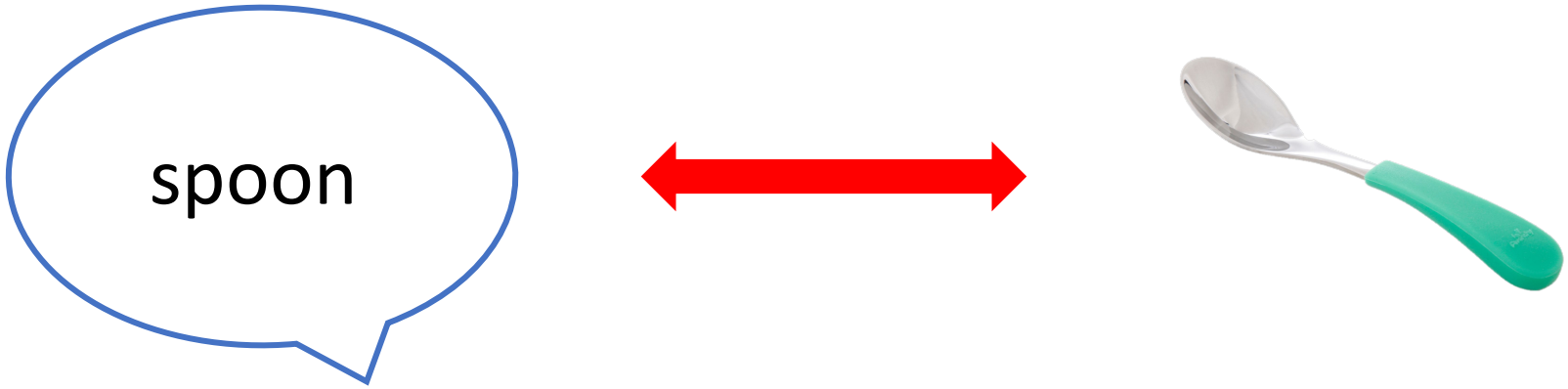
The start of word learning

7- to 11-month-olds

- Not talking!
- Working on
  - sitting stably
  - manipulating objects
  - standing
- *and not good at any of it*



The learning problem



To learn object names, infants must link object names they hear to the objects themselves

What are the data for learning?

To create the link between an object and its name, a learner needs:

- Exposure to the visual object
- Exposure to the spoken name
- Exposure to the co-occurrence of the object and its name

What is the input in the wild?

For other research on these properties of the at-home environment, see Clerkin et al. (2017) and Bergelson & Aslin (2017)

Head cameras

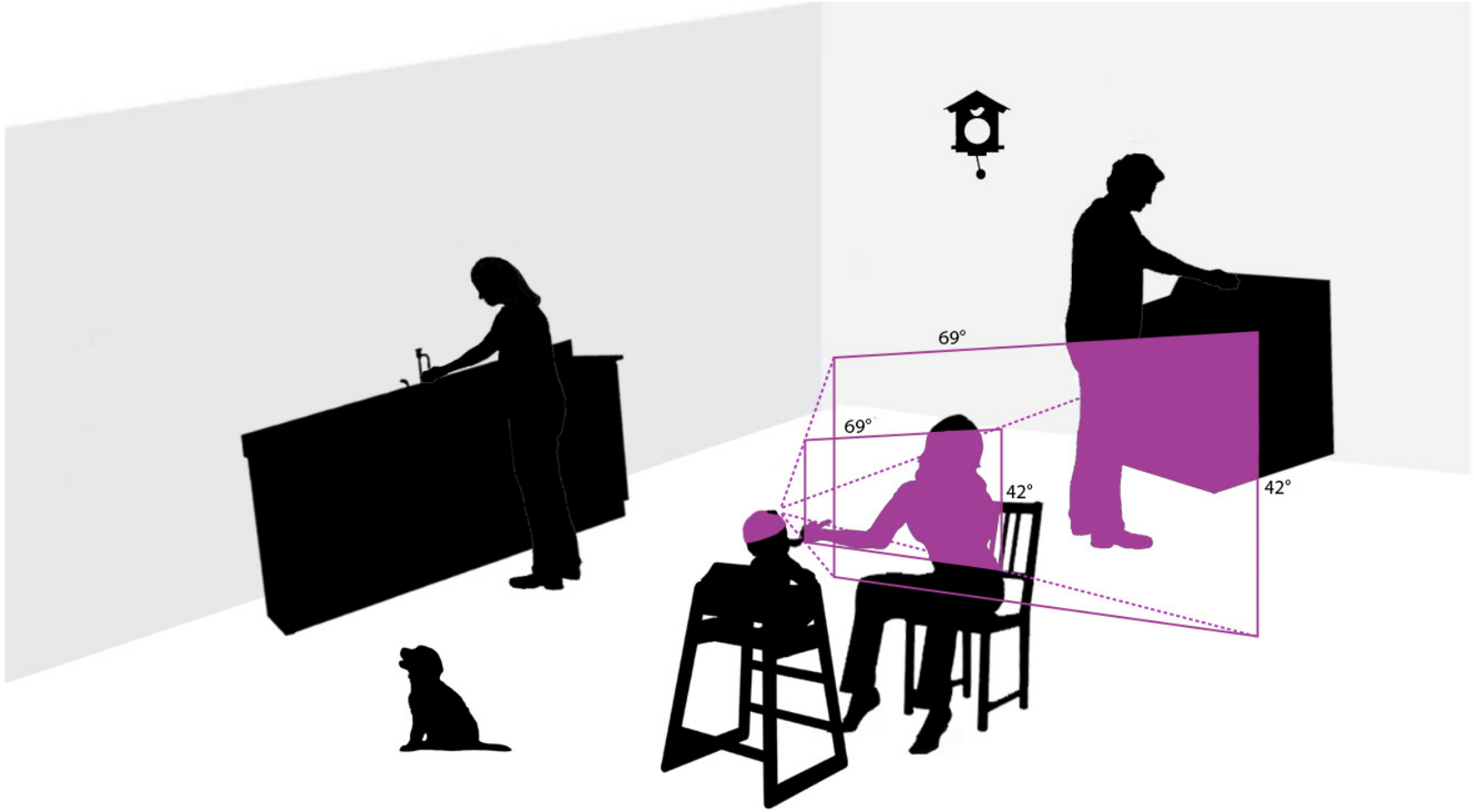


Figure from Clerkin et al. (2017)

Capturing the input from the infant perspective

Mealtime

- In infants' daily lives, the number of word tokens per minute is lower for mealtimes relative to some other activities, i.e., booksharing and grooming
- However, the names of food and food-related items are much more likely to occur during mealtime than during other activities (Tamis-LeMonda et al., 2018)

- Infants learn the names of many food and food-related items early (as per the MCDI: Fenson et al. 2007 and experimental work: Bergelson & Swingley, 2012)

- Thus, mealtime is the plausible (though perhaps difficult) context for learning these object names

Corpus

14 infants (6 male)

Ranging in age from 7.0 to 11.0 months (M = 9.0, SD = 1.33)

Analyses were conducted on footage captured during infant mealtimes

- **16.04** total hours, (M per subject = 1.29, SD = 0.79)

The total number of individual mealtime events in the sample was **344**

- Mean per subject = 24.57 (SD = 20.02)

Coding of the corpus

Still images were extracted from the corpus at 1/5 Hz for visual coding

- This yielded a total of 11,549 coded images
- Naïve adults named the five most obvious objects in each image, using basic level nouns

The speech from the mealtime videos was transcribed in its entirety

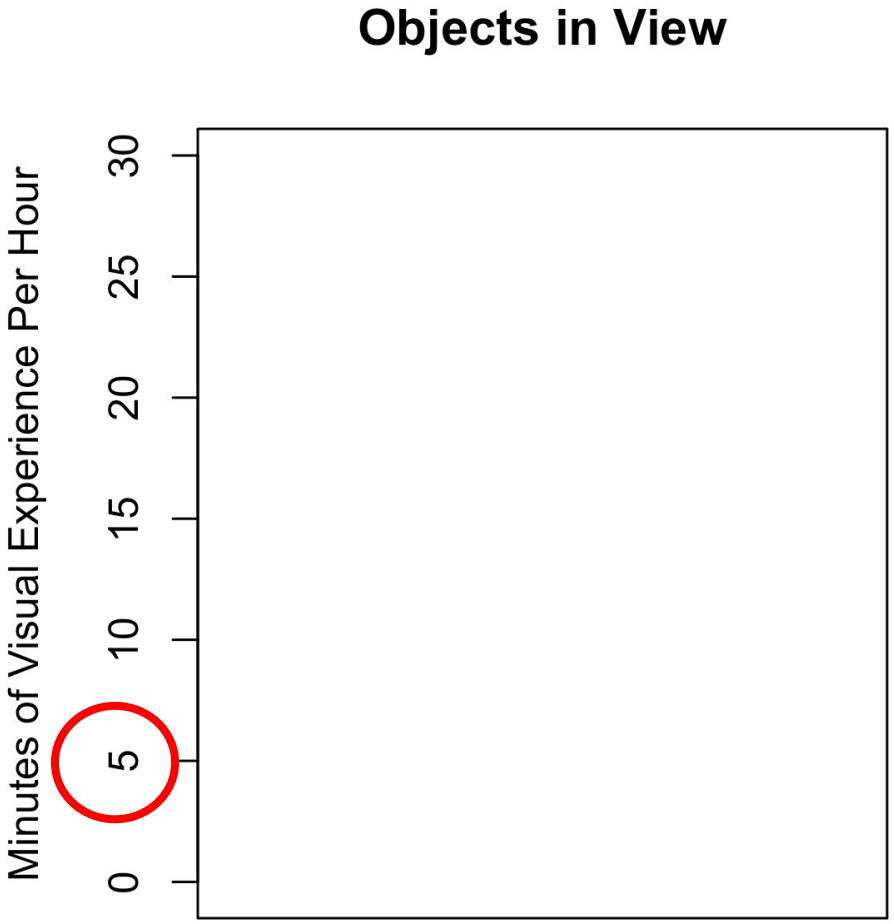
- **9.49** hours of video contained any speech (59.16% of all video)
- Naming instances were extracted – defined as any time an object name was said

Two main points

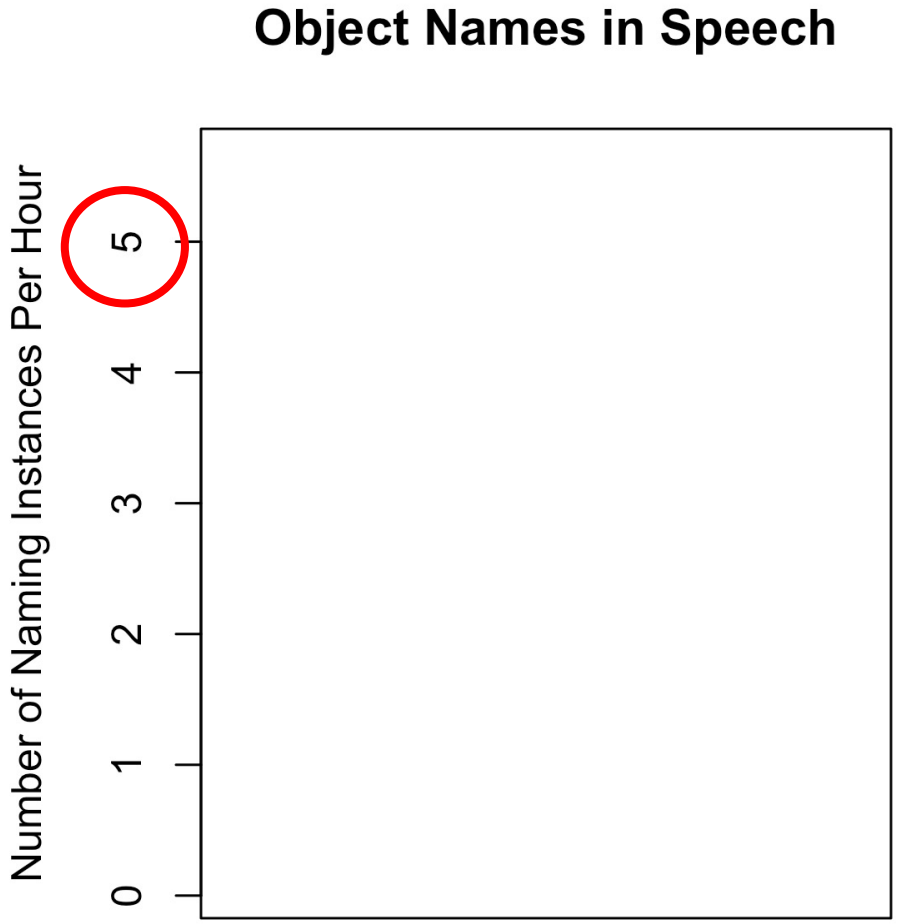
1) Seen-objects and heard-object names at mealtime have different fundamentally different frequency properties
2) Different early-learned object names may have different pathways

1) Seen-objects and heard-object names at mealtime have different frequency properties
    a) Base frequency
    b) Skewness

Frequencies of individual objects and names



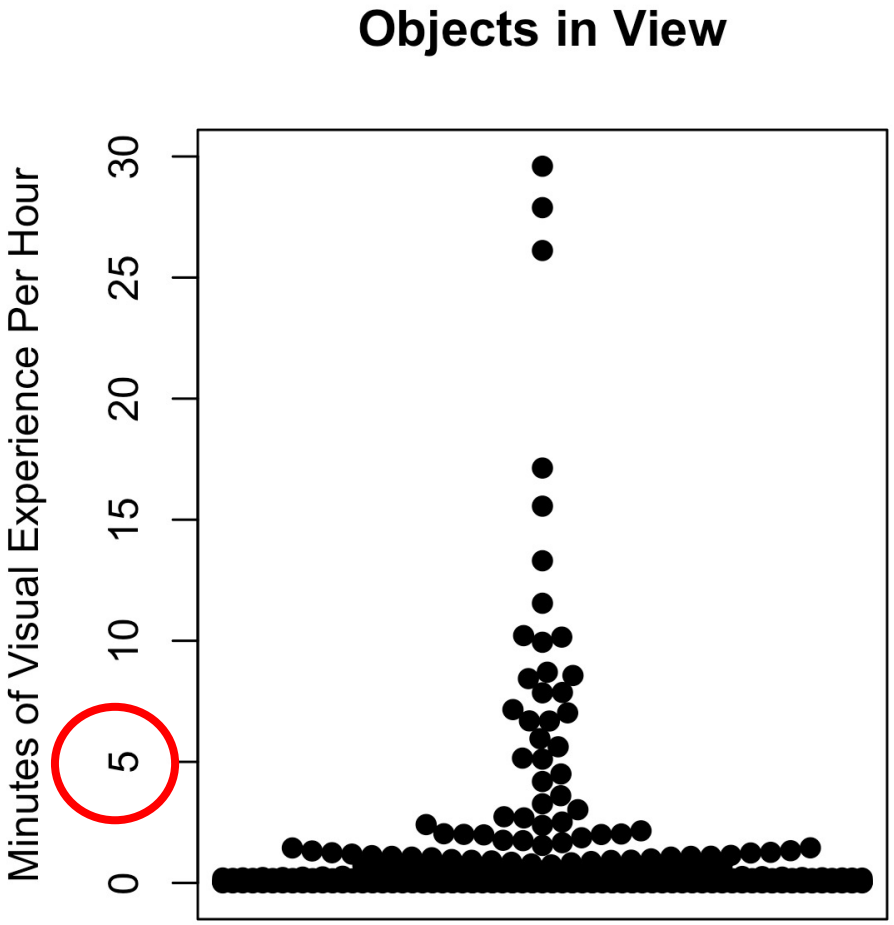
Total hours of mealtime = 16.04



Total hours of speech* = 9.49

*If names were calculated using total hours of mealtime and not hours of talk, these numbers would be smaller

Frequencies of individual objects and names*



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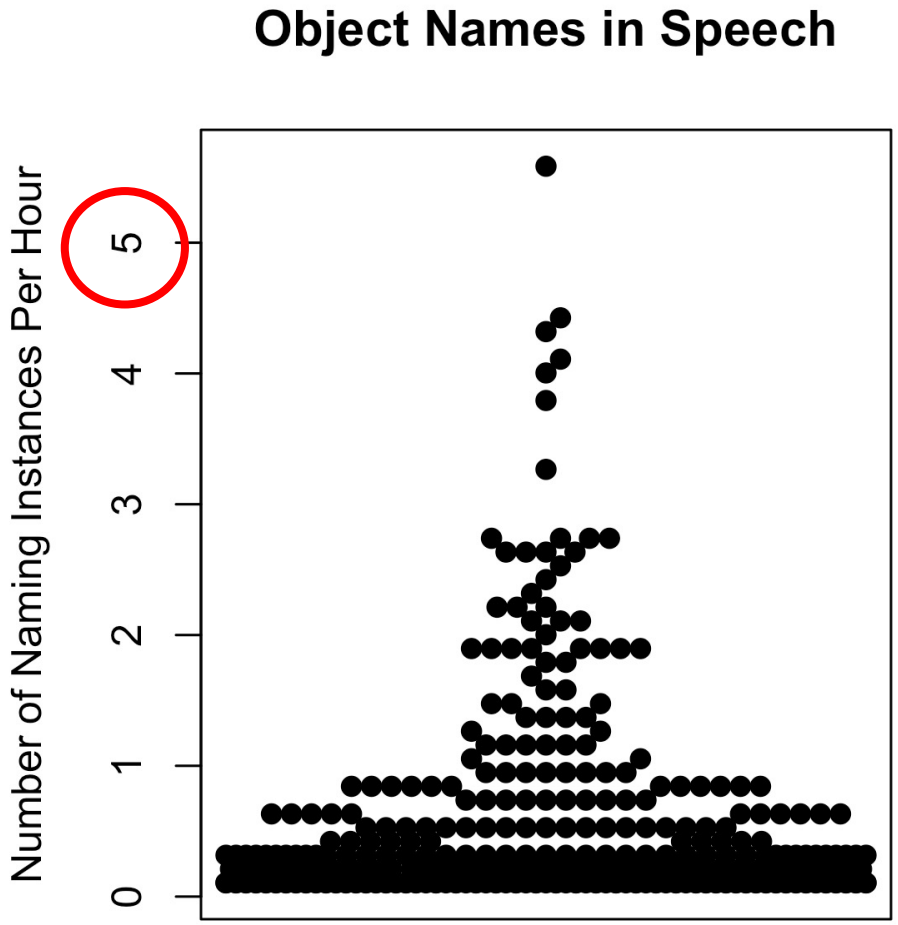
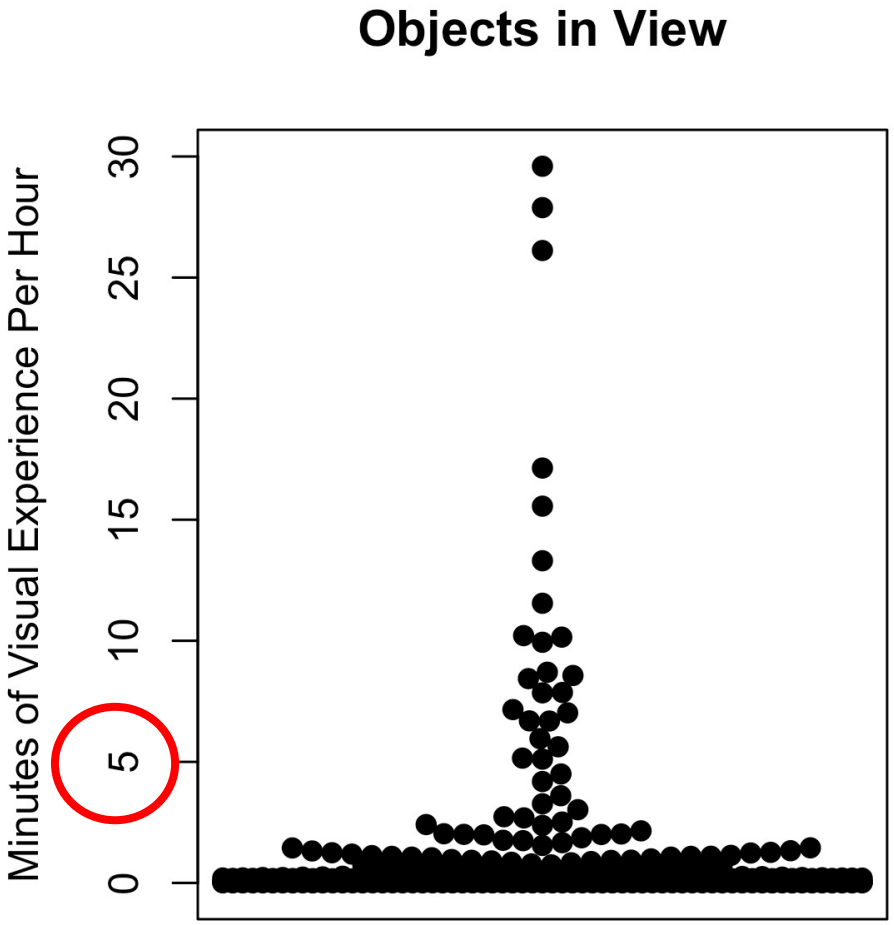


Total hours of speech = 9.49

*Each dot represents a visual object/an object name that occurred at least once in both domains

Frequencies of individual objects and names



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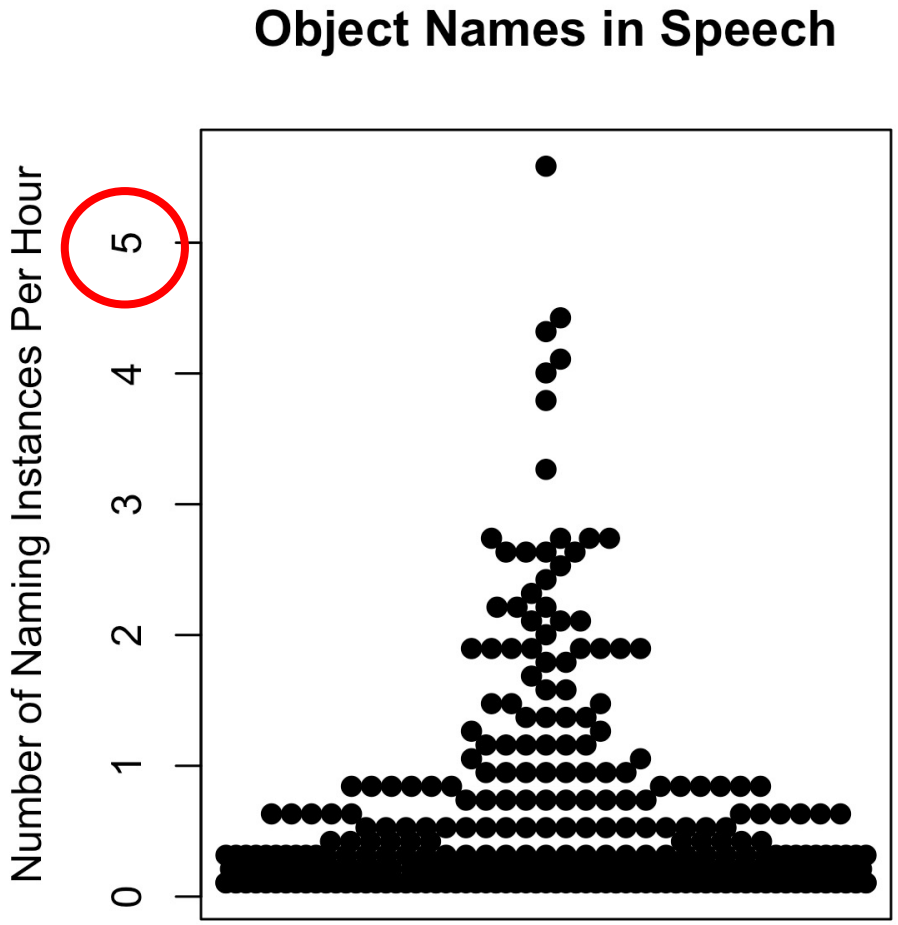

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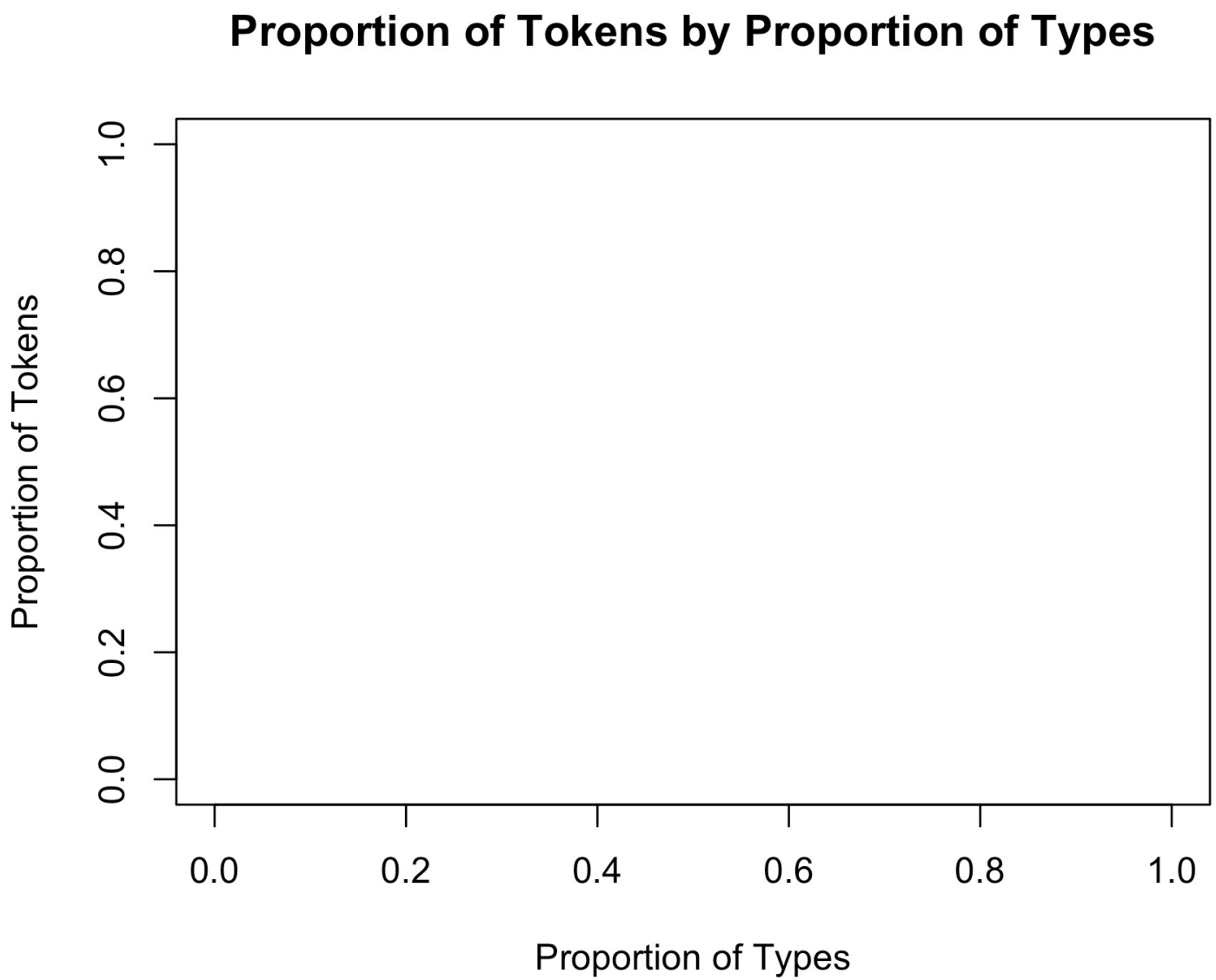
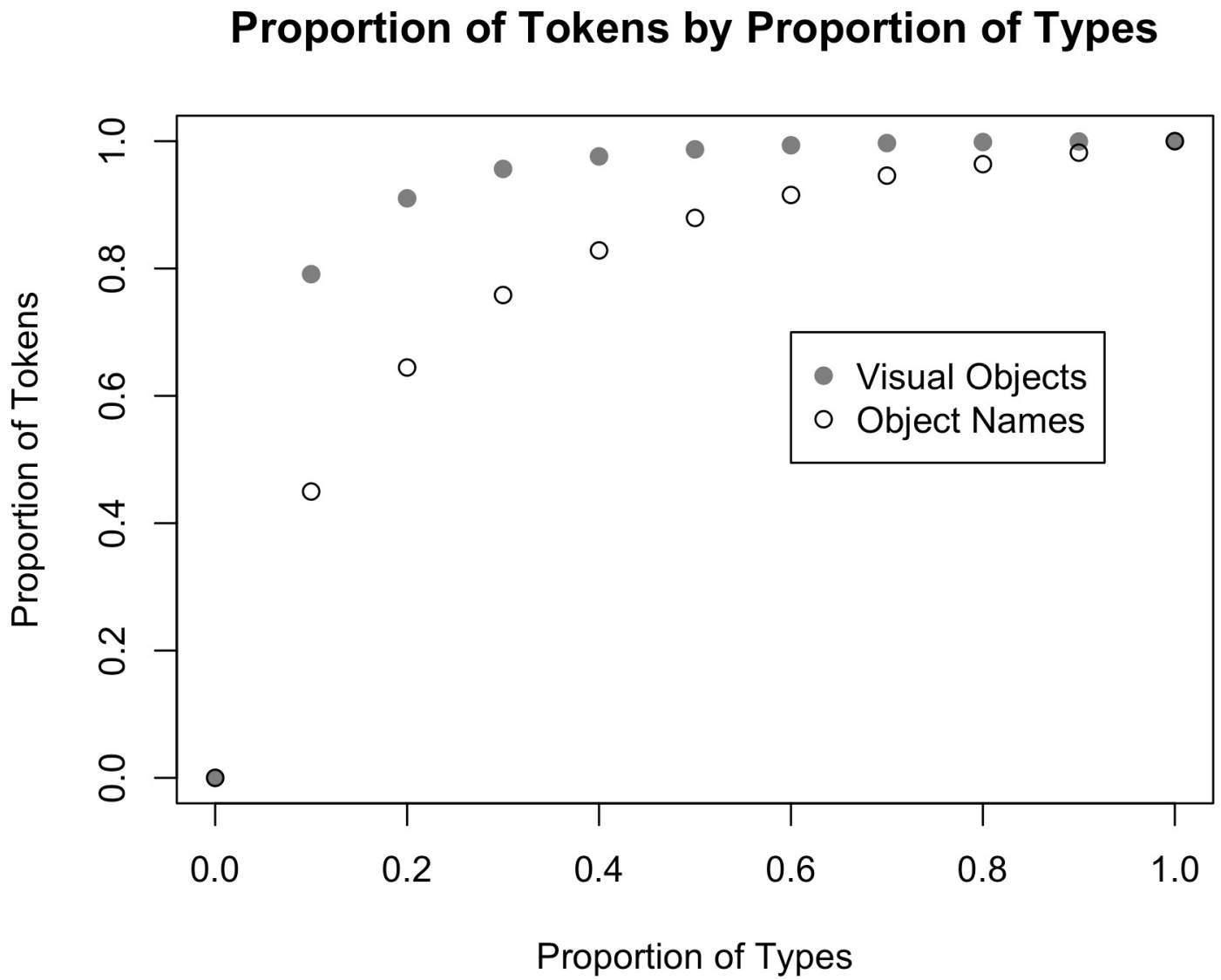
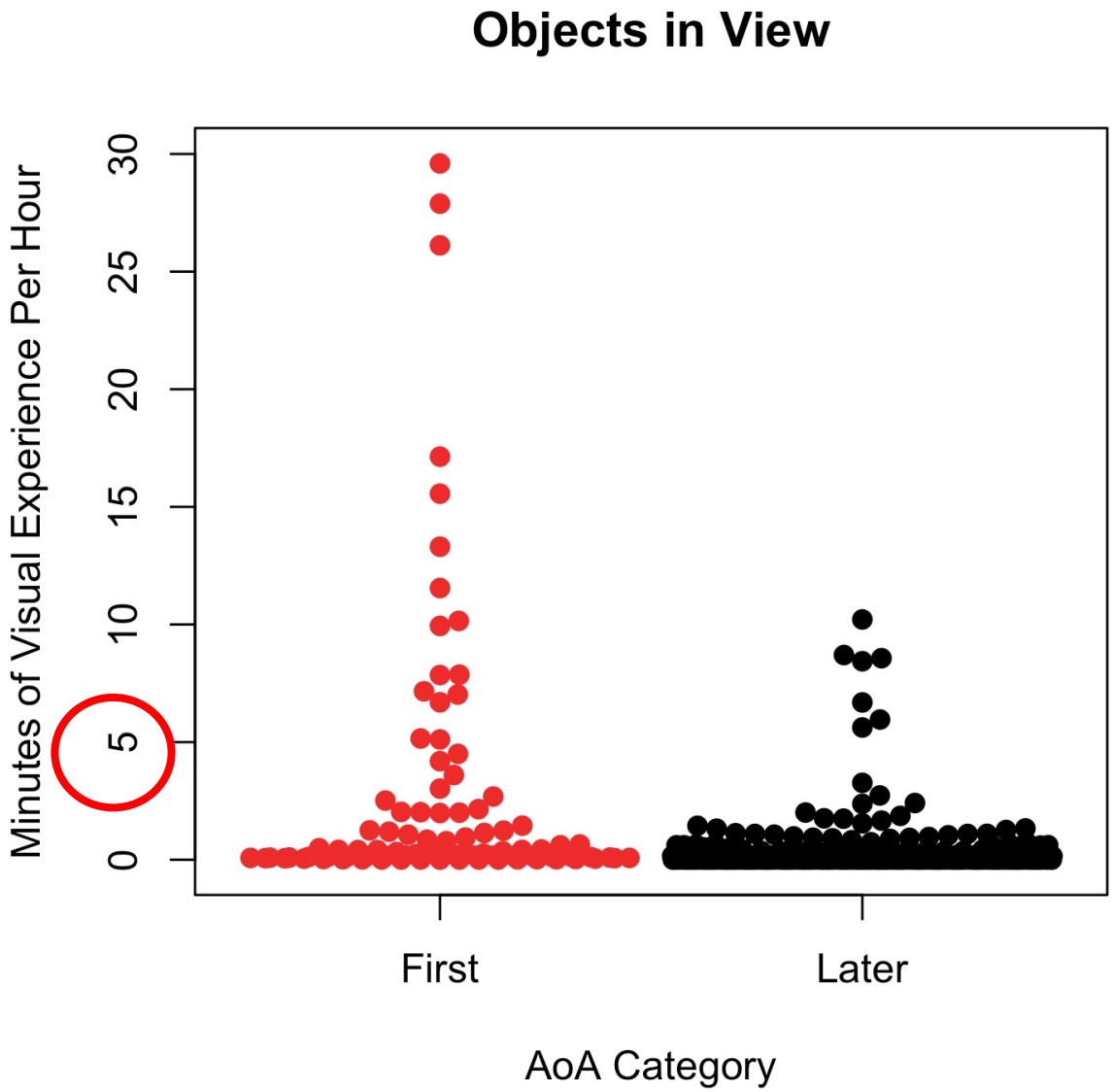
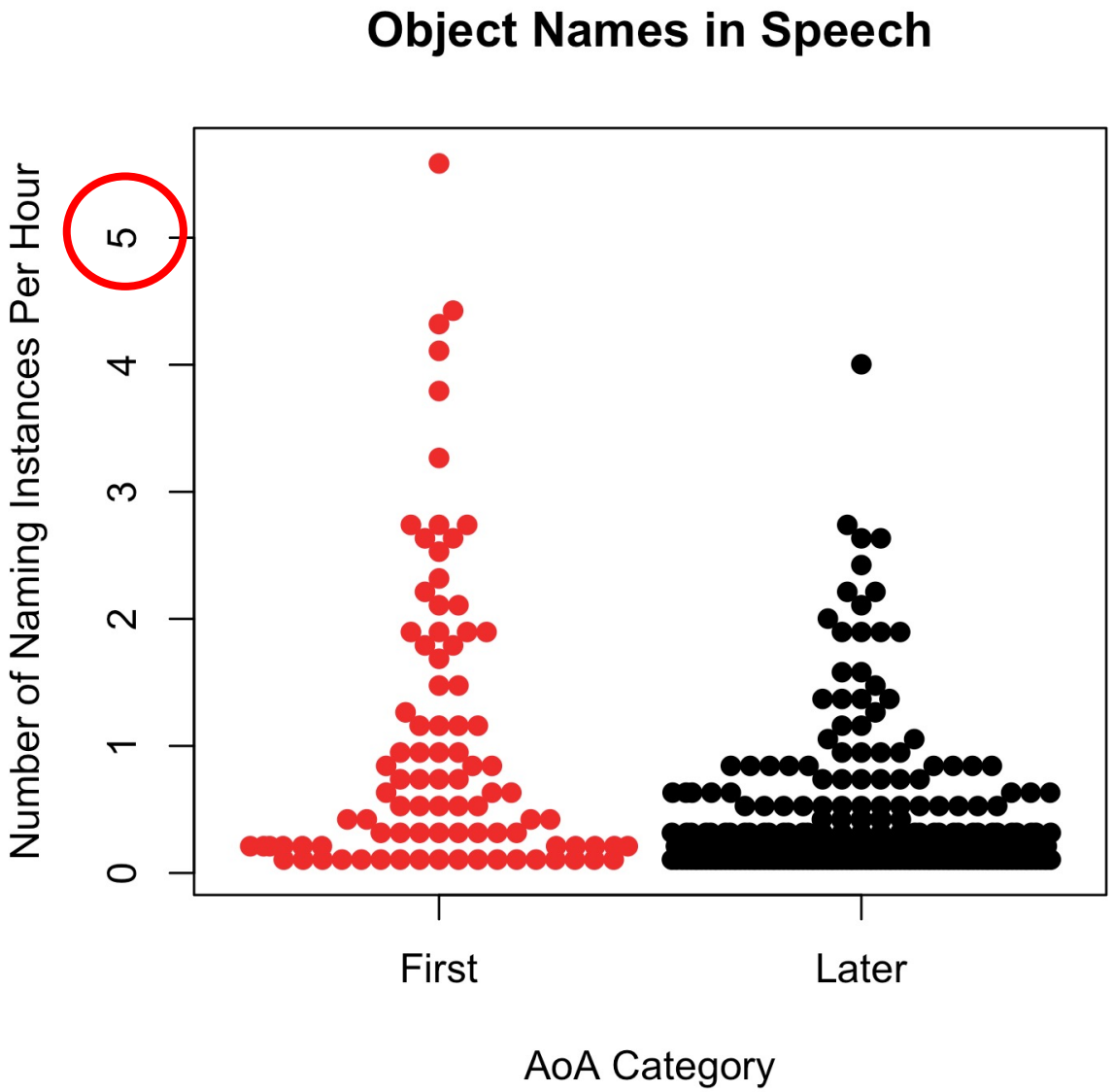

Proportion of Tokens by Proportion of Types
Proportion of Tokens
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of Types
0.0
0.2
0.4
0.6
0.8
1.0



Top 10% visual object types
= **80%** of all objects tokens

Top 10% object name types
= **45%** of all name tokens

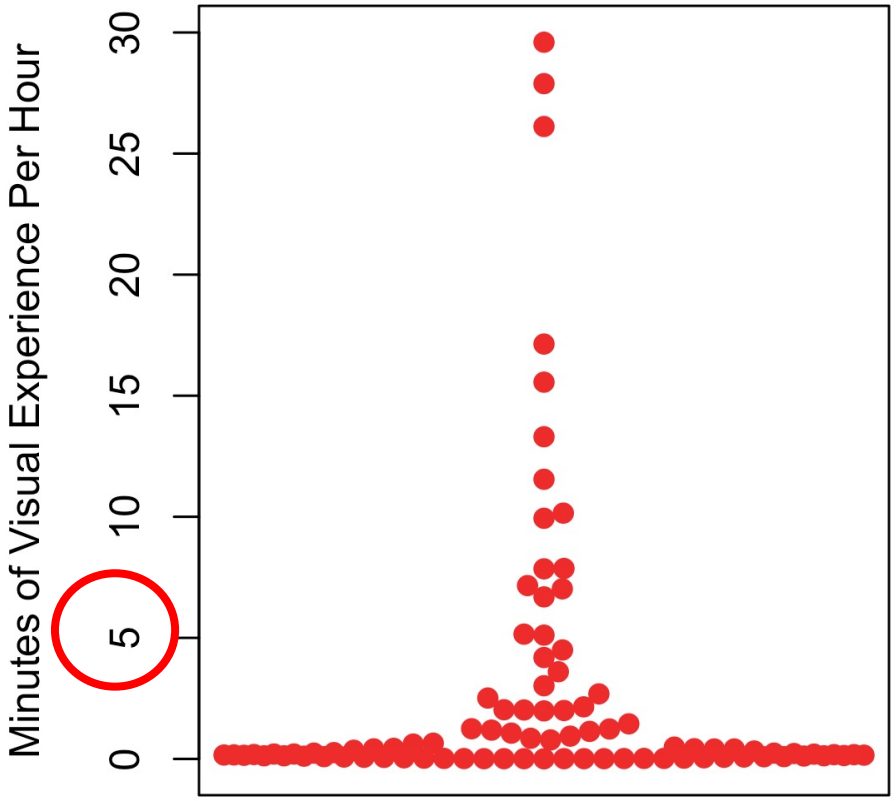




The First category is made up of MCDI words in the receptive vocabulary of 50% of 18-month-olds (Frank et al., 2016)

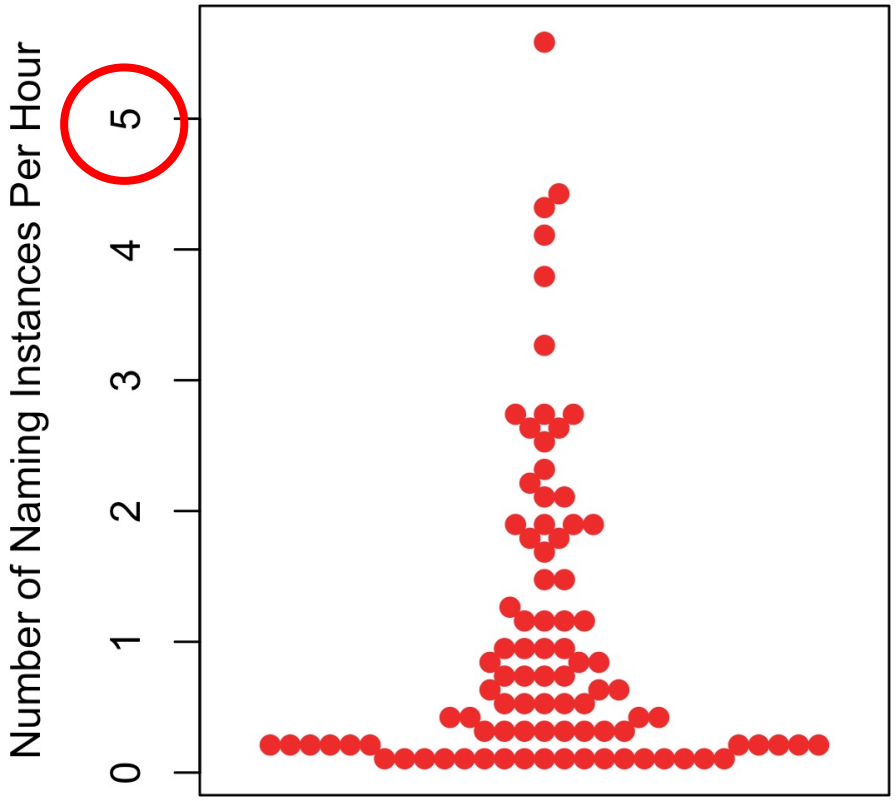
1) Seen-objects and heard-object names at mealtime have different frequency properties
    a) Base frequency
    b) Skewness
2) Different early-learned object names may have different pathways

First Objects in View



Total hours of mealtime = 16.04

First Object Naming



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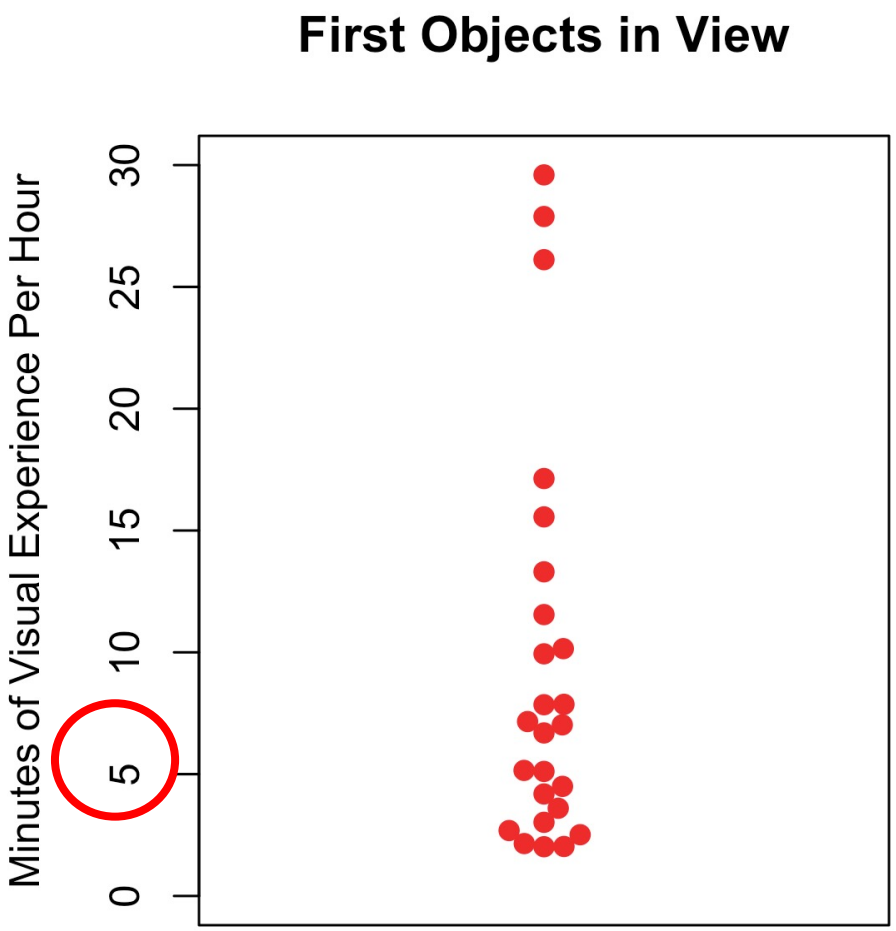
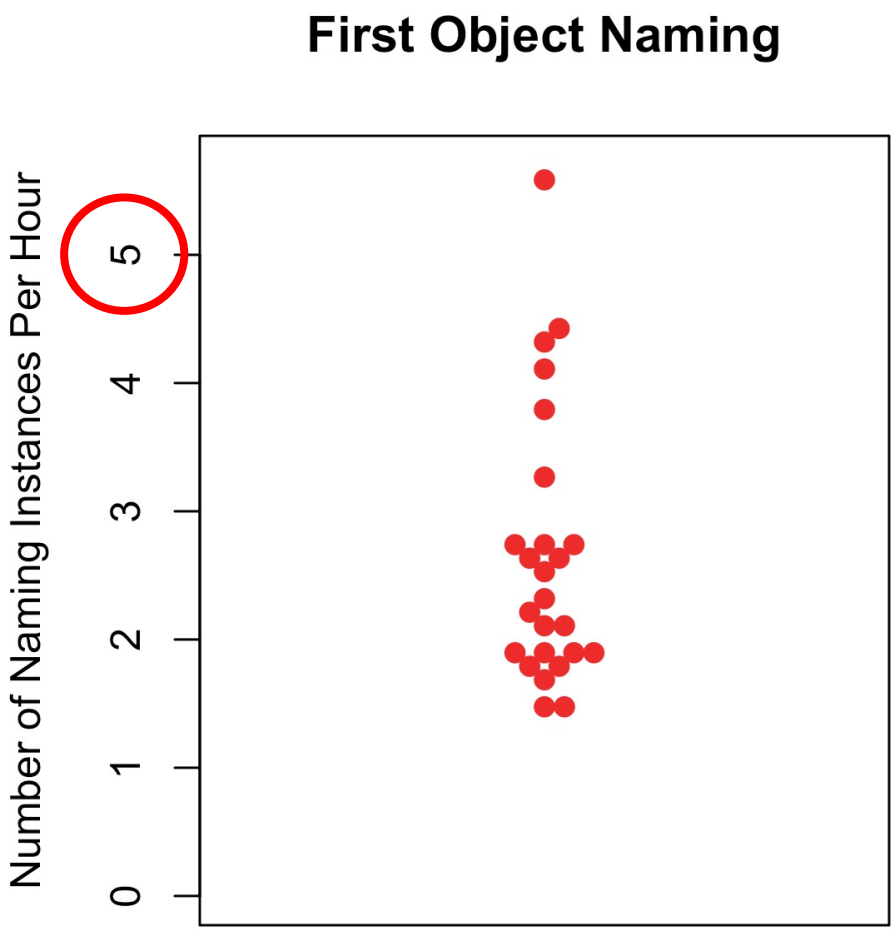
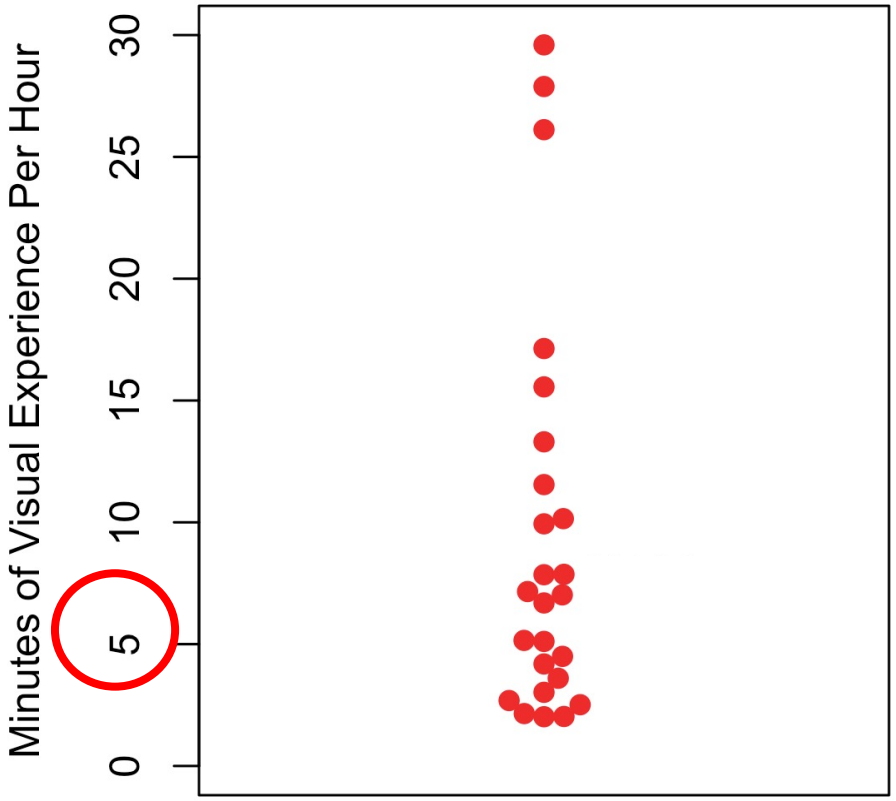




Highly Frequent Objects and Names are defined as the top 25 in each category (25 is the average of the number of First Objects that make up 80% of the First Object tokens and the number of First Object Names that make up 80% of the First Name tokens)

First Objects in View



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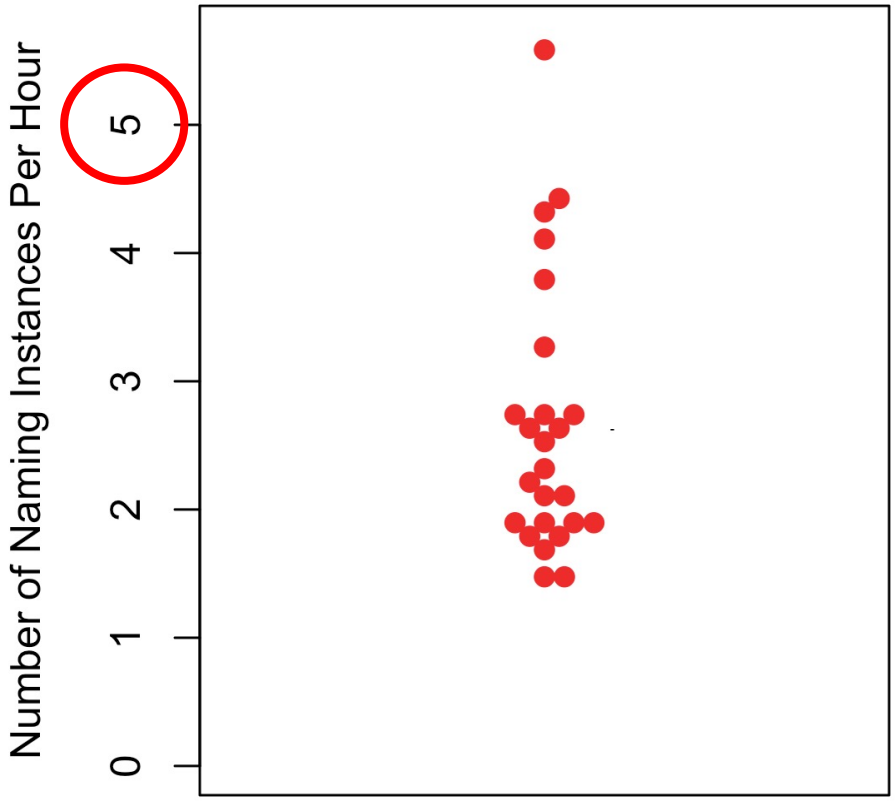
First Object Naming



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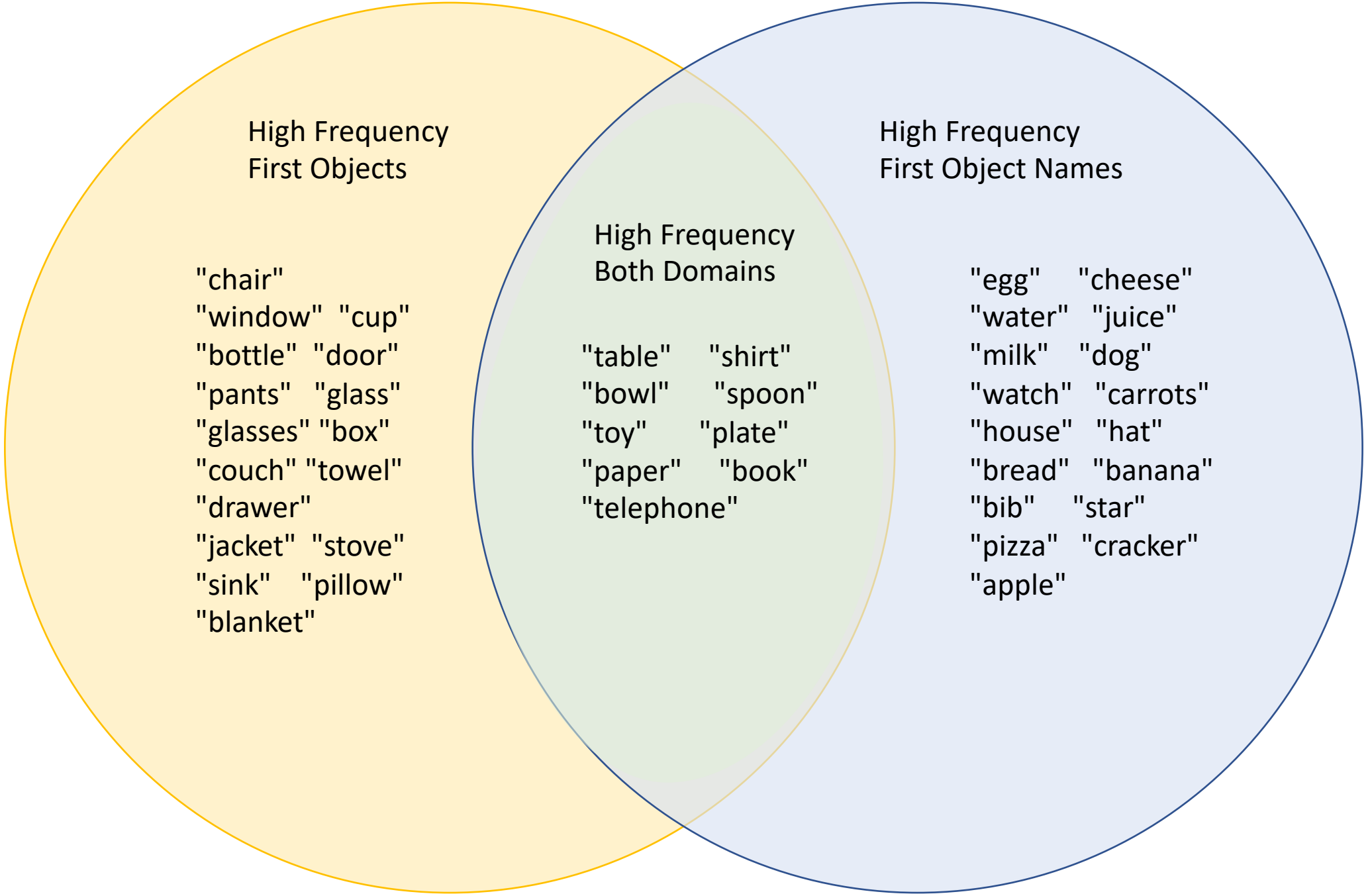
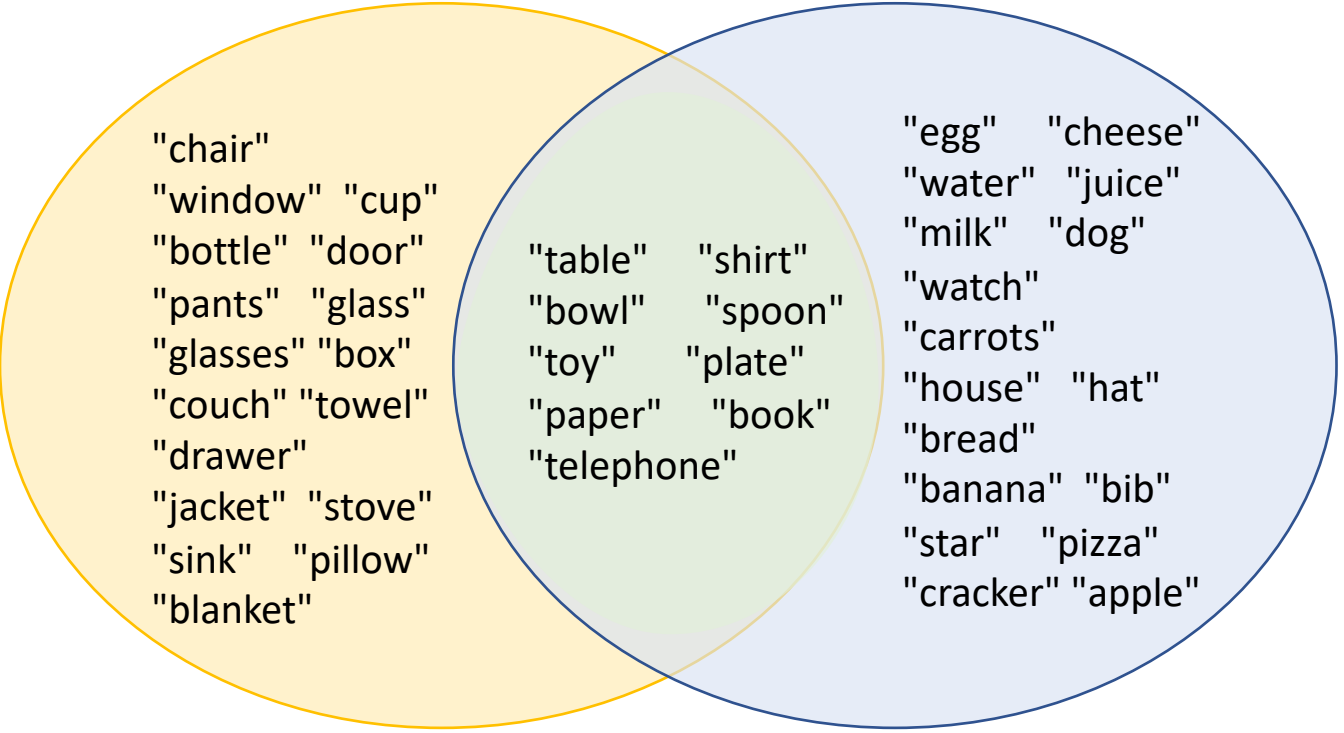
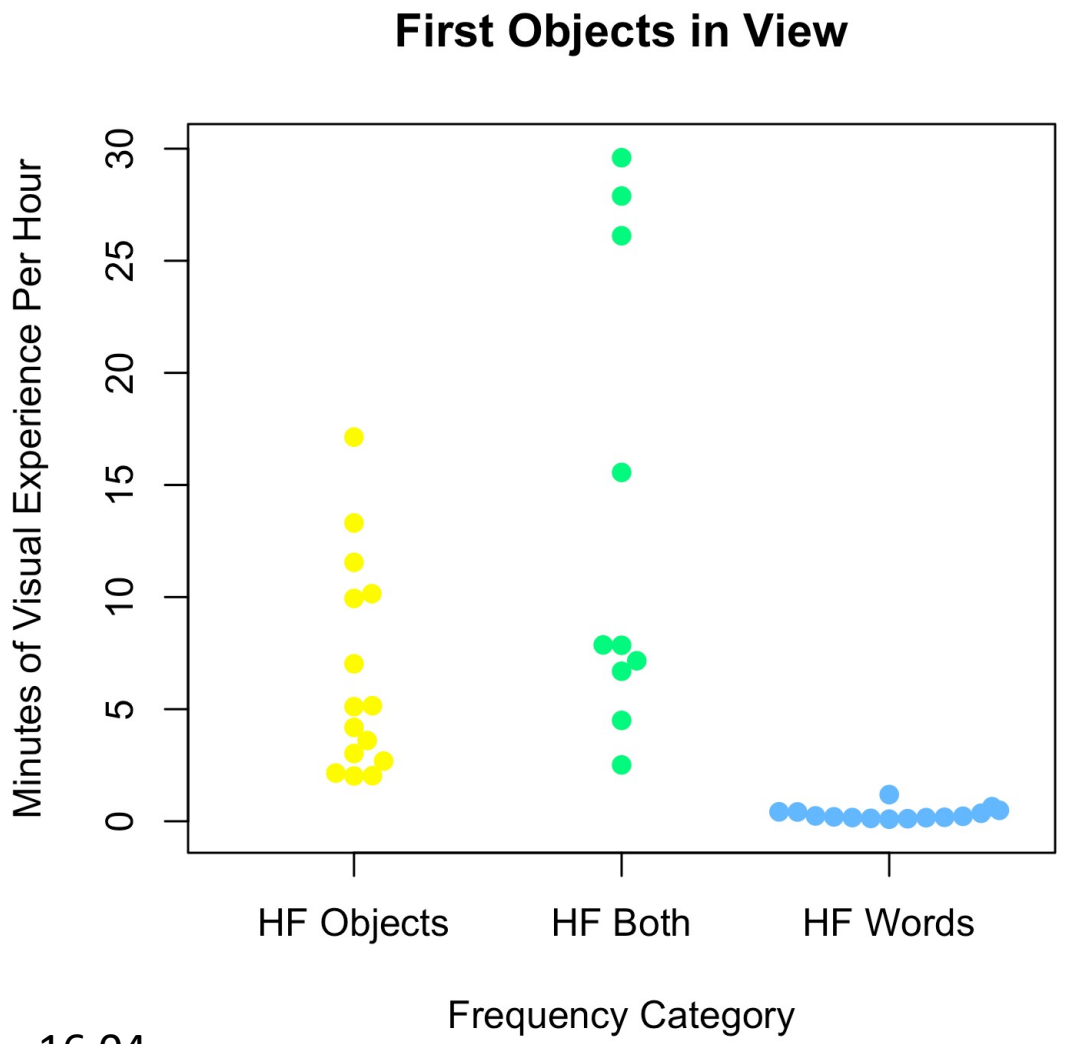

High Frequency
First Objects
"chair"
"window" "cup"
"bottle" "door"
"pants" "glass"
"glasses" "box"
"couch" "towel"
"drawer"
"jacket" "stove"
"sink" "pillow"
"blanket"
High Frequency
Both Domains
"table" "shirt"
"bowl" "spoon"
"toy" "plate"
"paper" "book"
"telephone"
High Frequency
First Object Names
"egg" "cheese"
"water" "juice"
"milk" "dog"
"watch" "carrots"
"house" "hat"
"bread" "banana"
"bib" "star"
"pizza" "cracker"
"apple"





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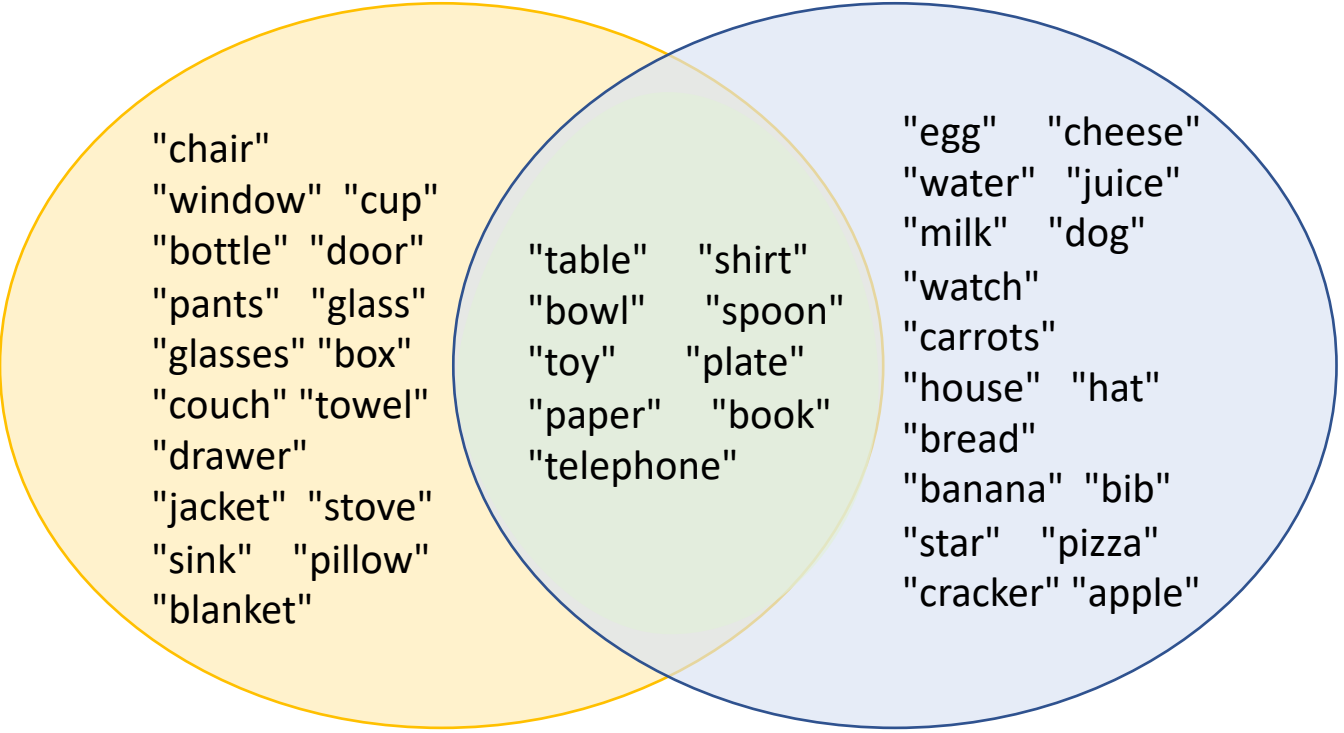

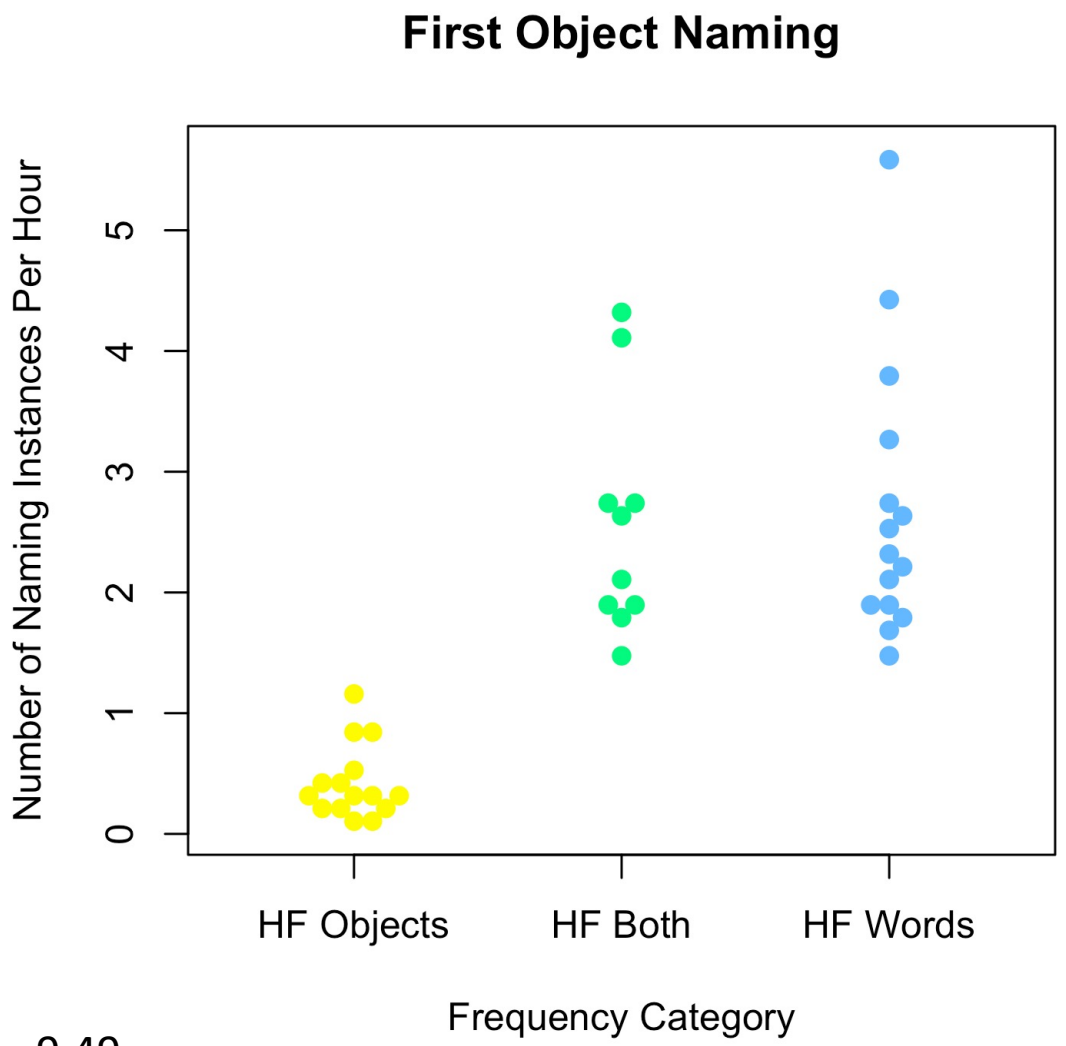

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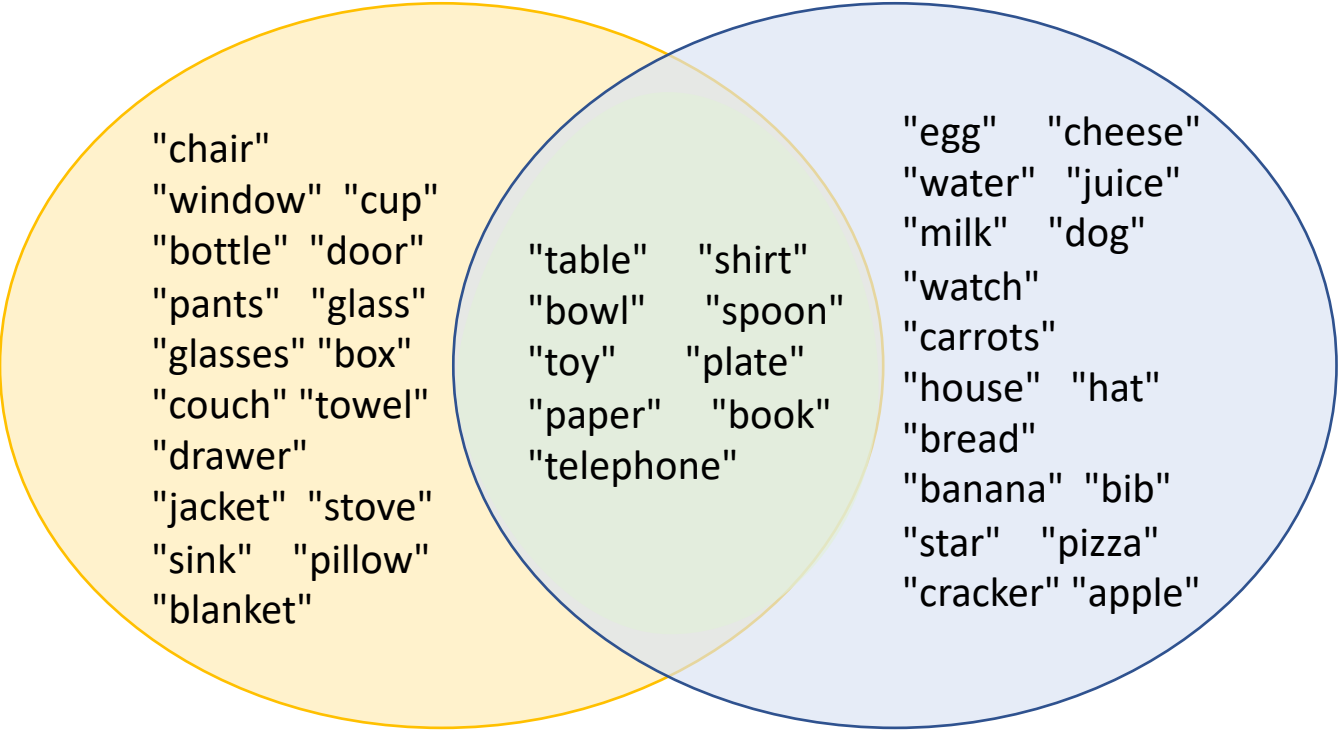

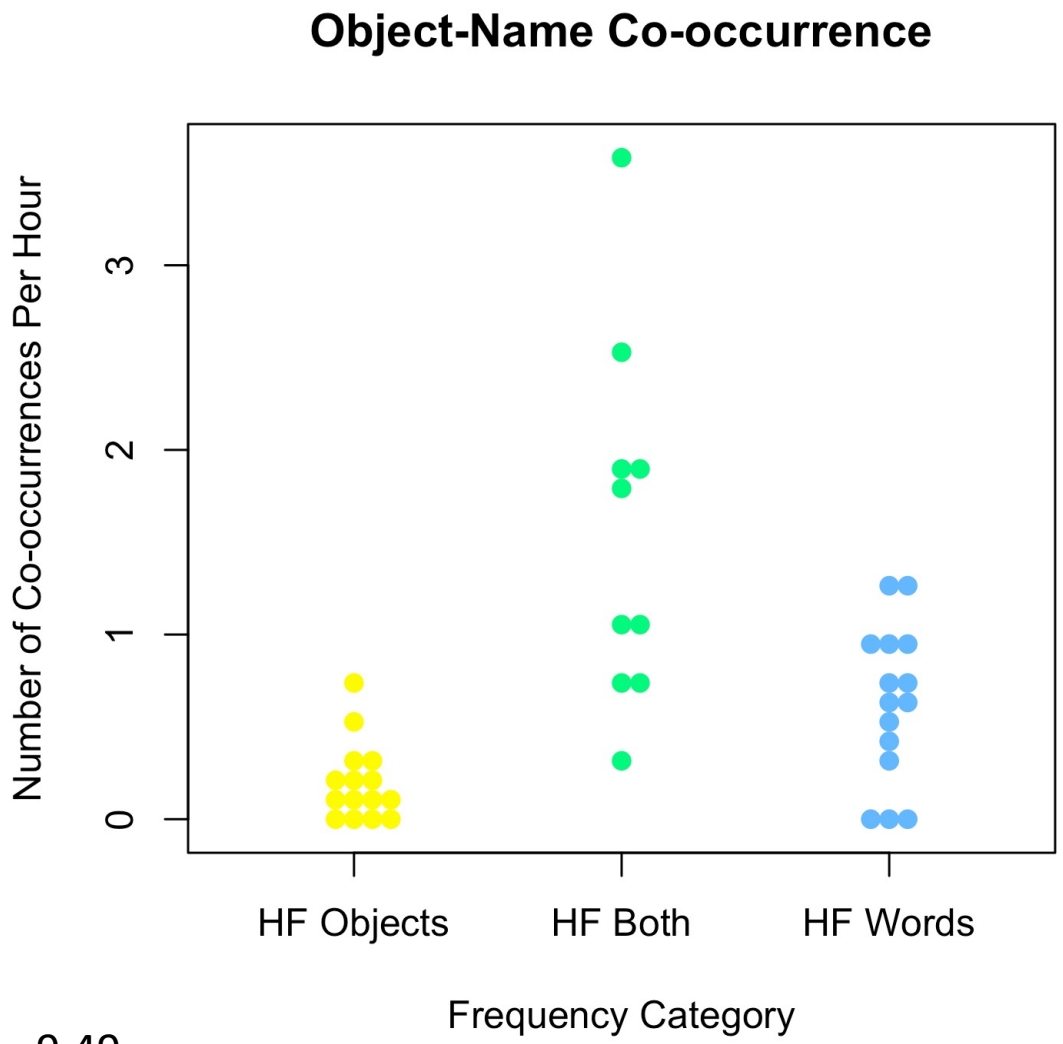

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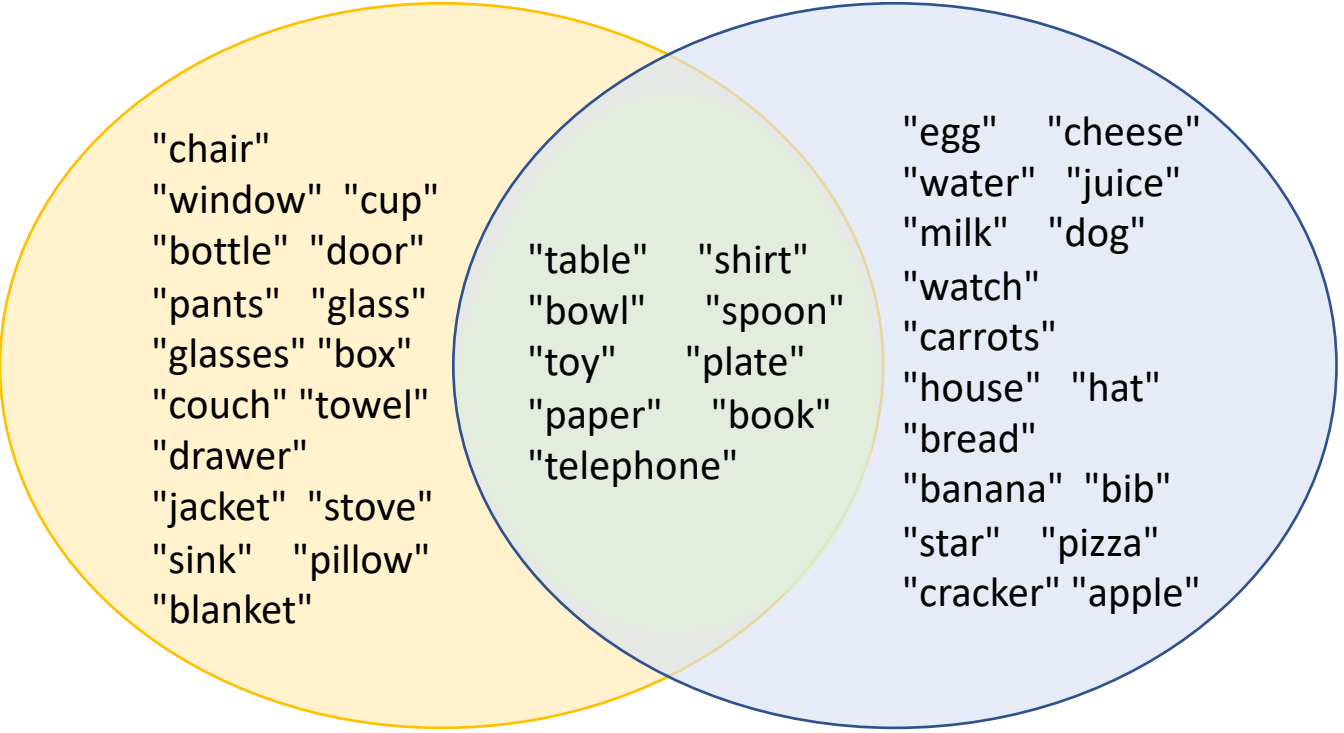
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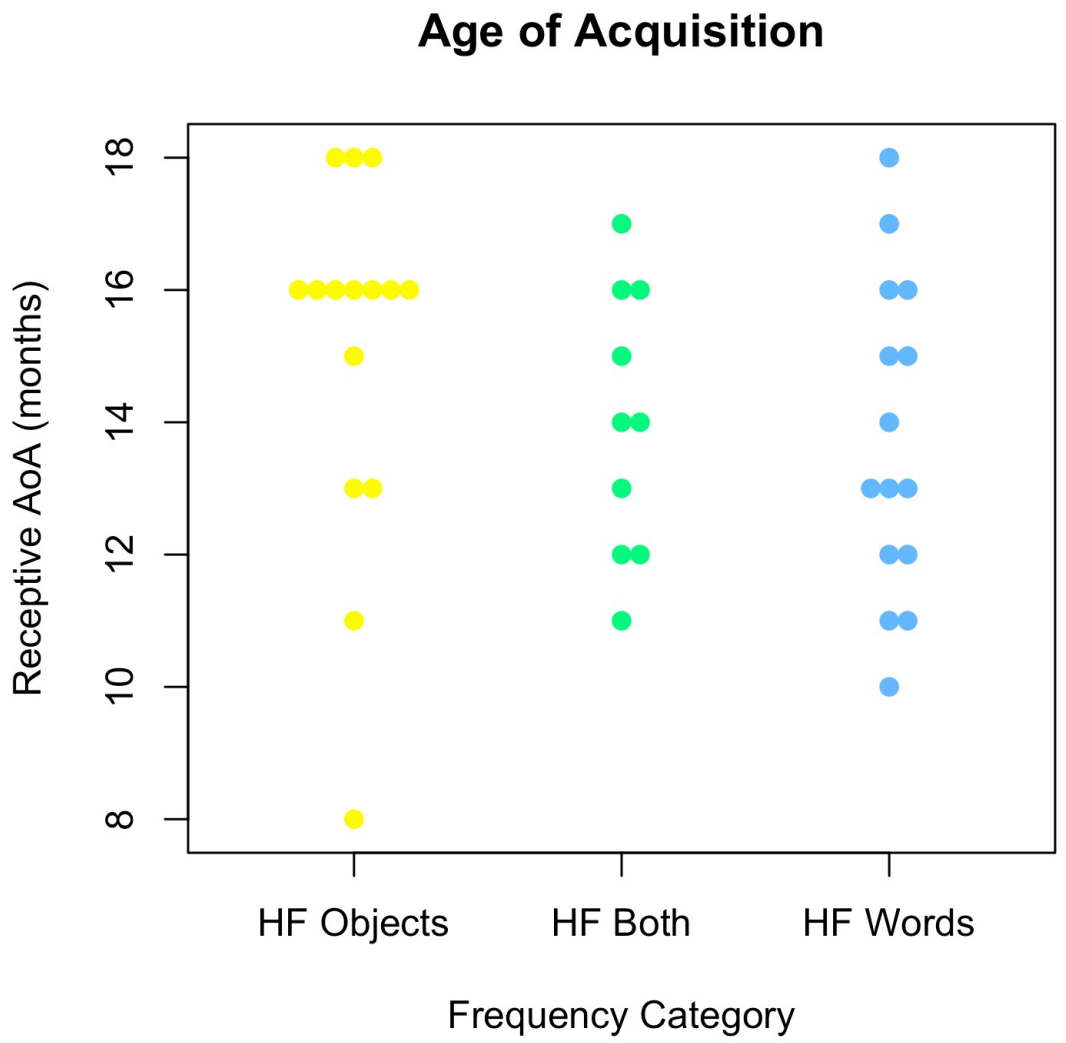
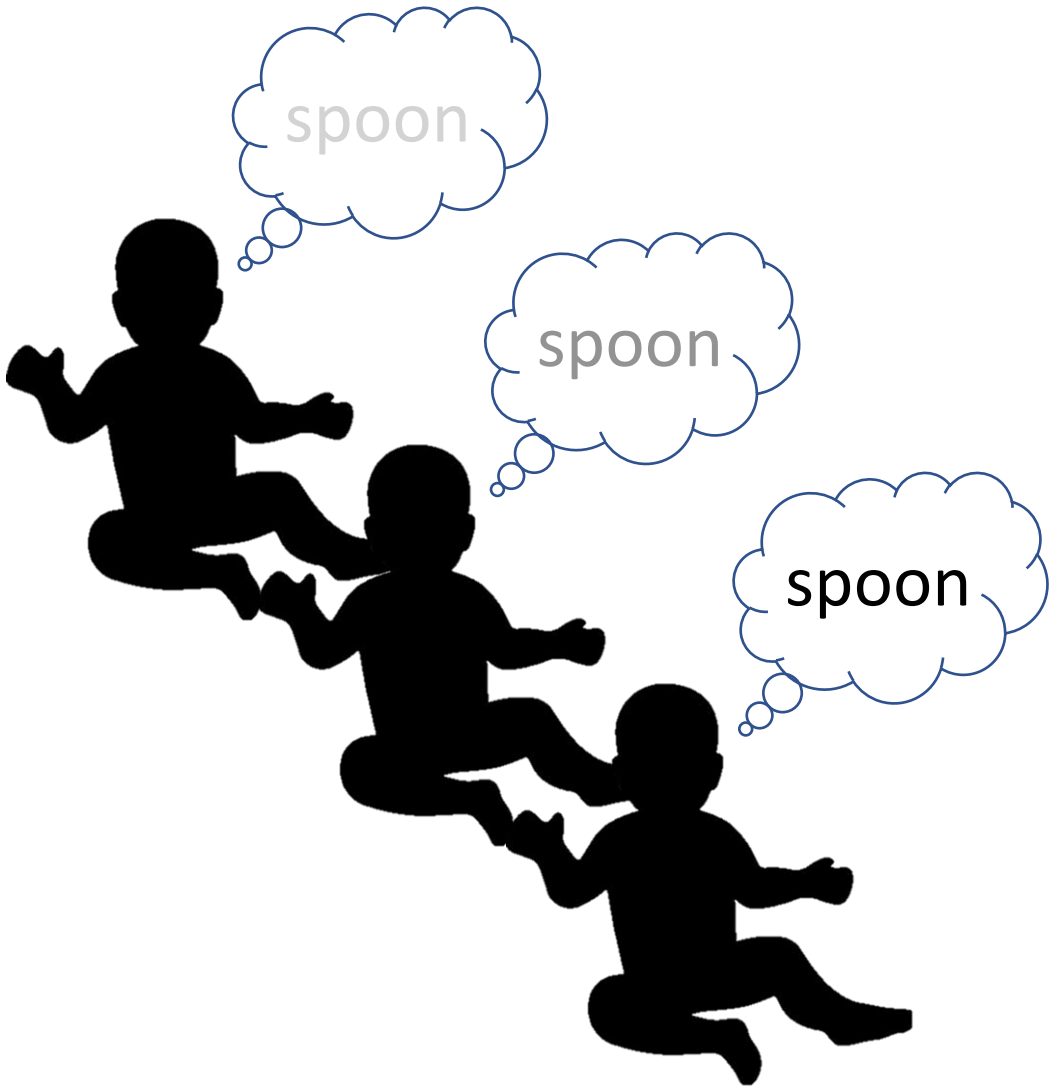
"carrots"
"house" "hat"
"bread"
"banana" "bib"
"star" "pizza"
"cracker" "apple"

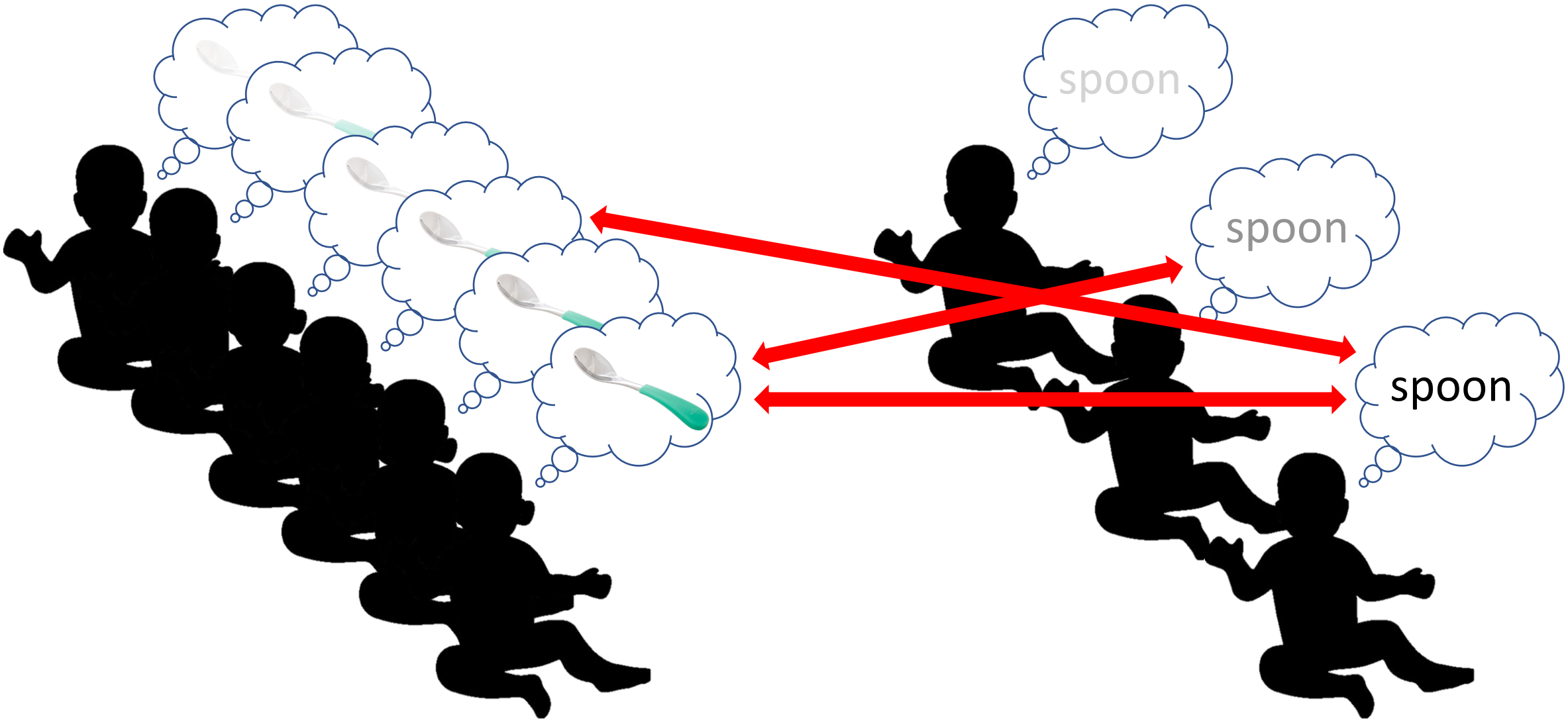

Age of Acquisition
Receptive AoA (months)
8
10
12
14
16
18
HF Objects
HF Both
HF Words
Frequency Category

What do the data tell us about word learning?

- The frequency properties of visual objects and object names in daily life are fundamentally different, and they **do not set up a rich co-occurrence structure**
  - However, **both modalities select for early-learned object names**

- The rarity of co-occurrences of early-learned object-name **pairs** in this context suggests that infants may be learning from minimal co-occurrence data **as long as half of the pair (the object or its name) is highly frequent**


spoon
spoon
spoon


spoon
spoon
spoon

What do the data tell us about word learning?

- Mealtime is the context for learning first object names related to food (Tamis-LeMonda et al., 2018), and there is evidence that infants this age already link these object names to their referents (Bergelson & Swingley, 2012)
- These are the data for learning this particular set of words in the real-world
- Thus, theories of word learning must seek to describe a learner (and classes of mechanisms) that can utilize these sparse co-occurrence data

Acknowledgements

Our participating families

The past and present members of the Cognitive Development Lab at IU, especially Lizzie Hart, Ariel La, Swapnaa Jayaraman, and Caitlin Fausey

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NSF

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See http://www.indiana.edu/~cogdev/homeview.html#Homeview for more information about the Homeview Project