

Language Acquisition: Word Learning

SS16 - (Embodied) Language Comprehension

Maria Staudte

Administration

- 2h Lecture + Exam (3CP)
- Exam date: 29th July
- http://www.coli.uni-saarland.de/~masta/SS16/embodiedLC_schedule.html
- Readings at the end of slides
- Contact me: masta AT coli

(Embodied) Language Comprehension

- Methods and recent insights into how “we understand language”
- Language is “embodied” & “situated”:
 - Language is inseparably bound to our body and our physical interaction with the world
 - Language is typically used and understood in context

“Embodied”

“To say that cognition is embodied means that it arises from bodily interactions with the world. From this point of view, cognition depends on the kinds of experiences that come from having a body with particular perceptual and motor capacities that are inseparably linked and that together form the matrix within which memory, emotion, language, and all other aspects of life are meshed. The contemporary notion of embodied cognition stands in contrast to the prevailing cognitivist stance which sees the mind as a device to manipulate symbols and is thus concerned with the formal rules and processes by which the symbols appropriately represent the world.” (Thelen et al., Behav. & Brain Sciences, 2001)

(Embodied) Language Comprehension

- Methods and recent insights into how “we understand language”
- Language is “embodied” & “situated”:
 - Language is inseparably bound to our body and our physical interaction with the world
 - Language is typically used and understood in context

(Embodied) Language Comprehension

- Methods and recent insights into how “we understand language”
- Language is “embodied” & “situated”:
 - Language is inseparably bound to our body and our physical interaction with the world
 - Language is typically used and understood in context

“Situated”

- “... the majority of contemporary findings in sentence processing point to a richly interactive cognitive processing system in which structural constraints and **contents-based** constraints have roughly equal timing and importance in their influence on real-time sentence comprehension. In this emerging theoretical framework, it is expected that any given linguistic process of interest will be best understood when analyzed not in isolation but embedded in the context in which it is typically situated.” (Spivey & Huettenlocher, in “Visually situated language comprehension”, 2016)

Overview of course

- 29.04.2016: Word learning 1
- 06.05.2016: Word learning 2 (verbs)
- 13.05.2016: Embodiment 1
- 20.05.2016: Embodiment 2
- 27.05.2016: NO CLASS
- 03.06.2016: Adult language comprehension: The VWP 1
- 10.06.2016: Adult language comprehension: The VWP 2
- 17.06.2016: Common Ground and Perspective-taking
- 24.06.2016: Speaker/Listener information 1
- 01.07.2016: Speaker/Listener information 2
- 08.07.2016: Social factors in language processing
- 15.07.2016: NO CLASS
- 22.07.2016: Applications in embodied language processing
- 29.07.2016: EXAM

Learning (a) language

- All (normal) human children...
 - learn a language.
 - can learn any language they are exposed to.
 - learn all languages at basically the same rate.
 - follow the same stages of language acquisition.
- But **what** is learned? And **how** exactly?

What is learned

- The sounds of a language (phonetics)
- The sound patterns of a language (phonology)
- Lexical items (words, morphemes, idioms, etc)
- Rules of word-formation (morphology)
- How words combine into phrases/sentences (syntax)
- How to derive meaning from a sentence (semantics)
- How to properly use language in context (pragmatics)

What is learned

- The sounds of a language (phonetics)
- The sound patterns of a language (phonology)
- **Lexical items** (words, morphemes, idioms, etc)
- Rules of word-formation (morphology)
- How words combine into phrases/sentences (syntax)
- How to derive meaning from a sentence (semantics)
- How to properly use language in context (pragmatics)

Stages of learning

- 0-6 months: Prelinguistic
 - no babbling yet
 - sensitive to native vs non-native sounds
- 6-12 months: Babbling
 - pitch and intonation resemble native language
- 12-.. months: One-Word
 - “holophrastic” sentences
 - competence better than performance
- 18-24 months: Two-Word
 - ~50 words, “telegraphic” sentences

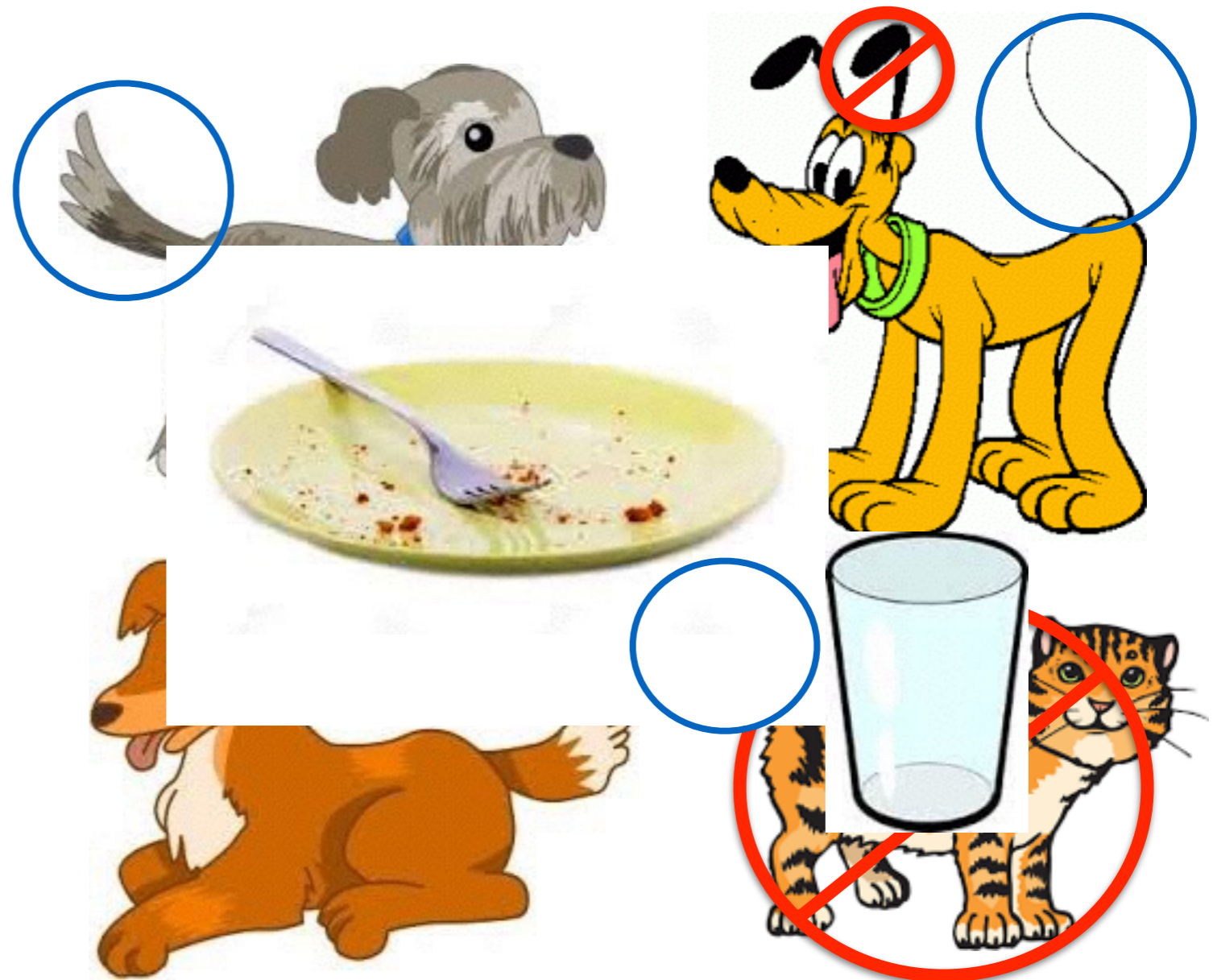
Lexical items / Words

Acquiring words & meanings

- Children learn single words
- Children learn the meaning of words
- What is the meaning??
 - “mummy”, “dog”, “tail”, “empty”

Acquiring words & meanings

- “mummy”
- “dog”
- “tail”
- “empty”



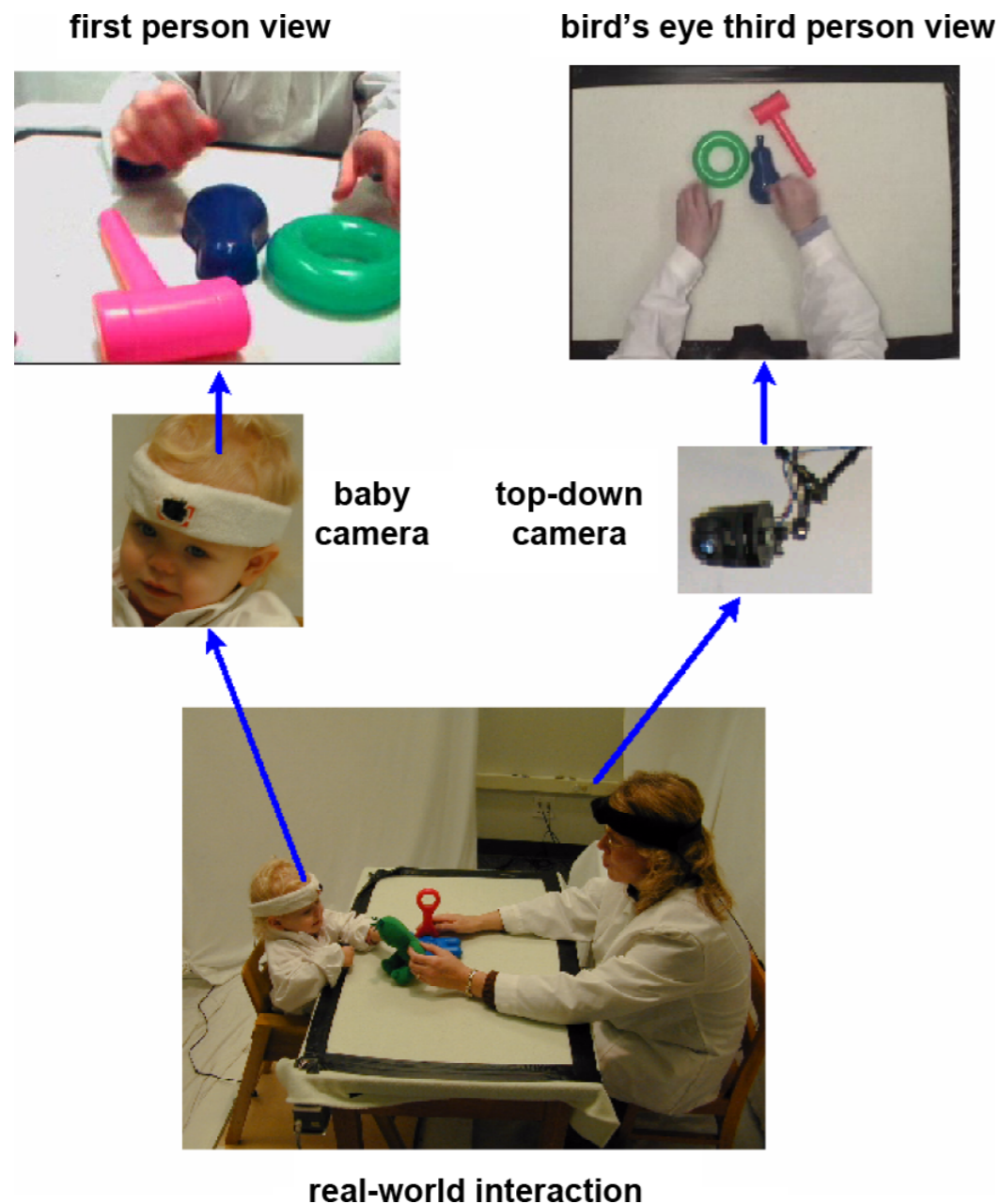
Word-to-World Pairings

- Children acquire a word by learning a word-to-world mapping - through experience
- Problems:
 - Hypothesis space is huge: Which word refers to which “thing”?
 - Subset problem: Wrong choice impedes falsification

“The fruit look yummy!”



Early hypothesis space...



- Maybe not as big as one might think
- Initially hands and mouth play an important role as well

(Yu et al., IEEE Trans. on Auton. Mental Dev., 2009)

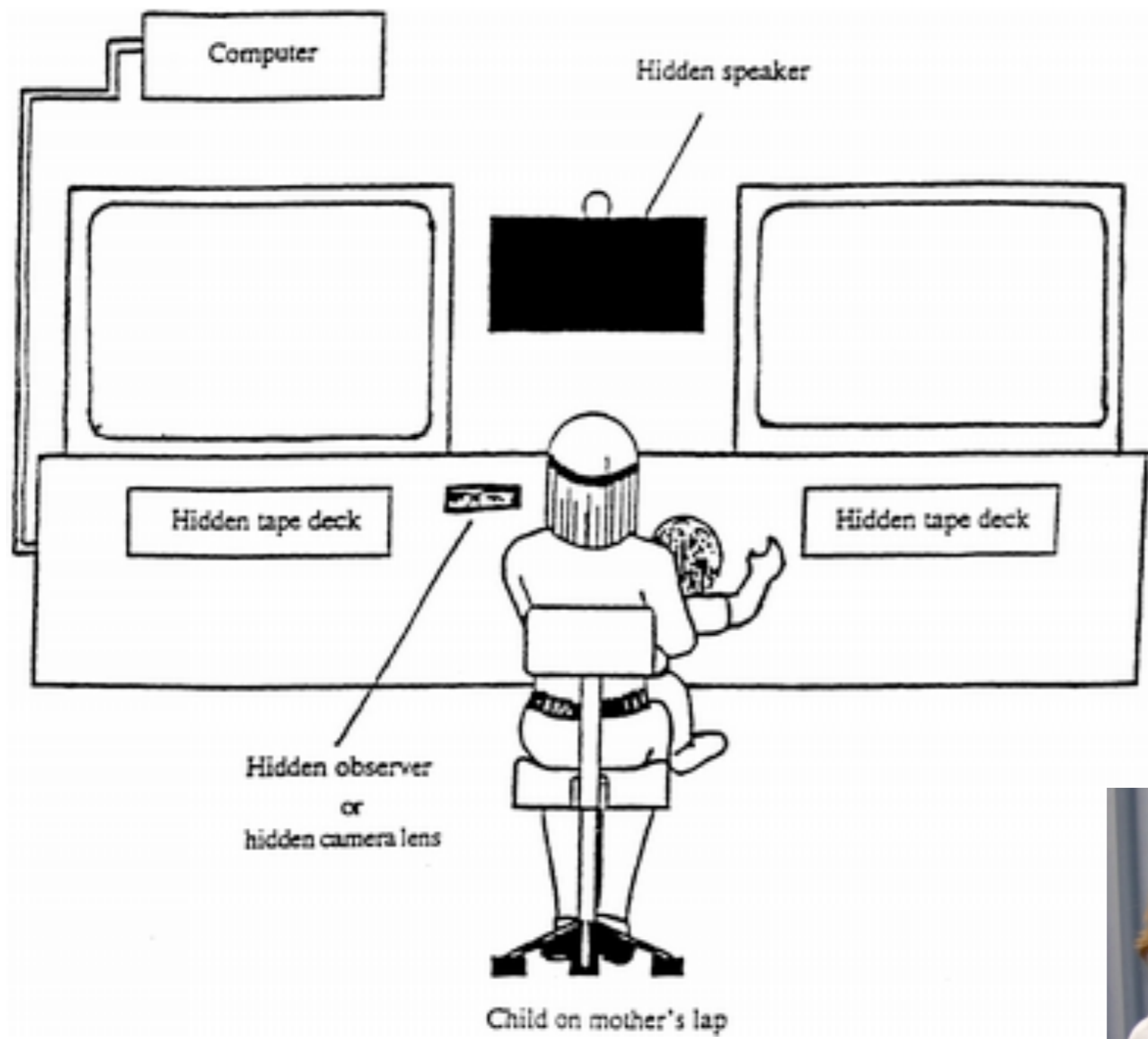
(Yu & Smith, Cognition, 2012)

The Visual World & Grounding Language

- The visual world plays an important role in grounding language:
 - Children observe and experience concrete objects and events > mental representations
 - Naming these objects and events is the first linguistic activity children perform
 - This is how the arbitrary system of language is grounded in, i.e., connected to, the world (cf. lectures on Embodiment)

The Visual World as Diagnostic Tool

- The visual world paradigm is a good diagnostic for language-learning studies:
 - Looking at entities or events after they have been mentioned signals understanding
 - E.g. in baby studies: gaze one of few possibilities to measure language processing (preferential looking)



The Visual World as Information Source

- The visual world is a very important information cue for language learners, even more so than for native speakers :
 - On-line compensation for knowledge gaps
 - Word-learning cue

The Visual World as Information Source

- Word learning
 - Observational learning
 - Using the visual context and the embedding of the new word in linguistic context for inferencing

*The monkey is observing **a dax**.*



*The monkey is observing **a dax**.*



Fast-Mapping (Carey, 1978)

*The monkey is
observing **a dax**.*



*The monkey is
observing **a dax**.*



???



*The monkey is
observing **a dax**.*



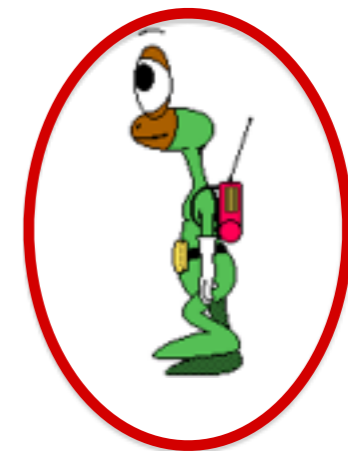
*There's **a dax**!*



*The monkey is
observing **a dax**.*



*There's **a dax**!*



Cross-Situational Word Learning (Quine, 1960; Yu & Smith, 2007)

There's a dax!



There's a dax!



Social Cues (e.g., pointing, gaze; Baldwin, 1993; Tomasello, 2000)

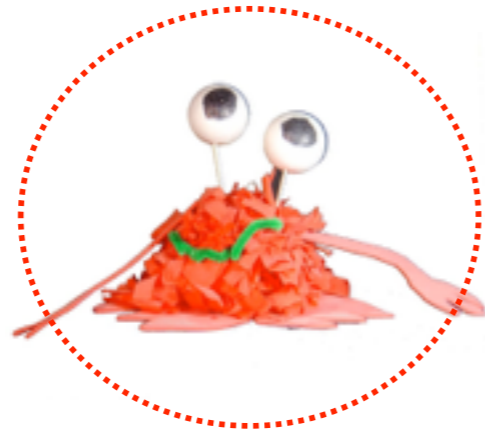
Is that it?

- Fast mapping vs CrossSWL
- CrossSWL can deal with uncertainty
 - But: Multiple hypotheses would need to be tracked...
- Is that really the case?

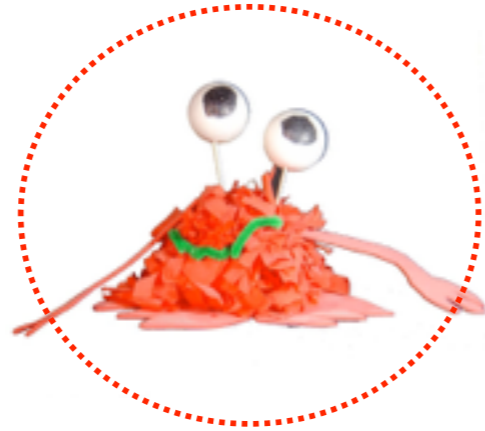
Propose-but-verify

- Tracking only a single hypothesis to keep memory load feasible (Medina et al. ,2011; Trueswell et al., 2013)
- Unrealistic to assume that a learner can keep track of everything!

*The monkey is
observing **a dax**.*



The monkey is
observing *a dax*.



There's *a dax!*

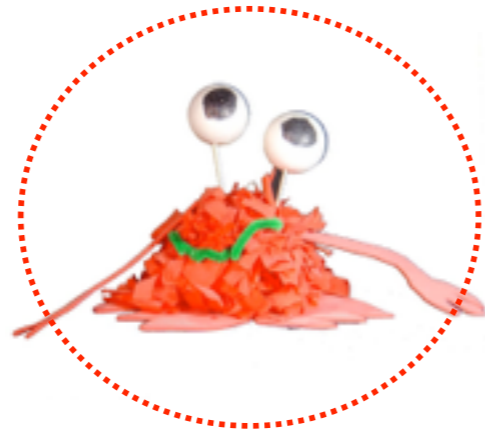
???



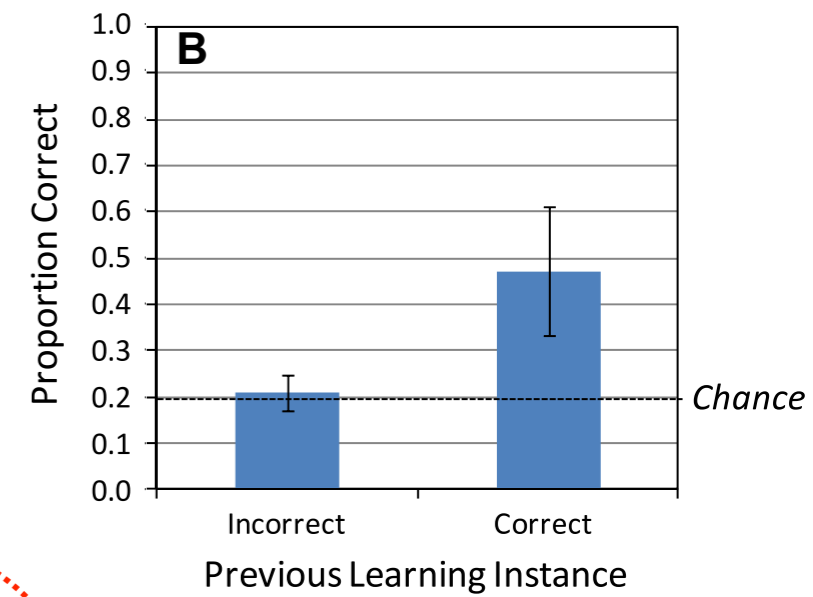
Single Hypothesis Tracking

- Trueswell et al. (2013)
 - No memory for unselected potential referents
 - Only last selection memorized
 - Propose-but-Verify Account

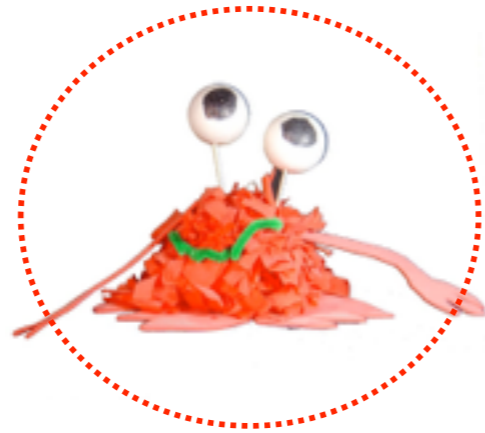
The monkey is observing *a dax*.



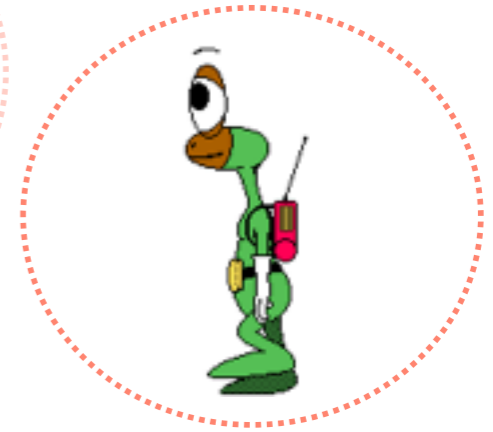
There's *a dax*!



*The monkey is
observing **a dax**.*

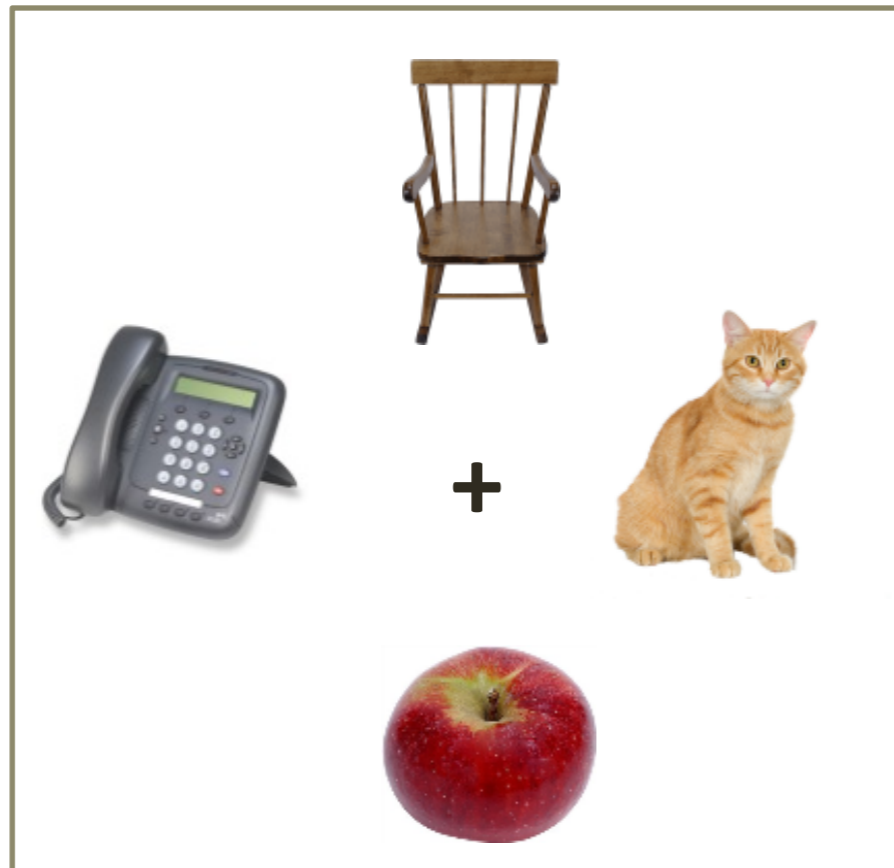


*There's **a dax**!*



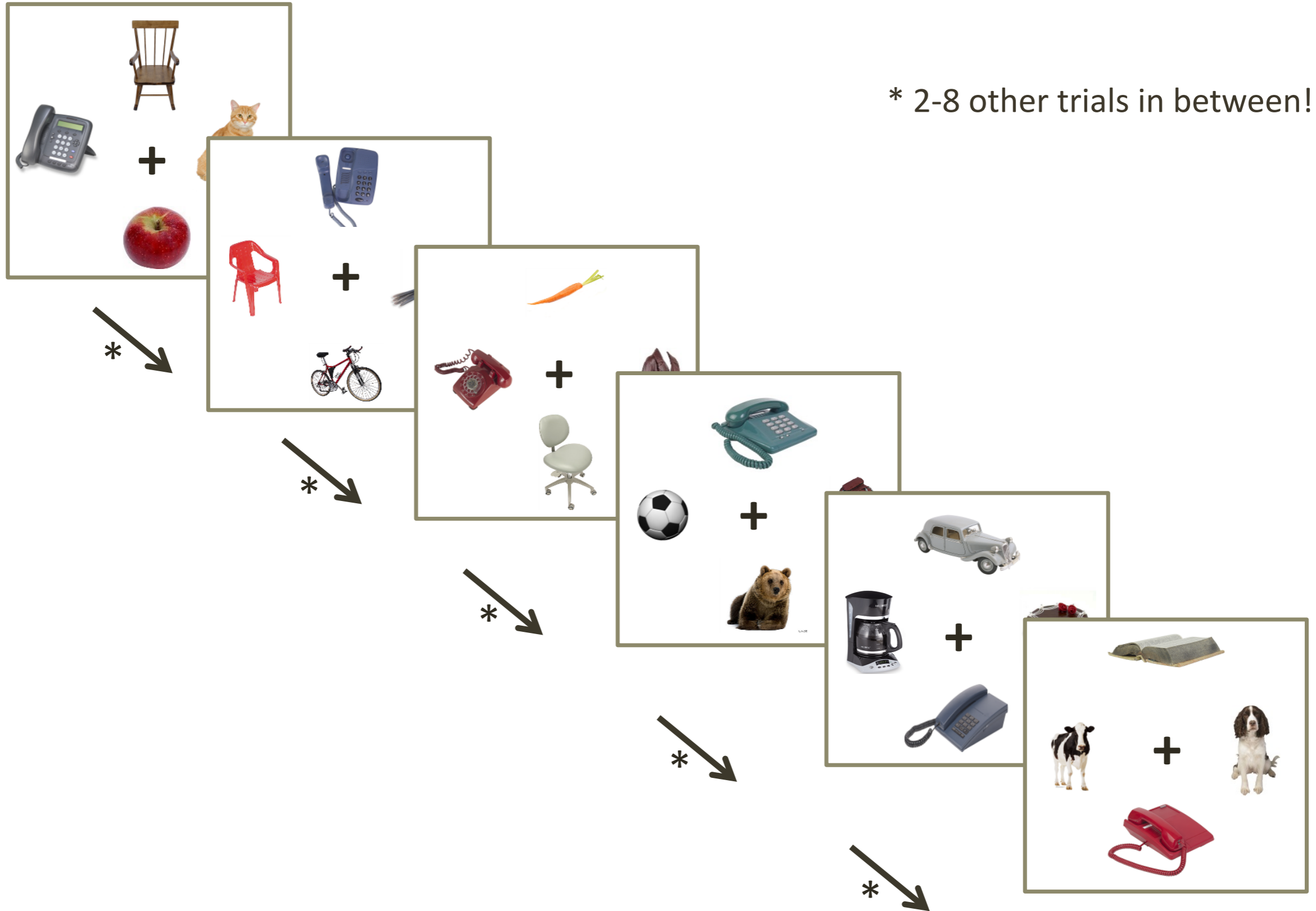
Single Hypothesis Tracking

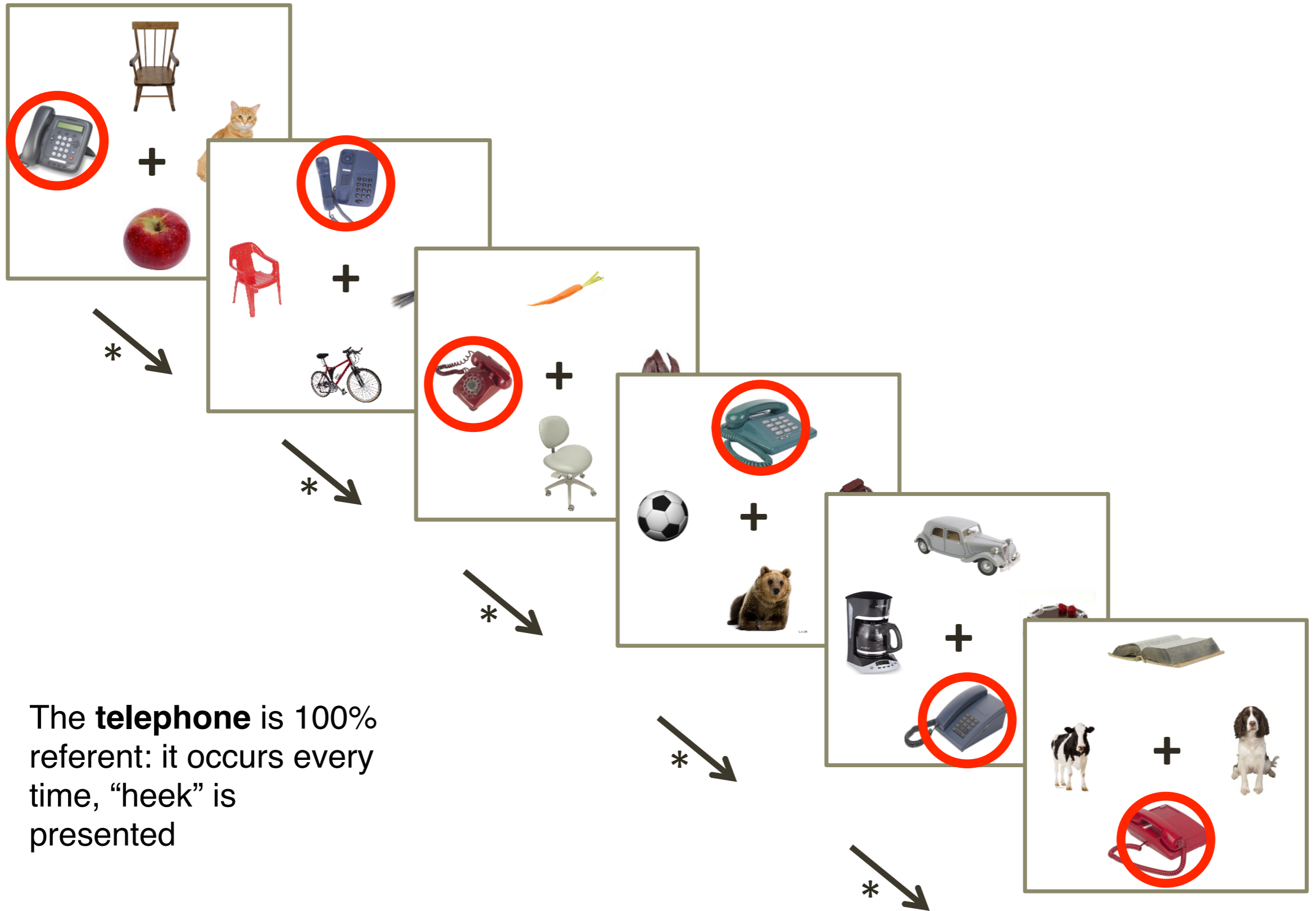
- Trueswell et al. (2013)
 - No memory for unselected potential referents
 - Only last selection memorized
 - Propose-but-Verify Account
- Too fragile to account for learning of ambiguous words
- Memory for all past selections? (Robust Propose-but-Verify Account)



🎧 "Oh look! A heek!"

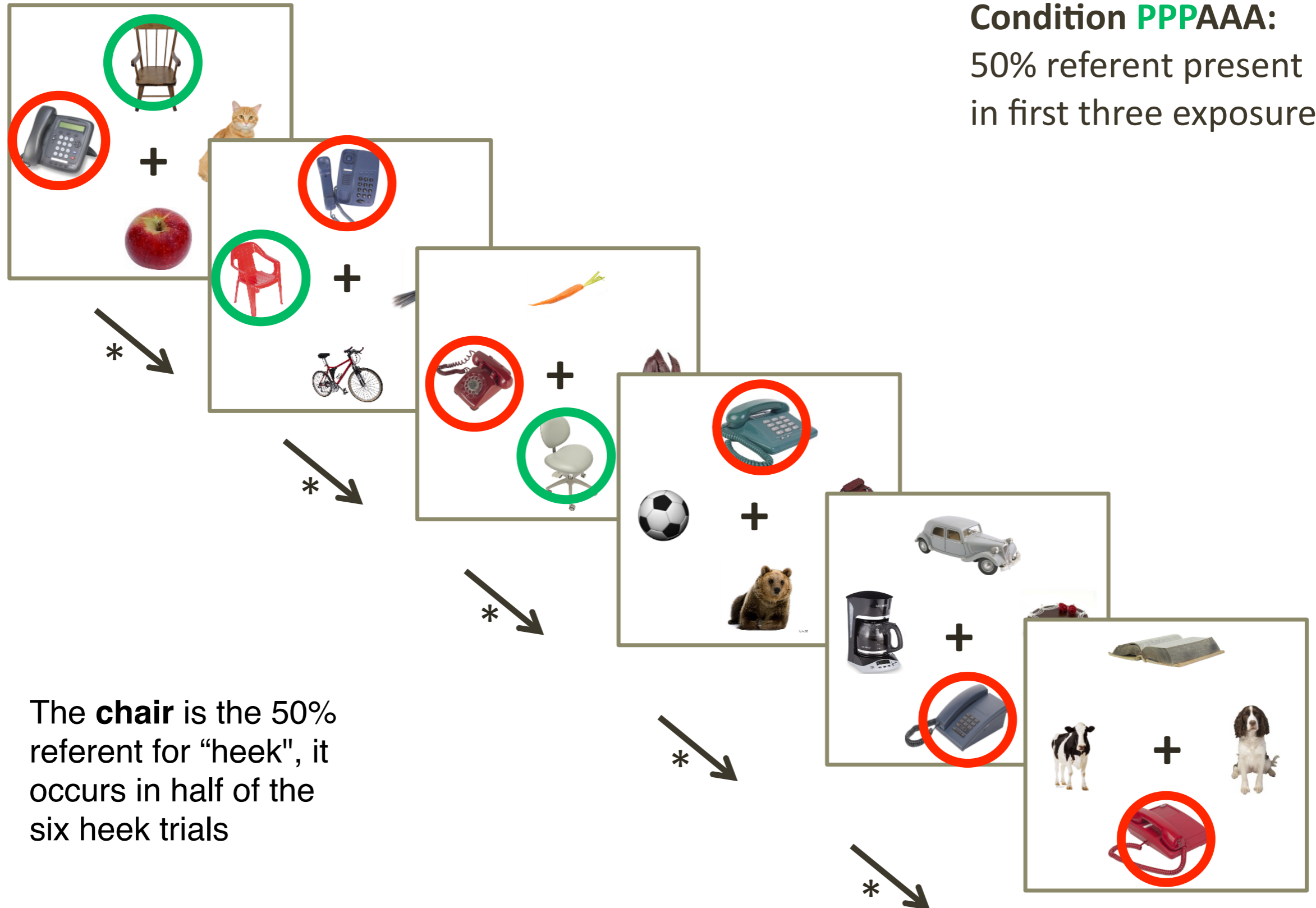
(Koehne, Trueswell & Gleitman, CogSci 2013)





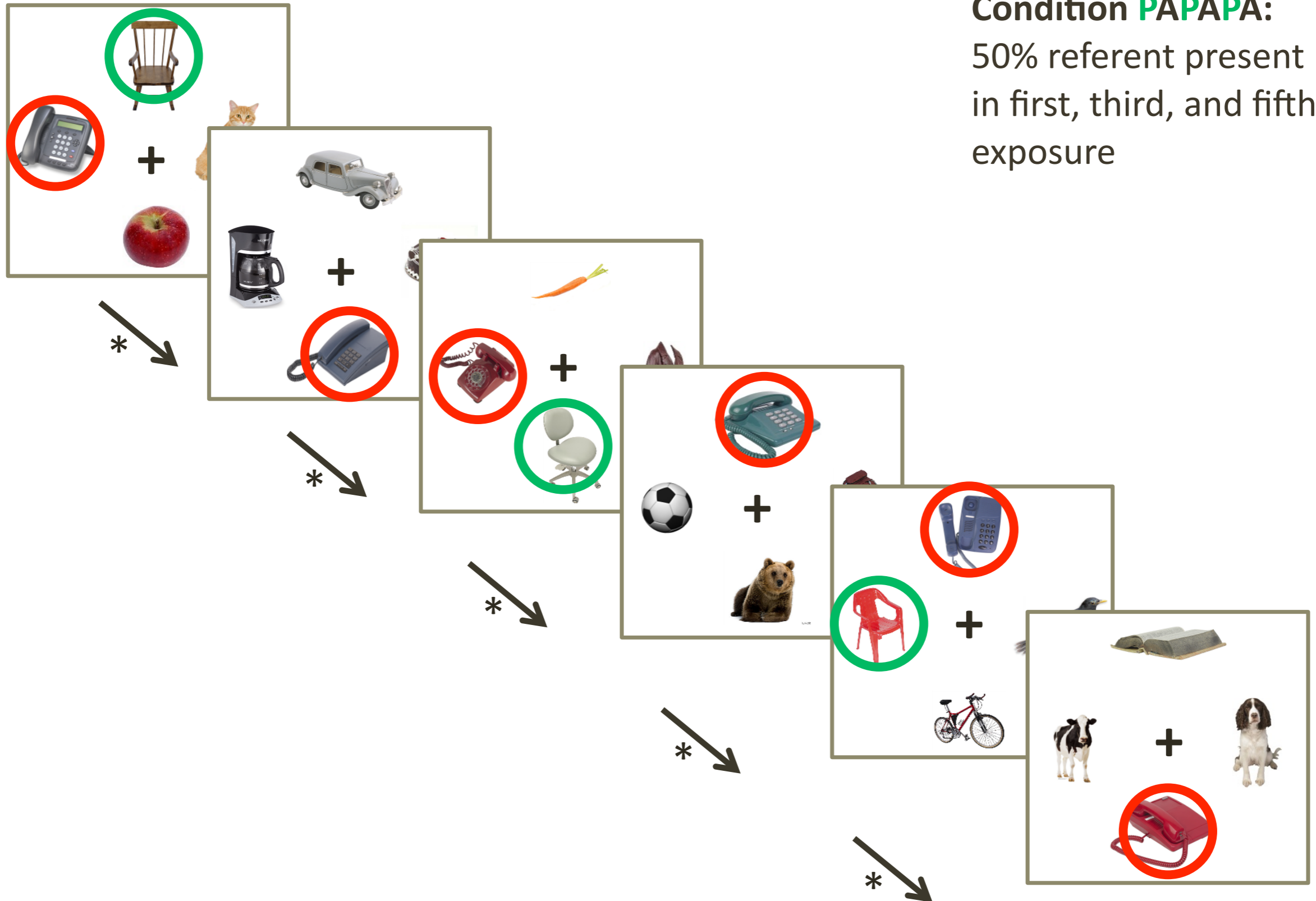
The **telephone** is 100% referent: it occurs every time, “heek” is presented

Condition **PPPAAA**:
50% referent present
in first three exposures

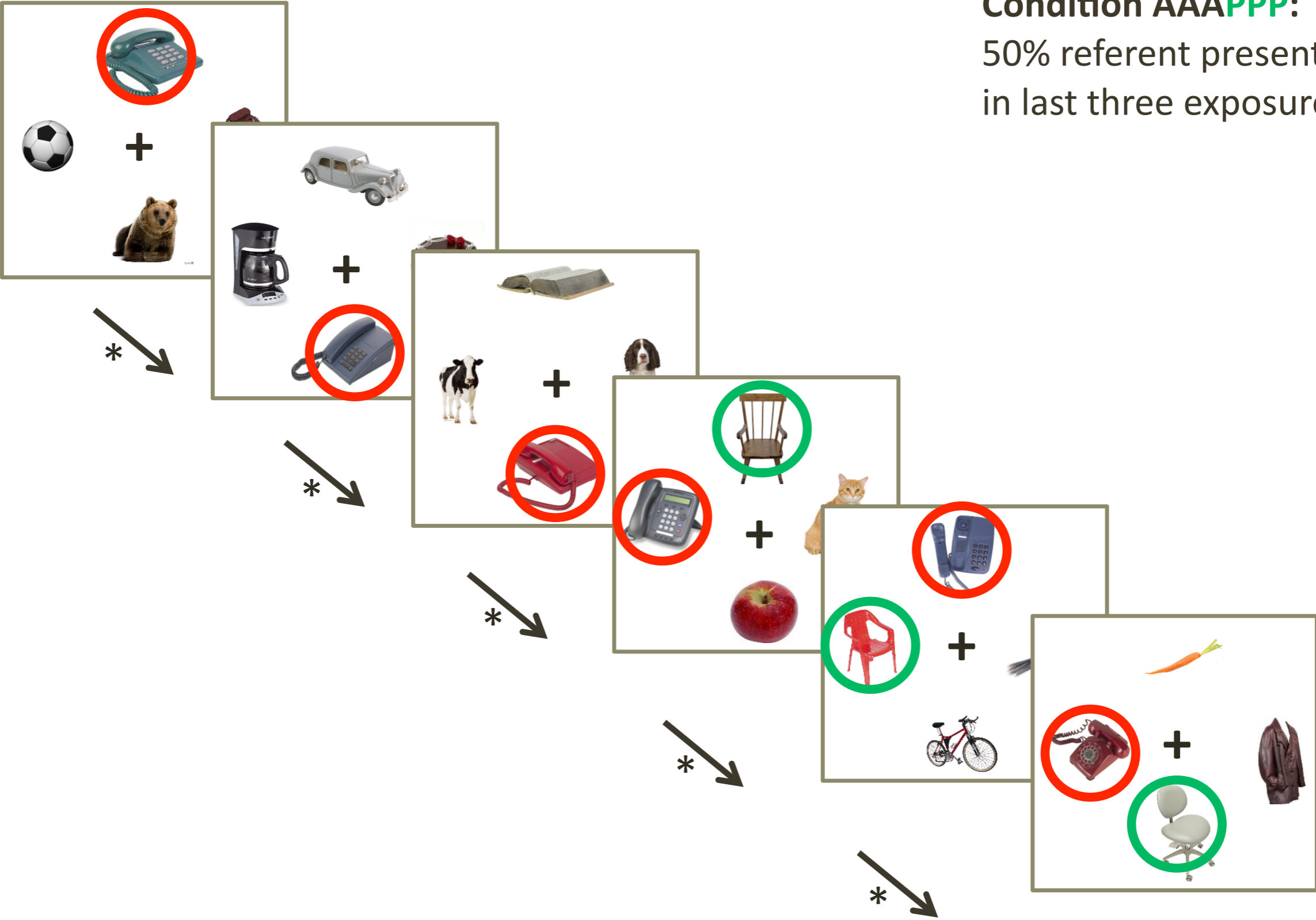


The **chair** is the 50% referent for "heek", it occurs in half of the six heek trials

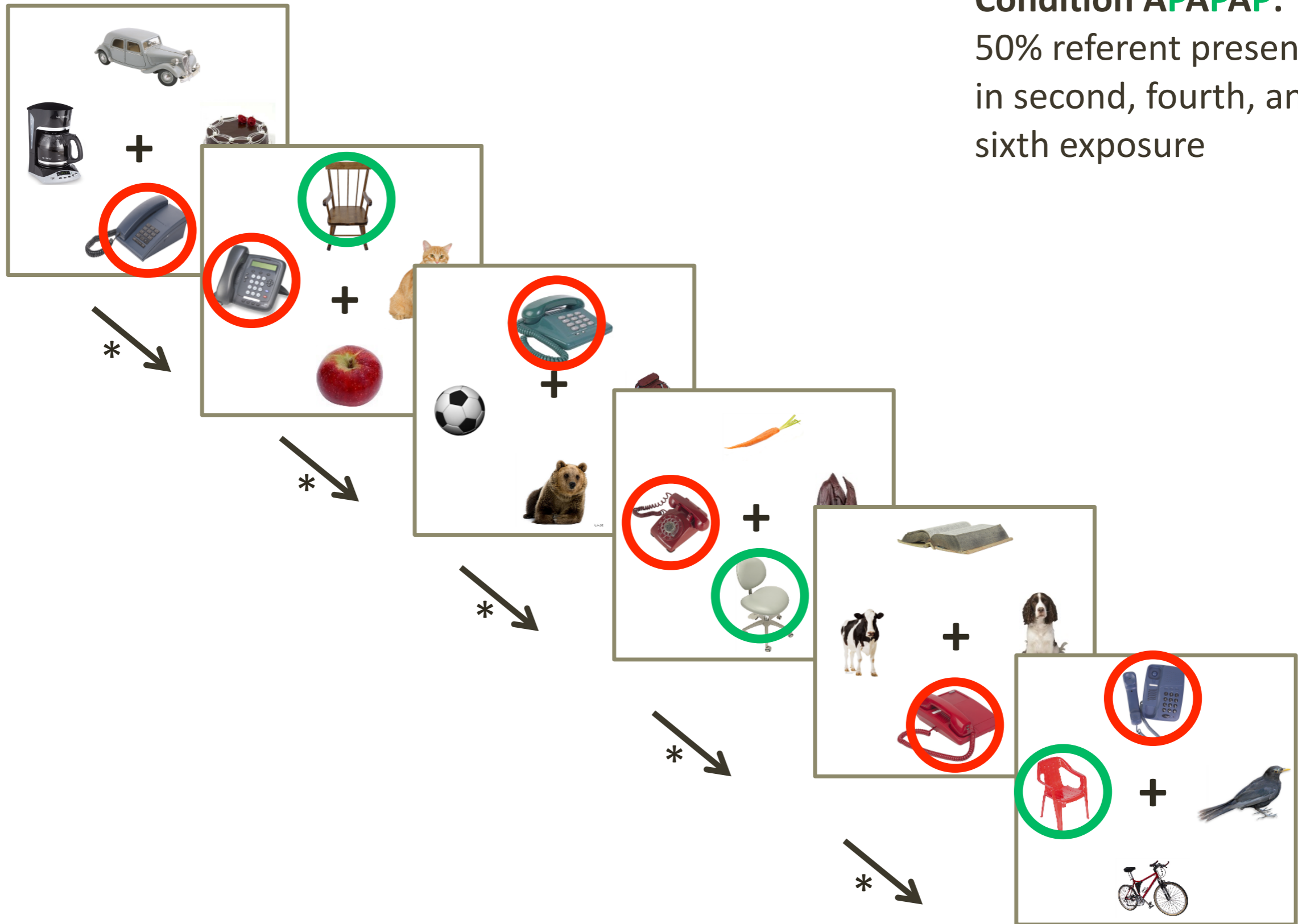
Condition PAPA:
50% referent present
in first, third, and fifth
exposure



Condition AAAPPP:
50% referent present
in last three exposures



Condition APAPAP:
50% referent present
in second, fourth, and
sixth exposure



Test phase

?

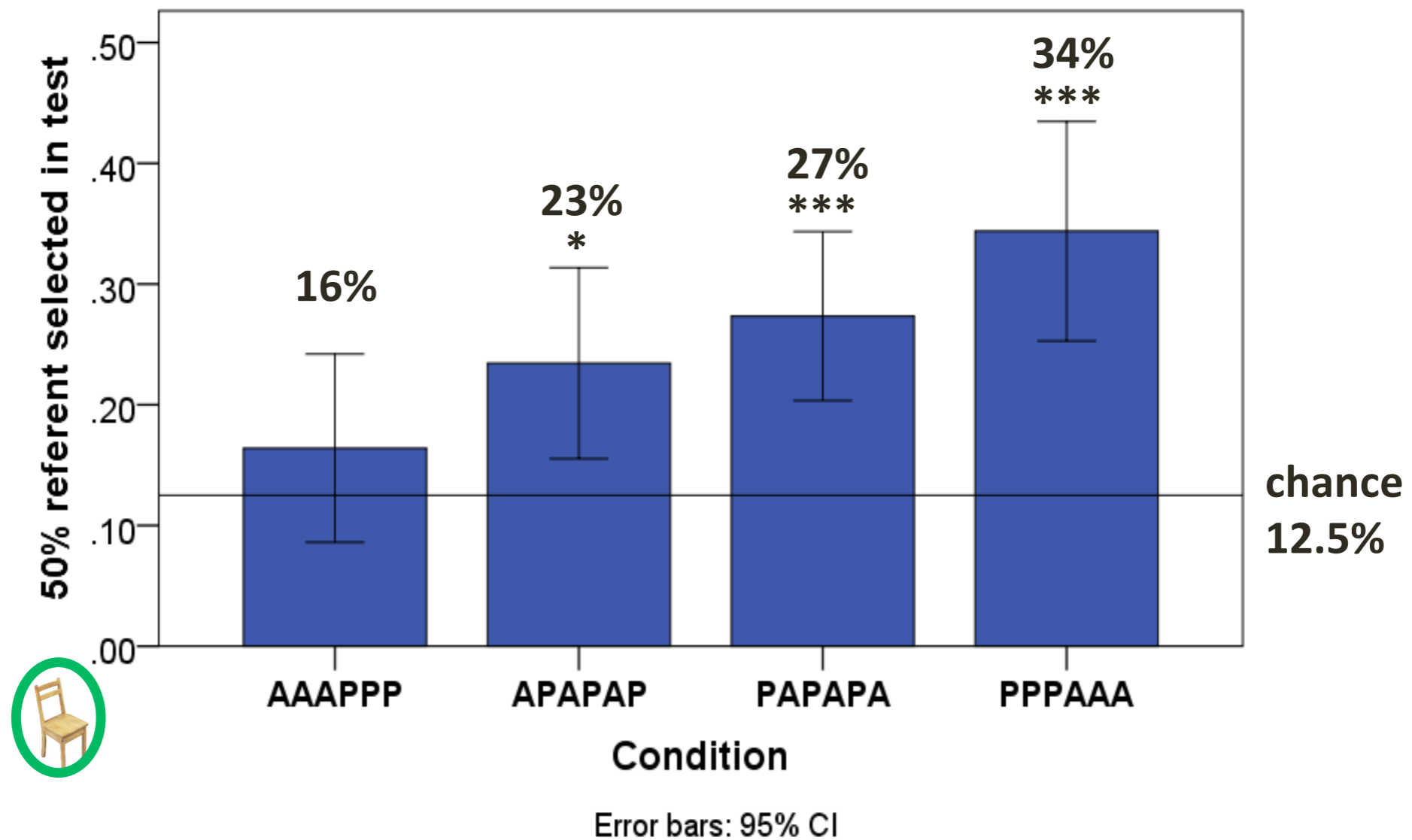


- What is the “heek”?
- Telephone not depicted!
- Second best candidate detected? (even though there was perfect referent)

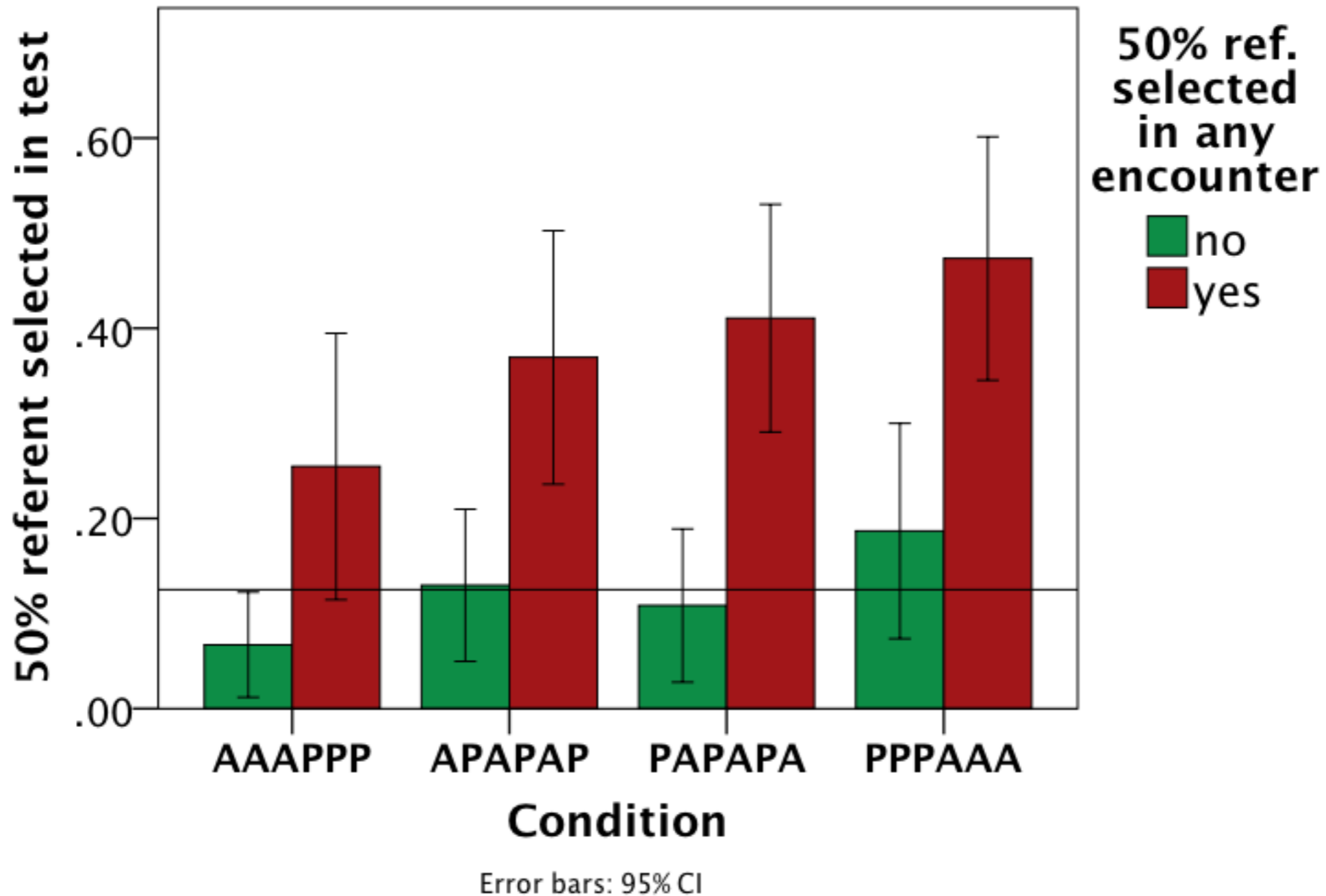
Predictions

- Selection of 50% referent (chair) in test:
 - *Cross-Situational Account* - Independent of condition and learning path
 - *Fragile Propose-but-Verify Account* - Only if it was the **very last proposal for a noun**, i.e., only possible in Conditions AAAPPP and APAPAP
 - *Robust Propose-but-Verify*: Only if it was **proposed at some point** during learning, possibly the more recent the better

Results



Results



Results

- The 50% referent (chair) was only selected if it had been **selected in previous *encounter***, independent of Condition (PP**P**AAA, PAPAP**A**, APAPAP**P**, AAAPPP**P**)
 - Supports the Robust Propose-but-Verify Account
- Selecting the 50% referent (chair) was still above chance when learners had **additionally** chosen the 100% referent (telephone) two to five times
 - Multiple-Proposal Memory rather than Multiple-Hypotheses Memory

Learning mechanisms


- Cross-situational word learning
 - Multiple hypotheses
- Fast mapping
 - Fragile vs Robust Propose-but-verify (multiple proposals can enter memory)
 - Fast mapping - slow learning...

Back to children


- Fast mapping and disambiguation
 - Is the tendency to assign novel words to novel objects in place from the beginning?
 - Does the ability to disambiguate relate to word learning (i.e. word-object association later on) ?

TEACHING TRIALS

Experiment 1: Unambiguous
Ostensive teaching trials
Where's the dofa?





Experiment 2: Ambiguous
Disambiguation trials
Where's the dofa?

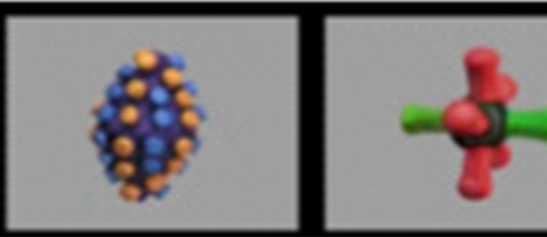


TEST TRIALS

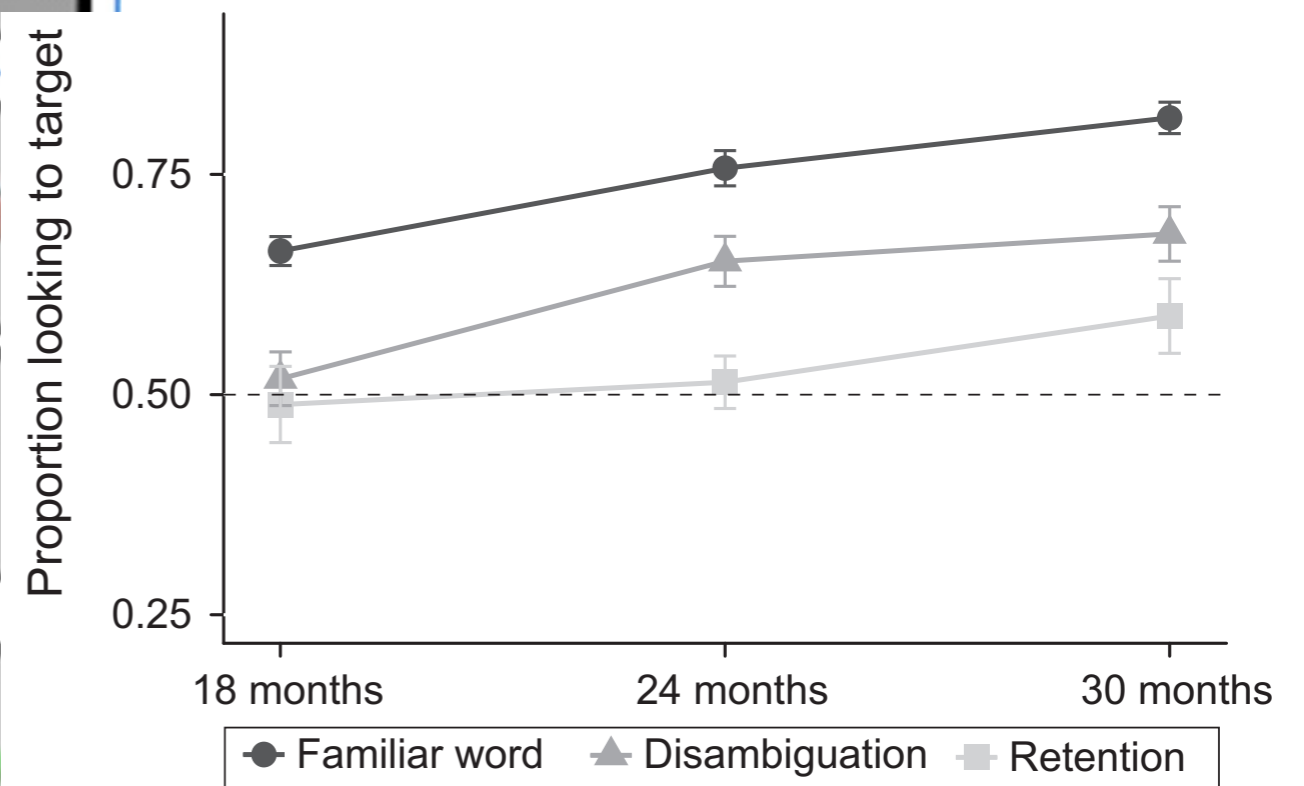
Experiments 1 & 2:
Familiar Word trials
Where's the car?

Experiments 1 & 2:
Novel Word Retention trials
Where's the dofa?



18, 24, 30 months
old children tested
in looking-while-
listening procedure



(Bion et al., Cognition, 2013)

Summary

- Children acquire words and their meaning in various ways:
 - through one-time associations (“proposals”),
 - using disambiguation to exclude referents,
 - that are refined (“verified”) probabilistically, across situations
- What about abstract words without direct empirical mappings?

References

- Bion, R., Borovsky, A., and Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word-object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition* 126, p.244-262.
- Köhne, J., Trueswell, J., Gleitman, L. (2013) Multiple propositional memory in observational word learning. *Proceedings of CogSci'13*.
- Spivey, J. and Huettenlocher, S. (2016) Toward a situated view of language. In: *Visually Situated Language Comprehension*. Knoeferle, P., Pyykkönen-Klauck, P., and Crocker, M. (Ed.). John Benjamins Publishing Company.
- Thelen, E., Schöner, G., Scheier, C., & Smith, L. B. (2001). The dynamics of embodiment: a field theory of infant perseverative reaching. *The Behavioral and Brain Sciences*, 24(1).
- Yu, C. and Smith, L. (2012). Embodied attention and word learning by toddlers. *Cognition* 125, p.39-53.