Using Eye Movements to Study Infants' Visual Attention in Real-world Word Learning Contexts

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INTRODUCTION

- Daily scenes that infants are exposed to are often cluttered with many different objects, making it difficult for children to learn word-object associations. [1]
- This brings about the referential uncertainty problem, in which one word can refer to multiple different objects. [2]
- Previous laboratory experiments studying word learning utilized simplified stimuli that were not representative of naturalistic learning environments.
- Word learning studies should consider a child's first-person point-of-view to get an accurate representation of what infants attend to.[3]

Our Study

- Our goal is to study infants' information selection process during naturalistic word learning. This is a critical first step to understanding how infants build word-object mappings.
- By collecting infants' real-time gazes using eye-tracking, we hope to examine: **1)** what objects infants choose to attend to (Object Looks) **2)** how often infants look at the target object (Target Looks) and **3)** whether labeling affects infant looking behavior (Labeling Effect)
- This study allows us to understand how infants address the referential uncertainty problem as well as discover the mechanism through which infants learn to form the correct word-referent mappings.

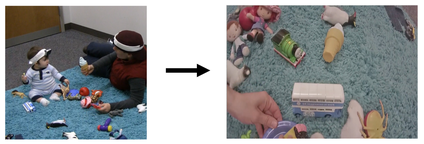
METHODS

Participants

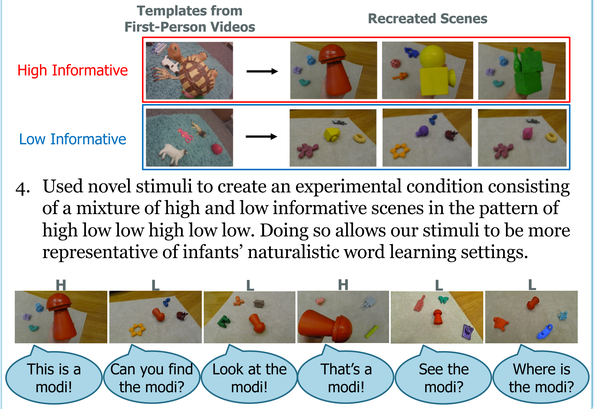
- Twenty-eight infants ranging from 8.6 to 23.2 months old (M = 14.38, SD = 3.70) were included.

Materials/Stimuli

1. Collected infant first-person videos recorded during naturalistic toy play interactions



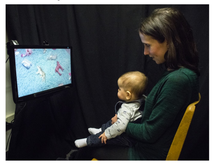
2. Discovered two types of learning instances from first-person videos: high informative scenes and low informative scenes
3. High and low informative scenes were recreated using novel toys. Naming moments were remade with a female voice and novel object names.



4. Used novel stimuli to create an experimental condition consisting of a mixture of high and low informative scenes in the pattern of high low low high low low. Doing so allows our stimuli to be more representative of infants' naturalistic word learning settings.

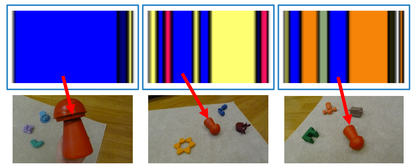
PROCEDURE

- Infants sat on their parent's lap 60-70 cm away from a computer screen presenting the stimuli
- Infant real-time gaze was recorded using the SensoMotoric Instruments screen-based eye-tracker



DATA PROCESSING

- Defined 5 Regions of Interest (ROI) for each trial: 4 objects and 1 background
- Generated visualization illustrating infant looking behavior



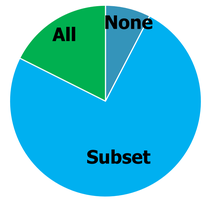
Each object is an ROI represented by a different color

- Blue represents the red target object
- Other colors represent the distractor objects or background

RESULTS

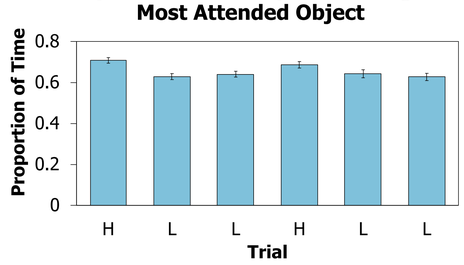
Object Looks

1 Percentage of Trials Looking at None, A Subset, and All Objects



Infants spent around 75% of trials attending to a subset of objects in view, 18% at all the objects, and 8% at none of the objects.

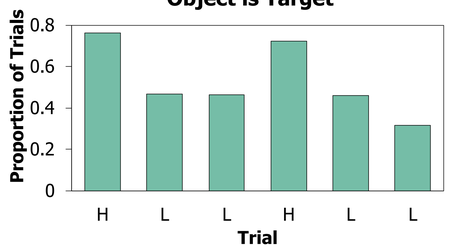
2 Proportion of Time Spent Looking at Most Attended Object



Among attended objects, infants spent around 68-71% of the time looking at one object in high informative scenes. In low informative scenes, infants spent 62-64% of the time attending to one object.

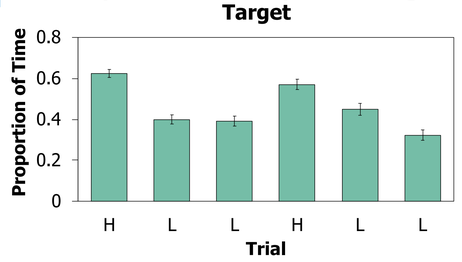
Target Looks

3 Proportion of Trials Most Attended Object is Target



Infants' most attended object was the target object in around 73-76% of high informative trials. In low informative scenes, infants' most attended object was the target object in around 32-47% of trials.

4 Proportion of Time Spent Looking at Target

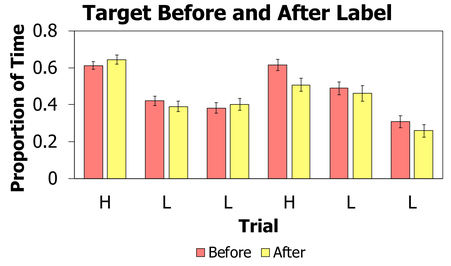


In high informative scenes, infants attended to the target object 57-62% of the time. In low informative scenes, infants spent around 32-45% of the time looking at the target object.

Labeling Effect

There are no significant differences in target looks before and after the label in most trials. In the second high trial, there is a slight difference in which infants attended to the target 62% of the time before the label and 51% of the time after.

5 Proportion of Time Looking at Target Before and After Label



RESULTS AND DISCUSSION

Object Looks

1. When looking at scenes with naturalistic properties, infants only attend to a subset of objects in view. This means that their attentional system is very selective, which may help increase the efficiency of word-object mapping by reducing referential uncertainty in the environment.
2. Within the subset of objects infants choose to attend to, they consistently look at one object over half of the time regardless of the visual properties of the scenes.
   - This preference shows that infants further reduce referential uncertainty by predominantly attending to one object.
   - From a word learning perspective, it is important to examine how likely infants' most attended object is the named target.

Target Looks

3. When the target object is salient, infants' most attended object is likely to be the correct target.
   - Although infants attend to one object predominantly regardless of scene properties, saliency of the target object can significantly increase the chance that infants will choose to attend to the named object.
4. More visually salient objects in high informative trials appear to draw infants' attention to it.

Labeling Effect

5. Infants do not change their looking behavior after hearing a label. This looking pattern suggests that one effective way for caregivers to help infants form the correct word-object associations is to name objects infants are already attending to rather than redirect them to a different object.[4]

CONCLUSIONS

- It is important to understand the information selection process during naturalistic word learning.
- Our methodology allows for the use of more naturalistic stimuli to study early language learning without losing the control of laboratory experiments.
- Referentially transparent learning instances (high informative scenes) may help infants find the correct referents easier, which may facilitate word learning.
- Visual properties, such as the saliency of objects, play a stronger role in directing infant attention than labeling.

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