

The effect of statistical frequency of multiple cues during infant cross-situational learning of word-referent mappings

1. Abstract

Previous research has shown that infants as young as 14-months of age can make word-object mappings through cross-situational statistics (Smith & Yu, 2008). We explored the effect of frequency of additional environmental cues on infant's ability to learn novel labels by adding distributional (marker words), prosodic (infant-directed speech) and gesture (head turn) cues. English monolingual 14-month-old infants (N = 32) were randomly assigned to one of two conditions; 100% cue frequency or 67% cue frequency. Our results indicate that, in the training trials, infants in the 67% condition spent more time looking to the gesture cue than either of the two objects. Infants in the 100% condition spent less time looking to the gesture cue and more time looking to the objects than those in the 67% condition. In the test trials, those in the 67% condition spent more time looking to the distractor object than those in the 100% condition. These results suggest that, at 14 months of age, infants are better able to map novel labels to novel objects when multiple cues are consistently given than when cues are statistically less frequent.

2. Background

- Infants as young as 13 -14 months can make label-object pairings based on repeated unambiguous pairings in a single session (e.g. Woodward et al., 1994).
- Further, cross-situational statistics can be used in this age group to learn nouns (Yu & Smith, 2008) when presented in ambiguous pairings.
- In adults, Walker et al. (2017) showed that complex syntax and vocabulary can be learned simultaneously from the same statistics.
- In adults, Monaghan et al. (2017) showed that variability in these cues facilitated statistical learning
- This study examined the effects of variability in additional environmental cues on infants' ability to learn novel labels by adding distributional, prosodic and gesture cues.

4. Results

Training Trials:

There was a significant interaction between condition and looking time to the Distractor, Face and Target Items ($\chi^2(3) = 99.746, p = < 0.001$).

Infants in the 67% cue condition spent more time looking to the face and less time looking to both target and distractor items than infants in the 100% condition during training trials.

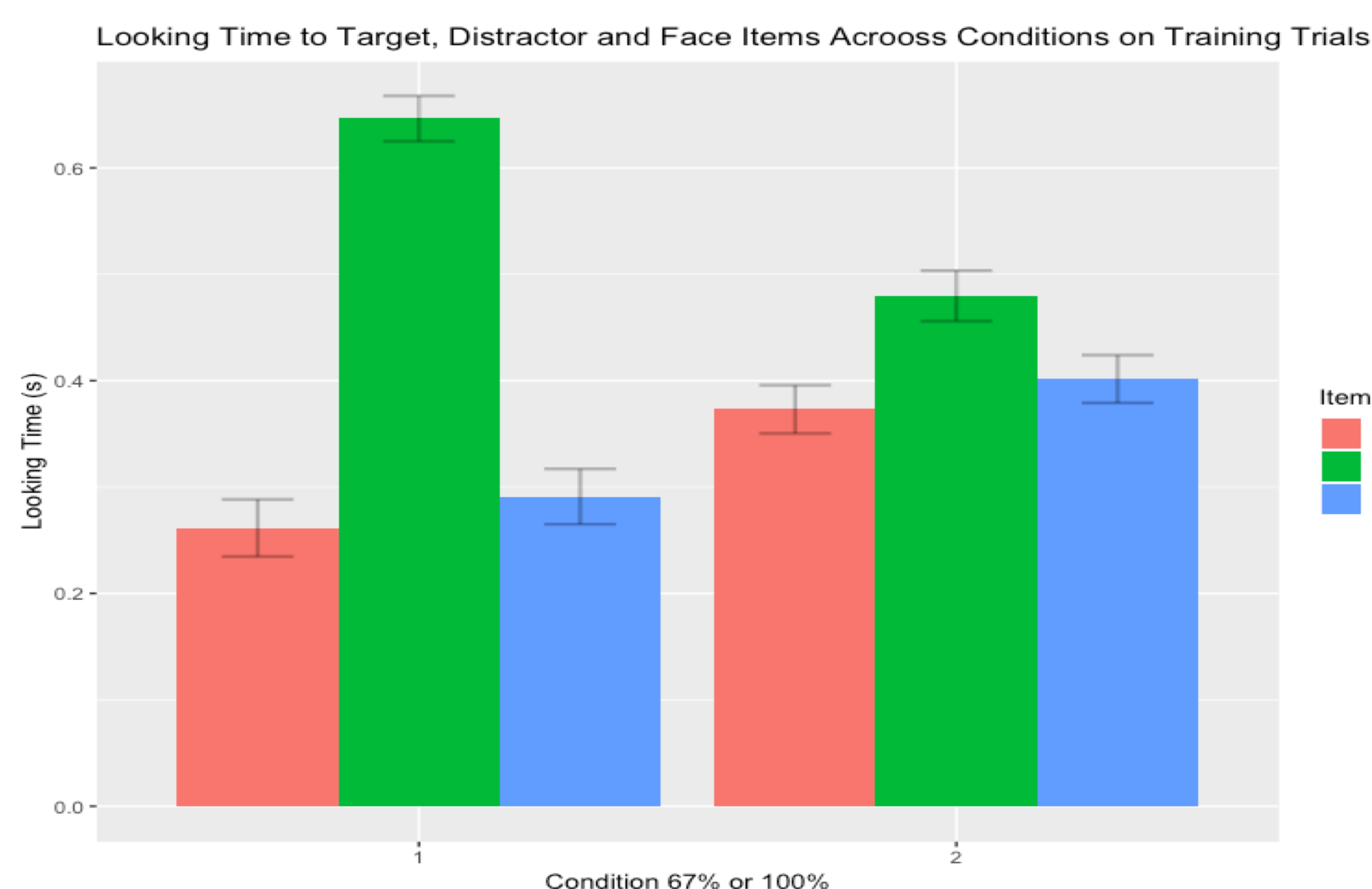


Fig. 4. Looking Time to the Target, Distractor and Face AOIs for those in the 67% and 100% Cue Conditions on Training Trials. Error Bars Represent Standard Error.

5. Conclusions

- In the training trials, infants in the 67% condition spent more time looking to the face than either of the two objects. Infants in the 100% condition spent less time looking to the face and more time looking to the objects than those in the 67% condition. In the test trials, those in the 100% cue condition performed significantly better than those in the 67% cue condition.
- Therefore, for infants of 14 months, environmental cues are most helpful on word learning when experienced with consistency. It is likely that, at this age, faces that are unfamiliar have a distracting effect on learning novel labels.
- Infant ability to use unambiguous object-label pairings to learn nouns is also a fragile result (e.g. Woodward & Hoyne, 1999). Perhaps on the cusp of this ability, small variations in procedure have the potential to lead to no learning.

3. Methodology

- Sample.** 32 14-month-old infants were recruited from the Lancaster Babylab Database to take part in one of two conditions.
- Similar to the procedure of Smith & Yu (2008), six novel pseudo-words were paired with six novel objects from the NOUN database (Horst et al., 2016).
- 30 x Training trials (Figures 1 & 2):
 - 2 objects were presented on the screen followed by the presentation of two novel labels. Each correct word pair occurred 10 times.
 - In addition, we presented head turn, marker word and prosodic cues. The head was presented in the centre of the screen and turned towards the 'target' object for that trial.
 - The marker words "Tha" and "Noo" followed the 'target' and 'non-target' object labels respectively.
 - An infant-directed, exaggerated prosody was given to the 'target' word.
 - In the 100% condition, all cues were given on all trials. In the 67% cue condition, the cues were pseudo-randomly presented to occur on 67% of trials.
- 12 x Test trials (Fig.3): One label was repeated 4 times with a target and distractor object in view.
- Eye movements were recorded using a Tobii X50. AOIs were defined as non-overlapping rectangles splitting the screen in to three equal areas during training trials and two equal areas during test trials.



Fig. 1. Example Training Trial on the First Frame.

Bimdah *noo* CHELAD *tha*

Fig. 2. Example Training Trial on the Final Frame.



Bimdah Bimdah Bimdah Bimdah

Fig. 3. Example Test Trial.

Test Trials:

There was a significant interaction between condition and looking to target or distractor ($\chi^2(1) = 5.25, p = 0.022$). Infants looked significantly longer to the target than the distractor objects in the 100% cue condition only.

There was no significant model improvement with the inclusion of age, gender, language comprehension, presentation order or block.

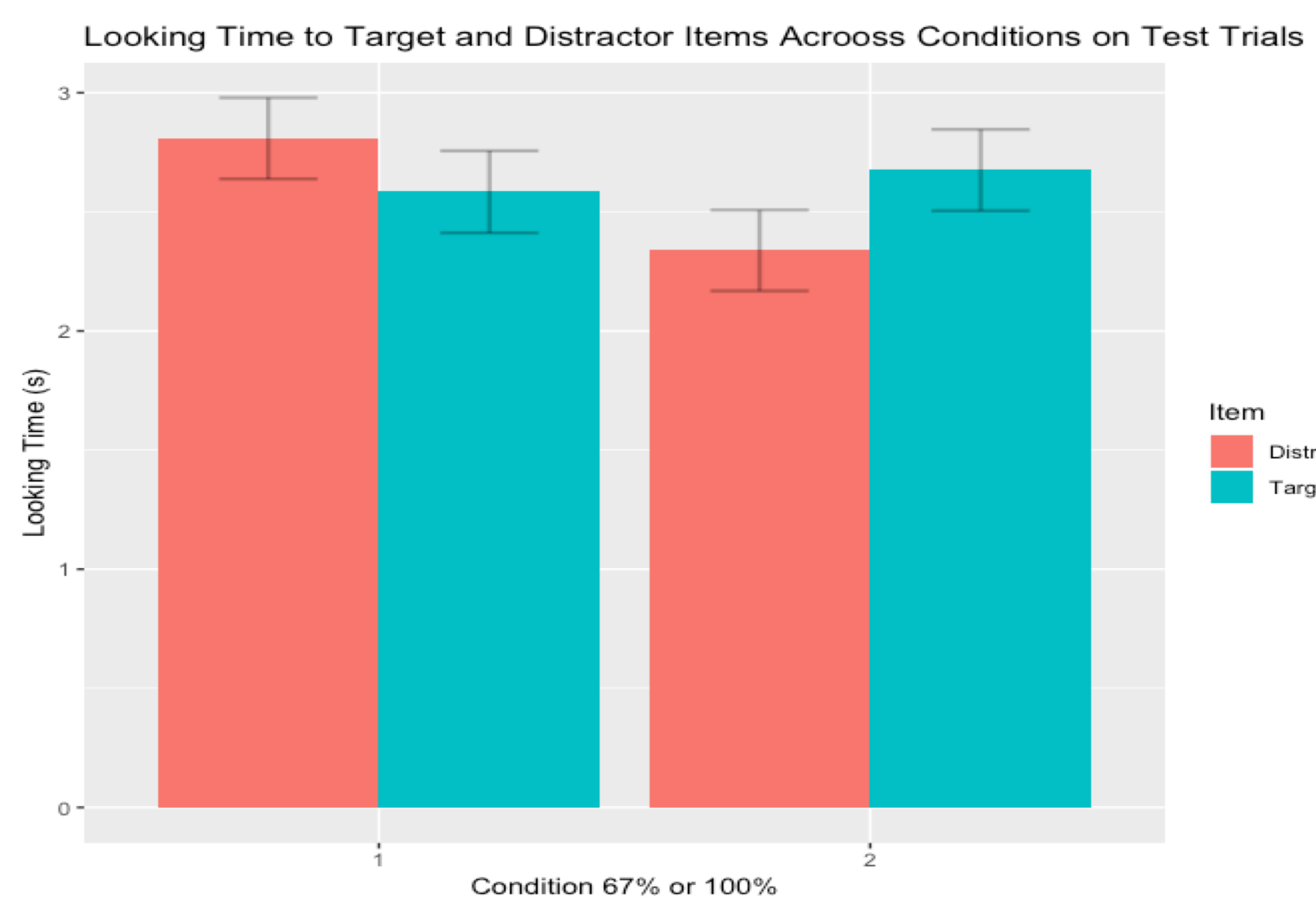


Fig. 5. Looking Time to the Target and Distractor AOIs for those in the 67% and 100% Cue Conditions on Test Trials. Error Bars Represent Standard Error.

6. References

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