

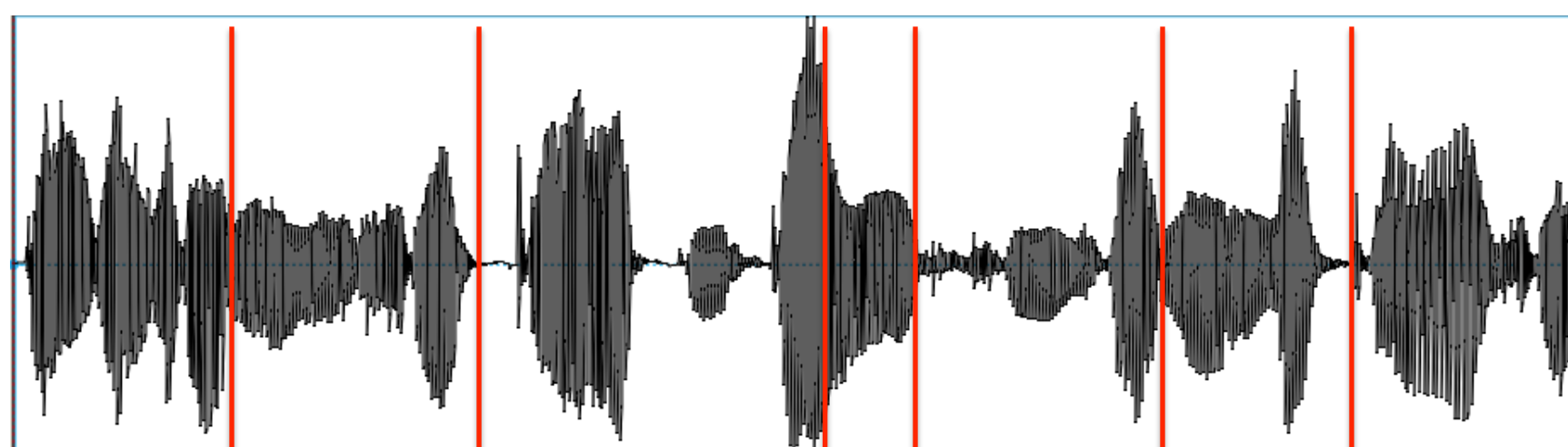
Generalizing Across Gender During Early Word Learning

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Introduction

How do infants find individual words in speech?

- The majority of speech heard by infants is spoken continuously with few reliable acoustic cues to indicate word boundaries.



Sp e s s o l l s a c a p l t a i n f u g a n e l l a c a s a

- Previous research has demonstrated that 8-month-olds can track the likelihood that two syllables will co-occur (also called transitional probability, TP) in continuous artificial (Saffran et al., 1998) and natural speech (Pelucchi et al., 2009), in order to extract candidate object labels.



$$P(\text{by}|\text{ba}) = \frac{\text{frequency of pair } \textit{baby}}{\text{frequency of } \textit{ba}}$$

$$P(\text{ba}|\text{ty}) = \frac{\text{frequency of pair } \textit{tyba}}{\text{frequency of } \textit{ty}}$$

- Further, Hay et al. (2011) demonstrates that words that contain high TP (HTP) make better object labels for 17-month-olds than those with low TP.
- However, little is known about how infants represent these newly segmented words.

In the current study, we test whether 17-month-olds can recognize newly segmented words from a natural speech if they are produced by a novel voice.

- While infants are sensitive to speaker characteristics from an early age (Mulak et al., 2017), they should come to ignore these same characteristics during word learning, as these types of indexical features do not affect the meaning of words (e.g., /dog/ produced by a female voice means the same thing as /dog/ produced by a male voice).

Experiment 1

To test infants' representation of the indexical features of newly segmented words, we familiarized 17-month-olds to a naturally spoken Italian corpus produced by a female speaker. Following familiarization, infants participated in a word learning task where the HTP words from the corpus were produced instead by a male speaker.

Hypothesis

- Infants should generalize across speaker gender. Thus, they should readily map HTP words to novel objects.

Participants

- 17-month-old monolingual English-learning infants (Experiment 1: n = 20) were recruited from the greater Knoxville area.



Picture: Infant and parent participating in study in the Infant Language and Perceptual Learning Lab

Experiment 1

Materials

- The familiarization corpus consisted of a naturally produced Italian speech stream with four embedded target words.
- Two words were HTP (TP=1.0) because their syllables always co-occurred, and two were LTP (TP=.33) because their syllables also occurred in other words.
- A native female Italian speaker produced 2 counterbalanced corpora, using target novel words (*casa*, *bici*, *fuga*, and *melo*).
- A novel, male native Italian speaker produced the same four target novel words in isolation to be used in the word-learning phase.

Procedure

Familiarization Phase: Infants listened to an Italian speech stream produced by a female voice while watching a cartoon (~2mins 30 sec).

Word-Learning Phase: Following familiarization, infants were trained and tested on two novel label-object pairings produced by a novel male speaker using the Switch Paradigm. Labels were the HTP words from the corpus.

Training. Infants were habituated to two novel label-object pairs. On each trial infants saw one object and heard the corresponding label. Object-label presentations continued until infants showed a 50% decrease in looking from the first to the last 3 training trials, or after 25 trials.

Testing. At test, infants were presented with both Same trials, in which the object-label pairing from habituation was maintained, and Switch trials, in which original object-label pairs were violated (i.e., Object A with Label B and vice versa). There were a total of 4 Same and 4 Switch trials counterbalanced across 8 testing orders.

- If infants learn the object-label pairings, they should look longer on Switch trials than on Same trials.

Results

- A paired t-test revealed that infants did not look significantly longer on Switch (mean = 7.49 sec, SD =3.30) than on Same trials (mean= 7.36 seconds), $p > .8$, suggesting that they did not learn the label-object pairings.
- At 17 months, infants may have a difficult time recognizing the words in training (male voice) as being the same as the words that they pulled out of continuous speech (female voice).
- Alternatively, infants may have failed to segment the HTP words from the speech stream.
 - Although previous studies have demonstrated that infants of this age are able to track statistics in natural language (Hay et al., 2011), here we used a different speaker than previous studies.

Visual Stimuli

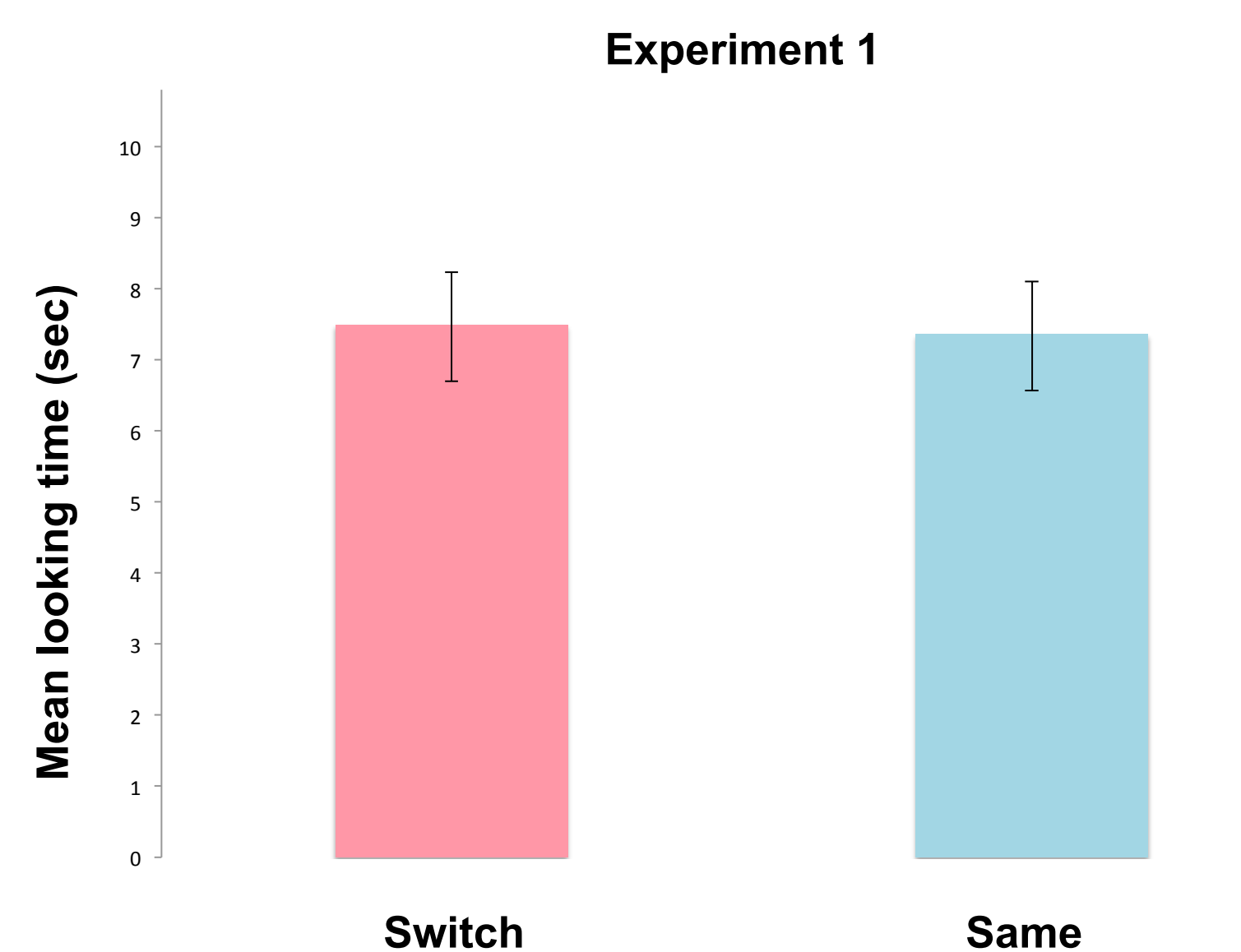


Figure 1: Mean looking time on Switch and Same trials for Experiment 1. Error bar represent standard error of the mean.

Experiment 2

Experiment 2 was designed to ensure that failure to learn in Experiment 1 was due to an inability to generalize across speaker gender and not a failure to track TP information in the new corpus. To that end, we set out to replicate Hay et al. 2011 with the same corpus used in Experiment 1, keeping the speaker constant between familiarization and word-learning phases.

Hypothesis

- If infants are sensitive to the TP information in our corpus, they should learn to map the HTP words from the corpus to novel objects, as they did in Hay et al. (2011).

Participants

- 17-month-old monolingual English-learning infants (n=19).

Methods

- The methods were identical to Experiment 1, with the following exception; the same native female Italian speaker who produced the familiarization corpus also produced the words used in the word-learning phase.

Results:

- Surprisingly, a paired t-test for Experiment 2 revealed infants did not look significantly longer on Switch (mean = 9.72 sec, SD =3.60) than on Same trials (mean= 9.35 seconds), $p > .6$, suggesting that they again did not learn the label-object pairings.
- We were unable to replicate the basic findings from Hay et al. 2011.

Experiment 2

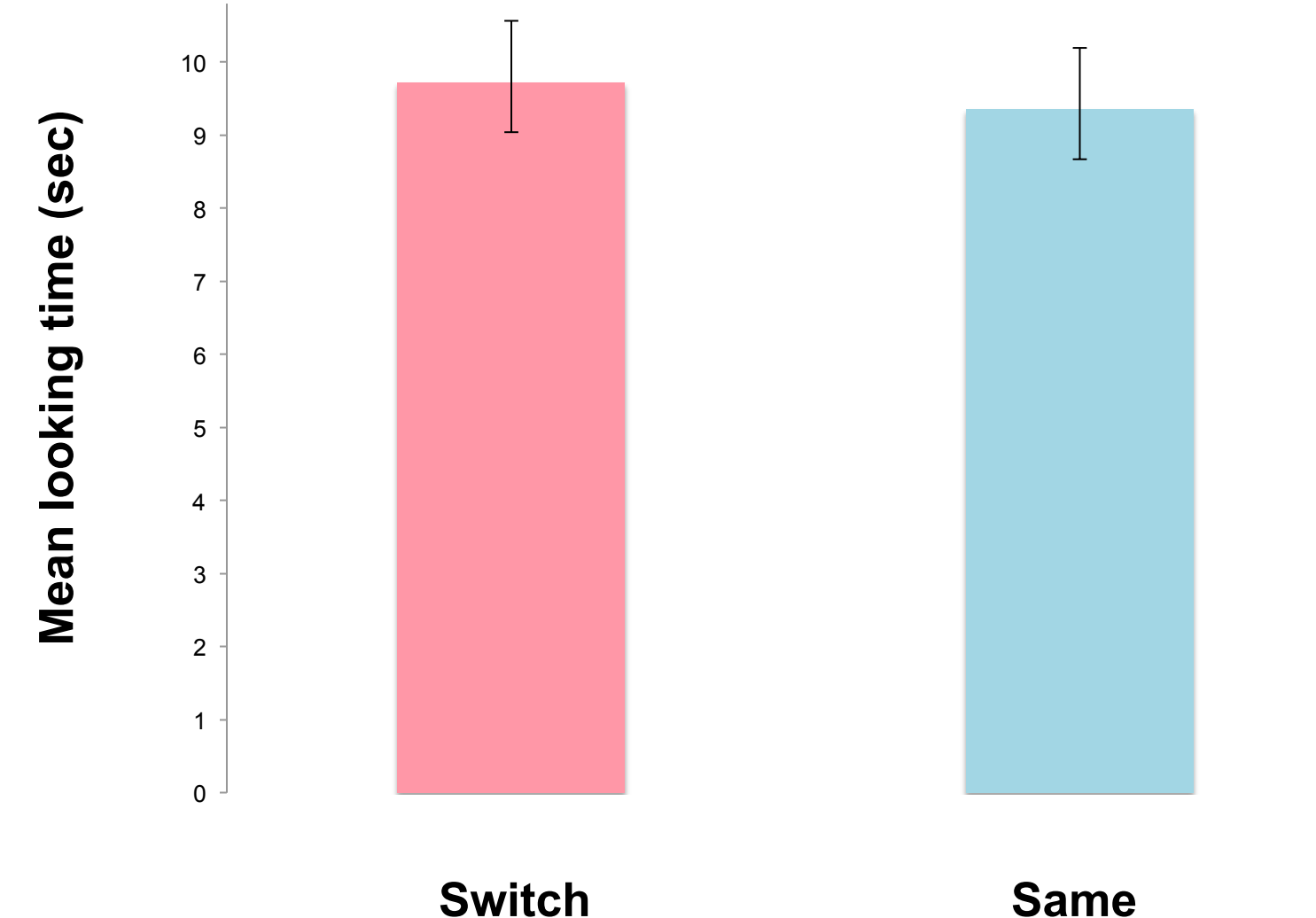


Figure 2: Mean looking time on Switch and Same trials for Experiment 2. Error bar represent standard error of the mean.

General Discussion

- In both Experiments 1 and 2, infants failed to map the HTP words to novel objects.

- We were unable to replicate previous work by Hay et al. (2011) and Graf Estes and colleagues (Graf Estes, 2012).

- This limits our ability to draw any meaningful conclusions about infants' ability to generalize across speaker gender.

- Thus, we do not yet know how specifically infants represent indexical (speaker) information in words that are newly segmented from natural speech.

- The reasons for our failure to replicate previous work remain unclear; however, one contributing factor may involve the participants' language proficiency.

- While is no vocabulary size data available from the infants in Hay et al. (2011), in the population we studied, over 25% of the infants scored below the 10th percentile for vocabulary size based on the MCDI parental report. For a point of reference, children are typically categorized as late talkers if they score below the 25th percentile in these types of vocabulary measures.

- Although vocabulary size and performance were not correlated in our sample, it is possible that infants with lower vocabulary size could be having a difficult time learning to map words from continuous speech even with support of the statistics.

- Further work will be necessary to identify how infants are representing these statistically defined words.

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Acknowledgements

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