Word Learning in Quiet and in Noise: A Preliminary Study

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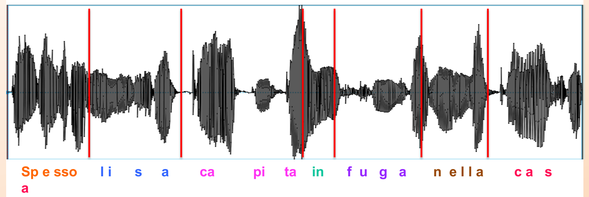
Introduction

How do infants find words in continuous speech?

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



- ❑ Previous research has demonstrated that infants can track the transitional probability (TP) between syllables (i.e., the likelihood two syllables will co-occur) in continuous artificial (Saffran, Aslin, & Newport, 1996) and natural languages (Pelucchi, Hay & Saffran, 2009) to discover word boundaries.

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

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

Can infants map newly segmented words to meaning?

- ❑ Finding words in continuous speech is just the first step in word learning. Word learning also involves mapping newly extracted sound sequences to meaning.
- ❑ Previous research from our lab suggests that sound sequences that have stronger TP patterns do in fact make better object labels for 17-month-olds than those with with weaker TP patterns (Hay, Pelucchi, Graf Estes, & Saffran, 2011).

How does background noise affect statistical learning and subsequent word learning?

- ❑ The infants' acoustic environment is exceedingly complex and noisy, yet much of what we know about statistical learning comes from laboratory studies conducted in artificially quiet listening conditions.
- ❑ Thus, it is unclear whether infants can track statistical regularities to extract candidate words under more ecologically valid listening conditions.

In the current study, we seek to establish a paradigm that we can use to test how statistical learning feeds into subsequent word learning in more ecologically valid listening conditions.

- ❑ Previous work by Hay et al (2011) used the Switch Paradigm, which provides only gross measures of dishabituation to mapping violations, and a between subjects design to measure word learning.

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

Methods

Purpose:

To develop a sensitive within subjects methodology to test the relationship between statistical learning and subsequent word learning.

Participants:

- ❑ 20- to 24-month-old monolingual English-learning infants (n = 20) were recruited from the greater Knoxville area.

Materials:

- ❑ We used a naturally produced Italian corpus in which the TP between syllables was manipulated in 4 target words: two high TP (HTP; TP=1.0) words with component syllables only occurring within those words, and two low TP (LTP; TP=.3) words with component syllables occurring in other words throughout the corpus.
- ❑ A female native Italian speaker produced 2 counterbalanced languages, target novel words (*casa, bici, fuga,* and *melo),* familiar words (*shoe, book, baby* and *doggie)*, and all English carrier phrases (e.g. *Look at the*)

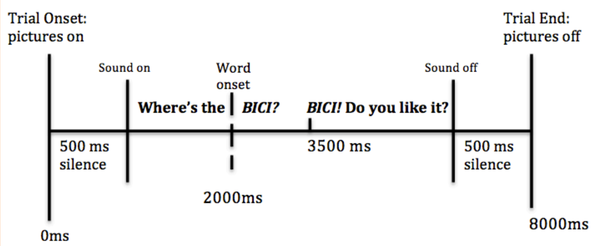
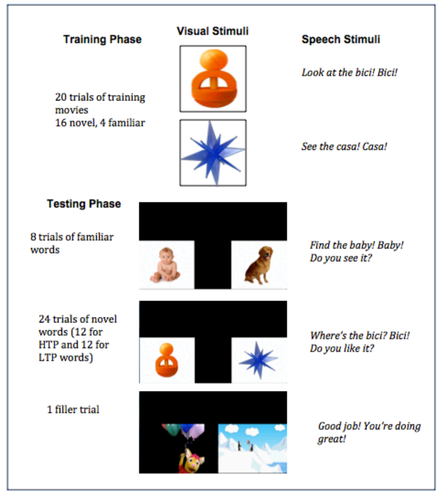


Figure1: Schematic timeline for the test trials

Procedures:

- ❑ Infants were first familiarized to one of the languages while watching an unrelated silent video (~2mins 15 sec).
- ❑ Following familiarization infants were trained to pair 2 HTP and 2 LTP novel Italian words heard in the corpus to novel objects on the screen. Familiar words and objects were presented intermittently as fillers.
- ❑ Finally, we used a Looking-While-Listening procedure (Fernald et al., 2008), to test accuracy and eye-gaze patterns to find the labeled object.
- ❑ Order of test trials was counterbalanced across participants.



- ❑ Learning was assessed by tracking eye movement using off-line coding on the iCoder software.

Results

- ❑ Infants were successfully able to learn both the HTP, $t(19) = 2.26$, $p = .036$, and LTP words, $t(19)=2.89$, $p = .009$. Although accuracy performance appears to be somewhat better in the LTP than HTP condition this difference was not significant.
- ❑ In both the HTP and LTP conditions, the infants showed the correct pattern of quickly shifting from the distractor to the target word after word onset in distractor onset trials and staying on the target word after word onset in target onset trials. This indicates that the infants were successful in recognizing the object-label pairings.

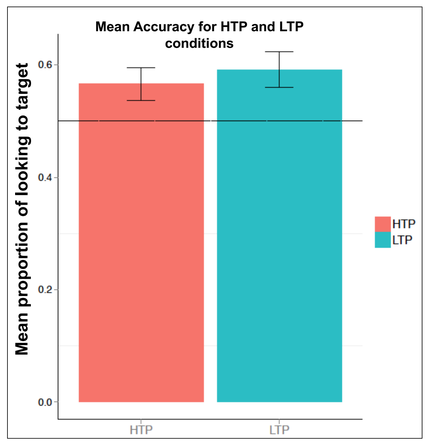


Figure 2: The mean accuracy of HTP and LTP words measured by proportion of time looking at target. Accuracy window was 300-2000ms following word onset. Error bar represent standard error of the mean.

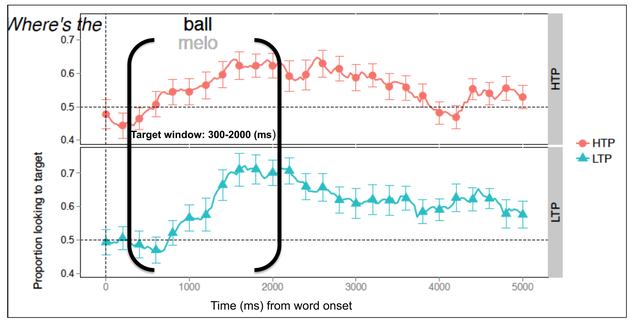


Figure 3: Eye-gaze plot shows the proportion of looking to the target across test trials. Both the HTP and LTP conditions show a pattern that indicates word learning. Again, the LTP seems to show a higher proportion of looking but it is not significantly higher than the HTP.

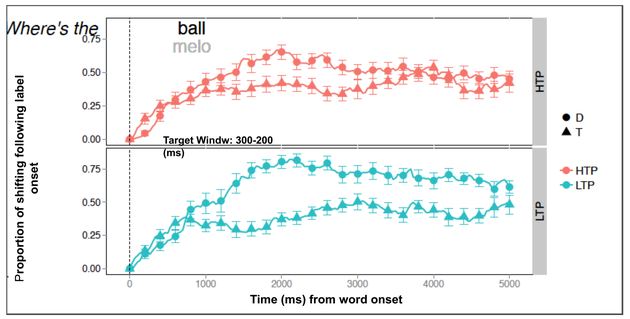


Figure 4: Proportion of shifting following word onset on target initial trials (i.e., trials in which infants were looking at the target at word onset) and on distractor initial trials (i.e., trials in which infants were looking at the distractor at word onset). This graph shows the typical separation expected in word learning. In distractor initial trials, infants were quick to shift their gaze to the target, and in target initial trials, the infants inhibited shifting behavior and maintained fixation on the target.

General Discussion

- ❑ We were successful in developing a within subjects design using the more sensitive Looking-While-Listening procedure.
- ❑ Infants were able to learn both HTP and LTP words from a novel natural language. However, our predictions that HTP words would make better object labels than LTP words was not supported.

Previous work has demonstrated that HTP words make better object labels that LTP word. Why did our infants learn both the HTP and LTP words?

- ❑ The infants tested in this study were much older (20-24 months) than those tested in the Hay et al. (2011) study (17 months). Children at this age could be at a developmental level that makes them better word learners. They may be adept at using several cues other than just statistical probability.
- ❑ Additionally, we provided referential support that was not used in the previous study. Referential support may have overridden the supportive effects statistical regularities have during early word learning. To address this issue, we would need to test infants using an unrelated corpus (i.e. one without statistical probability cues).
- ❑ While the HTP words had a higher TP than the LTP, the LTP syllables appeared 3 times more often in the corpus than the syllables of the HTP words. Thus, syllable familiarity may have been driving learning in this study.
- ❑ To address the role of syllable frequency in word learning we have developed test words in which the TPs of the target words are violated, but the syllable frequency is maintained (e.g., pair the first syllable of one LTP word with the last syllable of another LTP word – *caci* and *bisa* instead of *casa* and *bici*). This experiment would help elucidate the relative roles of syllable frequency and transitional probability during early word learning.

What next?

- ❑ After running the appropriate control conditions, we will present background during the familiarization phase to test the resilience of statistical learning. This will help us understand statistical learning and subsequent word learning in a more natural setting.

References

Hay, J. F., Pelucchi, B., Estes, K. G., & Saffran, J. R. (2011). Linking sounds to meanings: Infant statistical learning in a natural language. *Cognitive Psychology, 63*(2), 93-106. doi:10.1016/j.cogpsych.2011.06.002

Fernald, A., Zangl, R., Portillo, A. L., & Marchman, V. A. (2008). *Developmental Psycholinguistics: On-line methods in children's language processing* (I. A. Sekerina, E. M. Fernandez, & H. Clahsen, Eds.). Amsterdam: John Benjamins (pp. 97-135.). doi:10.1075/lald.44

Pelucchi, B., Hay, J. F., & Saffran, J. R. (2009). Statistical Learning in a Natural Language by 8-Month-Old Infants. *Child Development, 80*(3), 674-685. doi:10.1111/j.1467-8624.2009.01290.x

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical Learning By 8-Month Old Infants. *Science, 274*(5294), 1926-1928. doi:10.1126/science.274.5294.1926

Acknowledgements

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