Informativity in adaptation: Supervised and unsupervised learning of linguistic cue distributions

Dave F. Kleinschmidt, Rajeev Raizada, and T. Florian Jaeger, University of Rochester
dkleinschmidt@bcs.rochester.edu, raizada@bcs.rochester.edu, fjaeger@bcs.rochester.edu

Our question:

Do people use **category labels** during adaptation?

Language learning doesn't stop once you reach adulthood: talkers use linguistic cues to realize their intentions in different ways. To **adapt** to a new talker, you have to learn the way they use cues. If you know their intented meaning, this learning should be a lot easier. Learning with known category labels is called **supervised learning**, and learning from cues only is called **unsupervised learning**.

Why we ask:

Categories are **distributions** of cues
- Productions vary within talker
- Productions vary across talkers

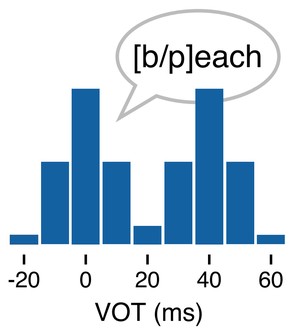
Requires **distributional learning** for
- Acquisition: learn language's distributions
- Adaptation: learn talker's distributions

Are they the same underlying process?
- Why is acquisition **slow** and adaptation **fast**?
- Adults have more information from experience
- Other cues **label** sounds with intended cateogry

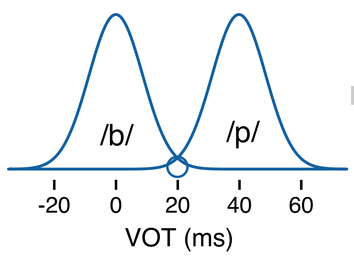
What we did:

Distributional learning of /b/ and /p/

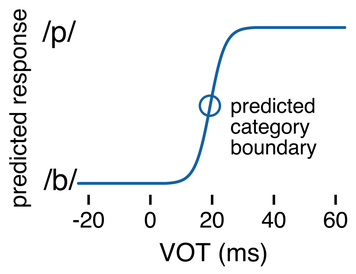
Listeners hear b/p minimal pair word



VOTs are drawn from a **bimodal distribution**



Sample of VOTs implies /b/ and /p/ **clusters** with particular means and variances

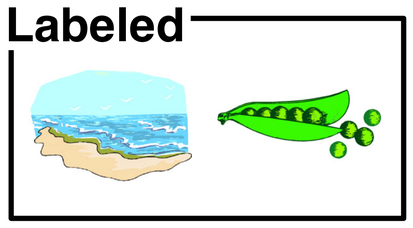


Learning is measured by how well listener's category boundary **matches predicted boundary**

...with and without labels

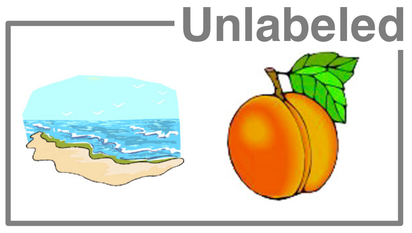
and click on matching picture. Trial is either:

Labeled



provide **teaching signal** (supervision): only *beach* matches, talker intended /b/

Unlabeled

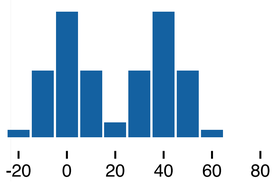


measure /b/-/p/ category boundary: both *beach* and *peach* match, ambiguous

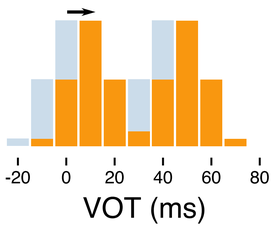
Experiment 1

Distribution shift:

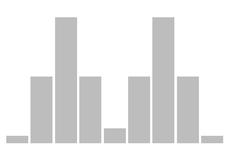
0ms shift



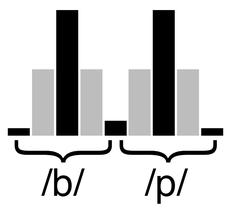
10ms shift



Unsupervised
All trials unlabeled

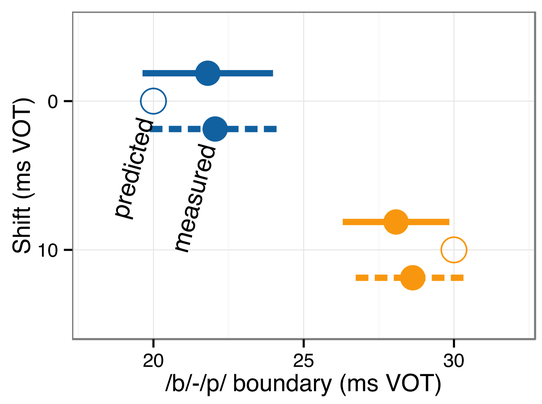


Supervised
Half unlabeled, half labeled

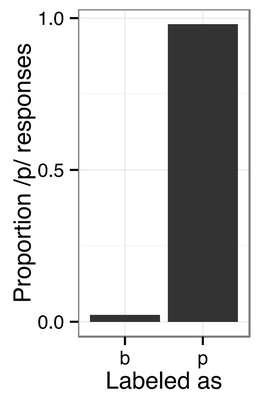


Results

Category boundaries measured from **unlabeled** trials



Accuracy on **labeled** trials: **98%**



Discussion

1) Learning was good: category boundaries match distributions

2) People used labels to **choose responses** (98% accurate)

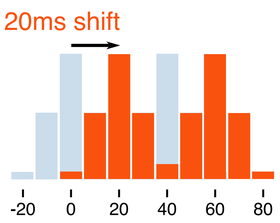
3) But **labels didn't change learning** (no difference between supervised and unsupervised)

4) Was it **too easy**?

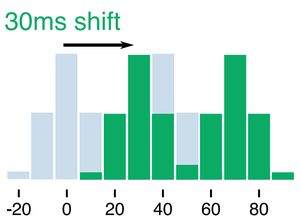
Experiments 2+3

Bigger shifts to make learning harder:

20ms shift



30ms shift



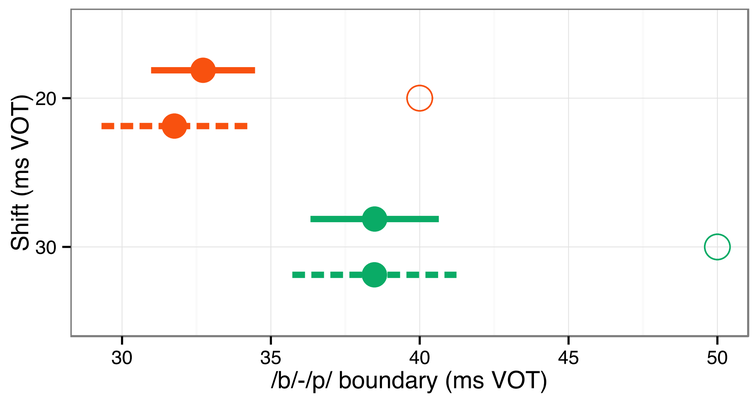
Same as Experiment 1:

Unsupervised
All trials unlabeled

Supervised
Half unlabeled, half labeled

Results

Category boundaries



Discussion

1) Learning was **worse** for large shifts (category boundaries much lower than distributions predict)

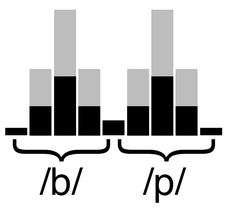
2) Still **no effect of labels** (unsupervised = supervised).

3) Were labeled trials distributed **too sparsely** over VOT?

Experiment 4

Mix labeled trials over whole VOT range

Supervised (mixed)
Half unlabeled, half labeled

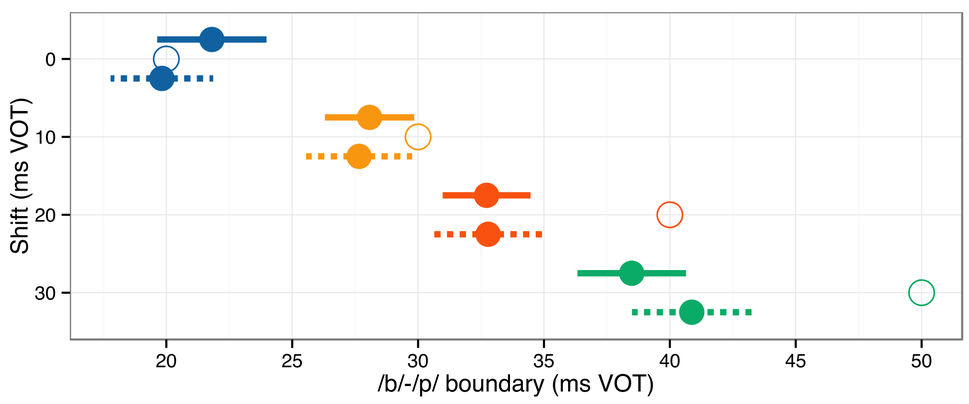


From Experiments 1-3:

Unsupervised
All trials unlabeled

Results

Category boundaries



Discussion

1) Still **no effect of labels** (or only marginal if any)

Conclusions

Surprisingly, **people do not appear to use informative labels for adaptation**, even though they do for classification.

Two possible reasons why:

1) Other studies use **intrinsic labels** (lexical or audio-visual cues).

2) Goldilocks problem: **too easy or hard** for label use to be detectable. Unlabeled trials contain a lot of distributional information, and high-shift conditions are very unnatural