Temporal information facilitates statistical learning of spectrally degraded speech

Katherine M. Simeon[1], Hillary E. Snyder[1], Casey Lew-Williams[2], & Tina M. Grieco-Calub[1]

[1]Northwestern University, Dept. Of Communication Sciences & Disorders
[2]Princeton University, Dept. Of Psychology

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Language Lab

Auditory Statistical Learning

- Adults and infants can track statistical properties of speech units

- Statistical learning is important for speech segmentation

Pretty baby, pretty doggy

Pelucchi et al., 2009; Saffran, 2003; Singh et al., 2012

Segmenting degraded speech

- Underlying assumption in statistical learning: Ability to discriminate individual speech units

- Discriminating speech units can be disrupted by spectral degradation

- Hearing devices, such as cochlear implants, spectrally degrade speech

- The present study lends insight into how speech segmentation works when processing degraded signals

The Present Study

- **Our question: How can spectral degradation affect statistical learning?**

- Experiment 1 (Exp 1): Segmenting speech with spectral degradation

- Experiment 2 (Exp 2): Segmenting spectrally degraded speech with a proportion of overt boundaries

Noise-band vocoding

Unprocessed   16-Channel   8-Channel
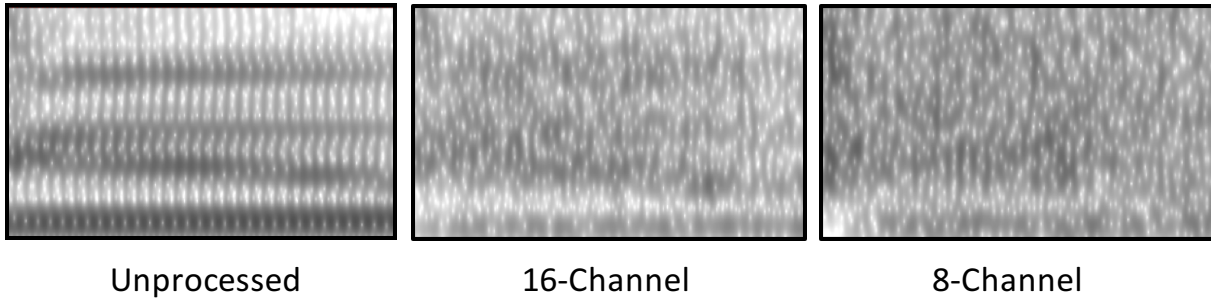
Shannon et al., 1995

The Stimulus

tibudogolatupabikugolatudaropitibudo

	Transitional Probability	Trisyllabic Sequences
High TP	TP = 1.0	pabiku, tibudo
Low TP	TP = 0.5	golatu, daropi
Novel (did not occur in speech stream)	TP = 0.0	robaku, dolati

# Exp 1: Segmenting Vocoded Speech

Methods:

- NH Adult Participants (N=48; 16 per listening condition)

- Exposure period where participant listened to speech stream

- 2-Alternative Forced Choice Task
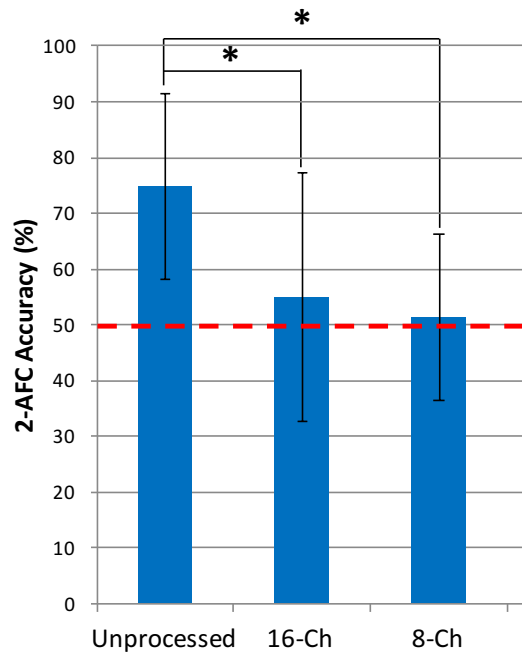
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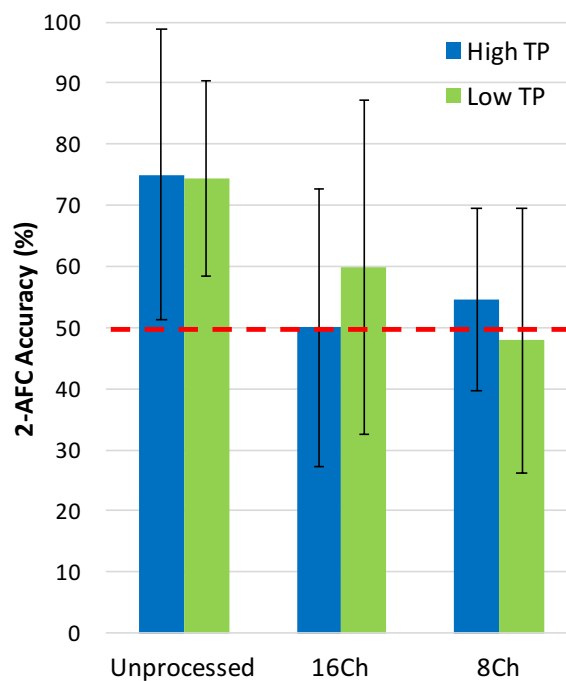
Disrupting Statistical Learning

- This suggests that spectral resolution is necessary for statistical learning

- Why does spectral degradation disrupt statistical learning?
  - ***Inability to discriminate individual speech sounds***
  - Inability to track statistics

> ***Syllable Recognition Task***
>
> - Same participants as in Experiment 1
>
> - Presented with a monosyllabic sound in the same listening condition heard in Experiment 1
>
> - Identified sound on push button array

Task performance differences
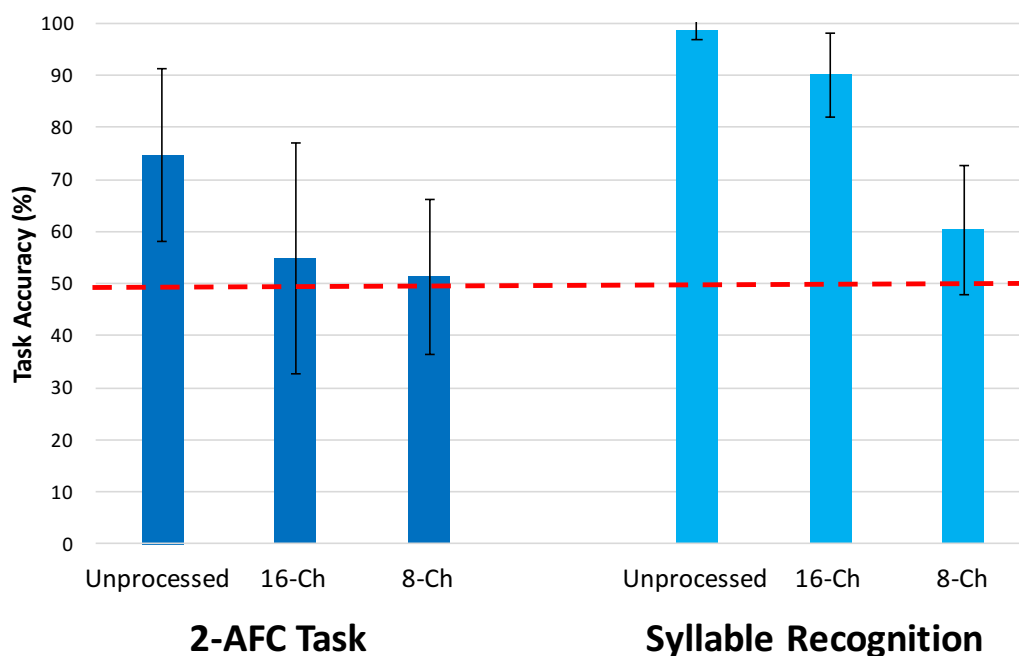
Why Pause?

golatupabikugolatudaropitibudodaropipabikugolatutibudodar
opigolatu **pabiku** golatudaropigolatupabikugolatuda
ropigolatudaropigolatutibudodaropigolatutibudogolatudaropi
golatudaropigolatutibudodaropi **tibudo** daropipabiku
daropigolatupabikudaropigolatupabikudaropitibudodaropigo

- Isolating specific sequences provide a temporal hint that is preserved in vocoding

- Insert pauses by flanking 20% of high TP sequences with 500 ms intervals of silence
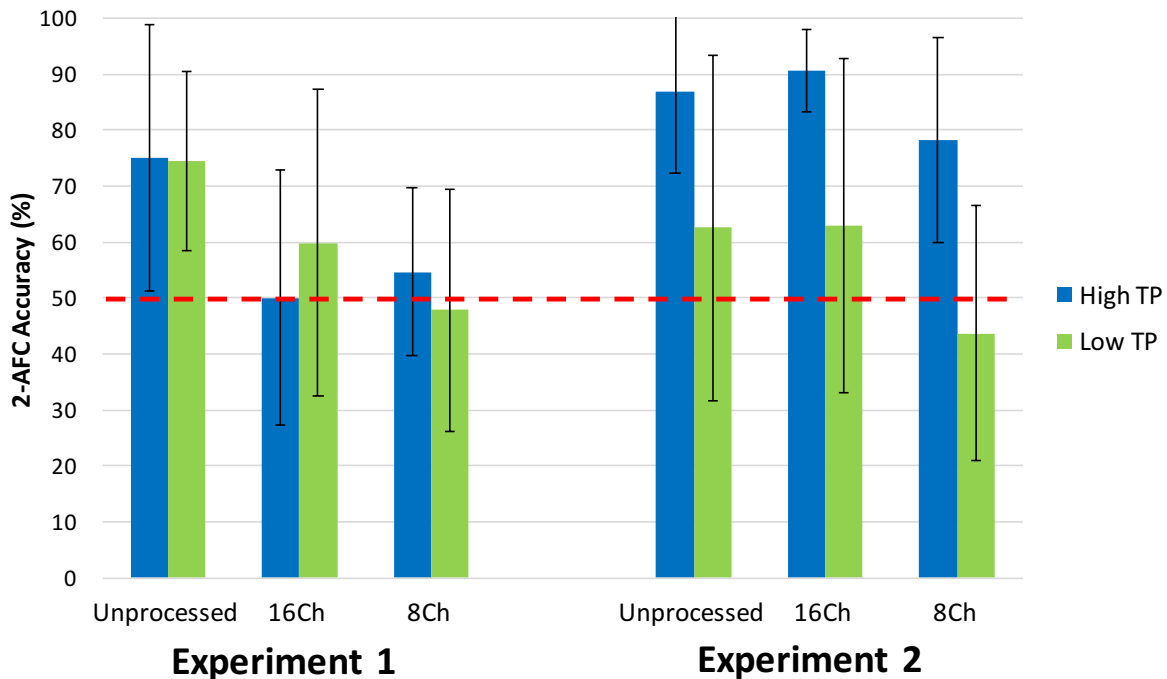 - 6.6% of all trisyllabic sequences in the stream were "isolated"

Lew-Williams et al., 2011

Exp 2: Isolated Sequences
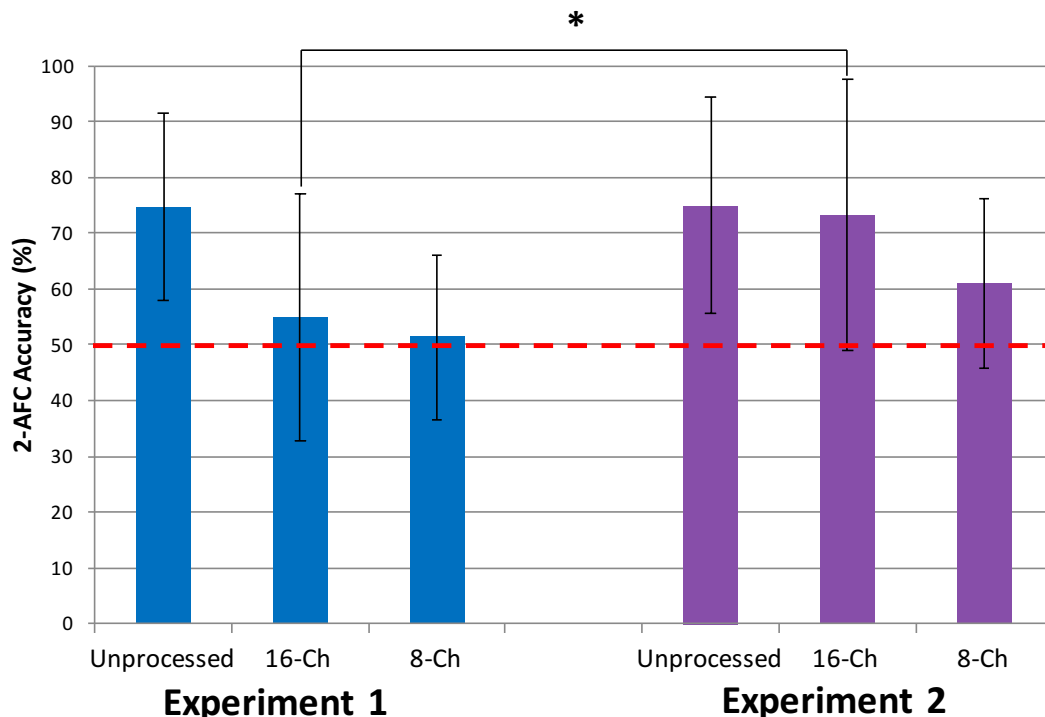
Exp 2: Isolated Sequences

Summary

- Spectral degradation disrupts statistical learning
  - Degradation interferes with ability to track statistics

- Other information, such as overt word boundaries, in the signal can facilitate the speech segmentation task
  - We can see this effect with a small amount of pauses
  - Varies based on amount of spectral degradation
  - Does not generalize to sequences that were not isolated

Acknowledgments

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