Lexical Bias in Phoneme Identification: Effects of Signal Quality and Cognitive Load

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Background

- **Lexical bias in phoneme identification:**
  - Ambiguous speech sound between /b/ and /g/, listeners are more likely to perceive it as /b/ when followed by "_ack,"
  - "back" is a real word while "gack" is not
- Reducing **signal quality**, such as hearing through a cochlear implant device, increases lexical bias[1].
- Similarly, **cognitive load** from multitasking may also amplify this effect[2].
- **Goal:** To investigate the interaction between **signal quality** and **cognitive load** in shaping **lexical bias**.

Method

Auditory Stimuli[1] (Fig. 1)

- Two /b/-/g/ continua (7 steps) varying format transitions of the word-initial stop
  - _ap context (favoring /g/): bap-gap
  - _ack context (favoring /b/): back-gack

Visual Stimuli[3]: Un-nameable images

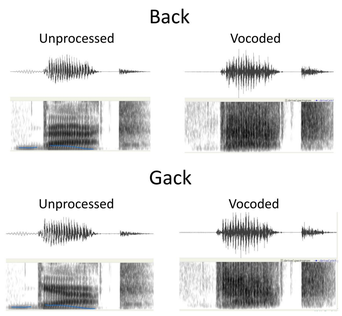


Fig 1. Waveforms & spectrograms of unprocessed and vocoded versions of words Back and Gack.

Experimental Design

- **Signal quality (Fig. 1)**: Unprocessed or Vocoded
- **Cognitive load (Fig. 2)**: Low or High
- **Dual-task**
  - Auditory: Word recognition task
  - Visual: Image memory task

18 younger adults (18-22 y/o) native English speakers with normal hearing

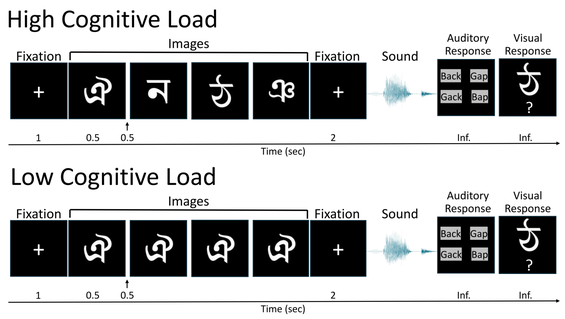
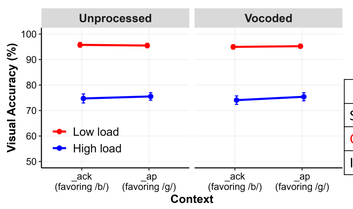


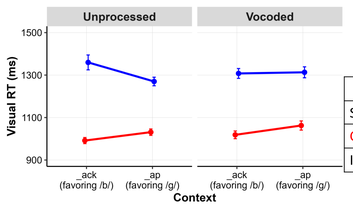
Fig 2. Trial design for high and low cognitive load conditions.

Results

Visual: Lower accuracy and slower response time under high cognitive load



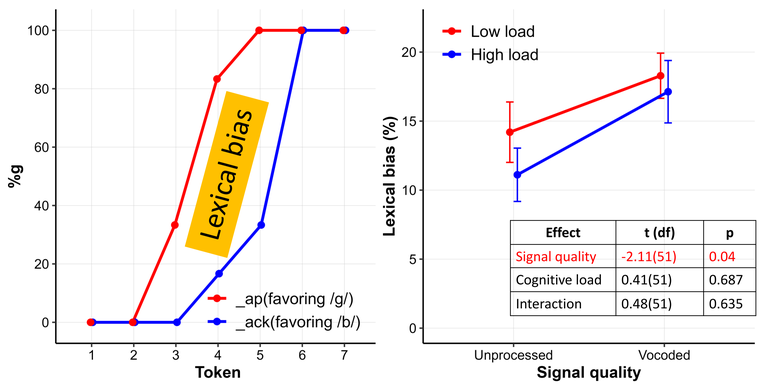
Effect	t (df)	p
Signal quality	0.32(987)	0.748
Cognitive load	16.51(987)	<0.001
Interaction	0.08(987)	0.940



Effect	t (df)	p
Signal quality	0.20(987)	0.839
Cognitive load	-12.61(987)	<0.001
Interaction	-1.11(987)	0.269

Fig 3. Visual results across signal quality and cognitive load. Error bars = SE.

Auditory: Lexical bias increased with reduced signal quality but not cognitive load



Effect	t (df)	p
Signal quality	-2.11(51)	0.04
Cognitive load	0.41(51)	0.687
Interaction	0.48(51)	0.635

Fig 4. Left: Lexical bias was calculated as the area difference between _ap and _ack contexts. Right: Lexical bias across signal quality and cognitive load. Error bars = SE.

Discussion

- Consistent with previous studies[1], lexical bias in phoneme identification increased with lower signal quality (left panel of Fig. 4).
- We did not observe a significant effect of cognitive load on lexical bias.
  - This is inconsistent with previous studies[2].
  - This discrepancy may be due to task differences: Unlike our study, previous studies presented visual and auditory stimuli simultaneously.
- **Signal quality** may be more prominent in driving the lexical bias effect than **cognitive load**.

References

1. Gianakas, S. P., & Winn, M. B. (2019). Lexical bias in word recognition by cochlear implant listeners. The Journal of the Acoustical Society of America, 146(5), 3373-3383.
2. Mattys, S. L., & Wiget, L. (2011). Effects of cognitive load on speech recognition. *Journal of memory and Language*, *65*(2), 145-160.
3. Gennari, S. P., Millman, R. E., Hymers, M., & Mattys, S. L. (2018). Anterior paracingulate and cingulate cortex mediates the effects of cognitive load on speech sound discrimination. NeuroImage, 178, 735-743.