

# EXPLORING THE EFFECT OF BABBLE BACKGROUND NOISE ON LEARNING PATTERNS IN AN ARTIFICIAL ACCENT OF ENGLISH IN MONOLINGUAL AND BILINGUAL YOUNG ADULTS



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## Introduction

- Speech perception and learning often occur in noisy, real-world environments, rather than quiet laboratory settings. (Mattys et al., 2012).
- Background noise degrades the acoustic signal and increases perceptual uncertainty, placing greater demands on attention, working memory, and linguistic processing (Mattys et al., 2012; Alqattan & Turner, 2021).
- Bilingual experience has been associated with advantages in some language learning tasks, particularly in learning novel speech sounds (Antoniou et al., 2015).
- Studies using an artificial accent paradigm suggest a bilingual advantage in learning and reproducing novel phonetic and phonological features under quiet conditions (Spinu et al., 2020, 2023).
- However, this advantage is inconsistent and may depend on task demands and linguistic conditions (Bialystok, 2018; DeLuca et al., 2019).
- Importantly, bilingual listeners often experience more difficulty in speech perception in noise (e.g., Alqattan & Turner, 2021; DiToro et al., 2017).
- It remains unclear whether bilingual advantages in learning and reproducing novel accent speech persist under noisy conditions.

### Research Questions:

- How does babble background noise affect accent learning in monolingual and bilingual listeners?
- How do feature type and number of features per sentence influence accent learning in monolingual and bilingual listeners?
- To what extent does working memory (digit span) predict accent learning in monolingual and bilingual listeners?

## Experiment

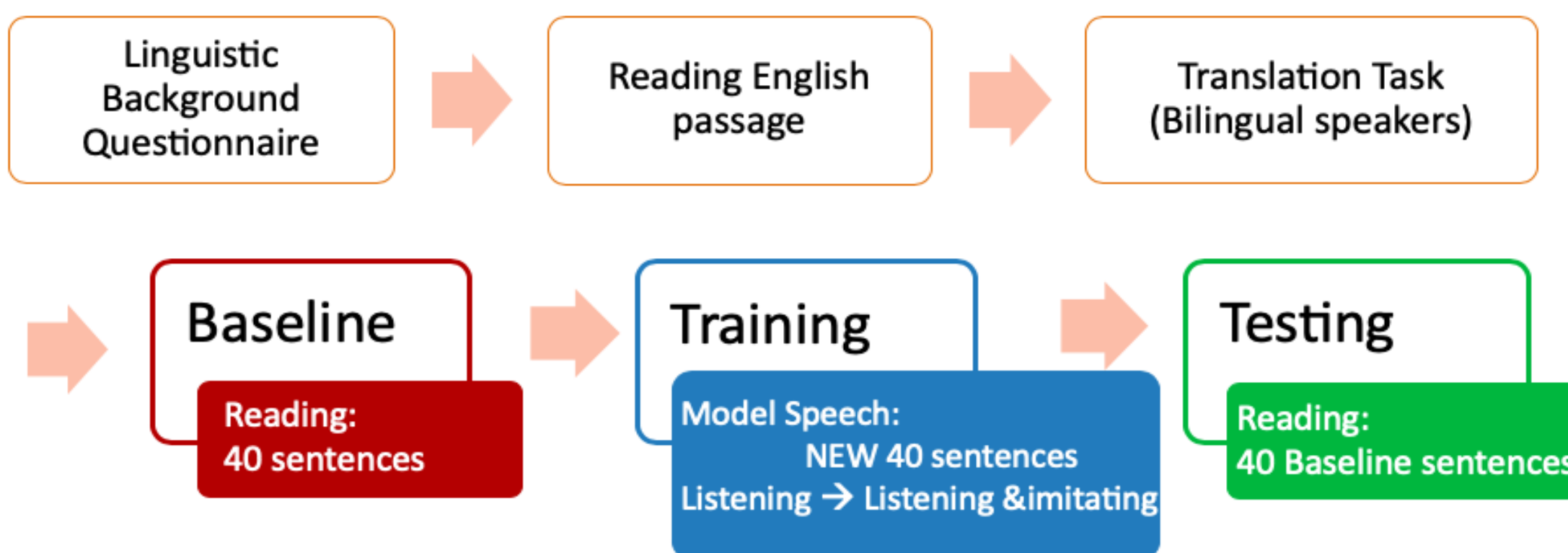


Figure 1. Order of experimental tasks.

## Participants

Undergraduate and Graduate students from CUNY Graduate Center and Brooklyn College with normal hearing.  
 13 monolingual English speakers  
 13 early bilingual speakers

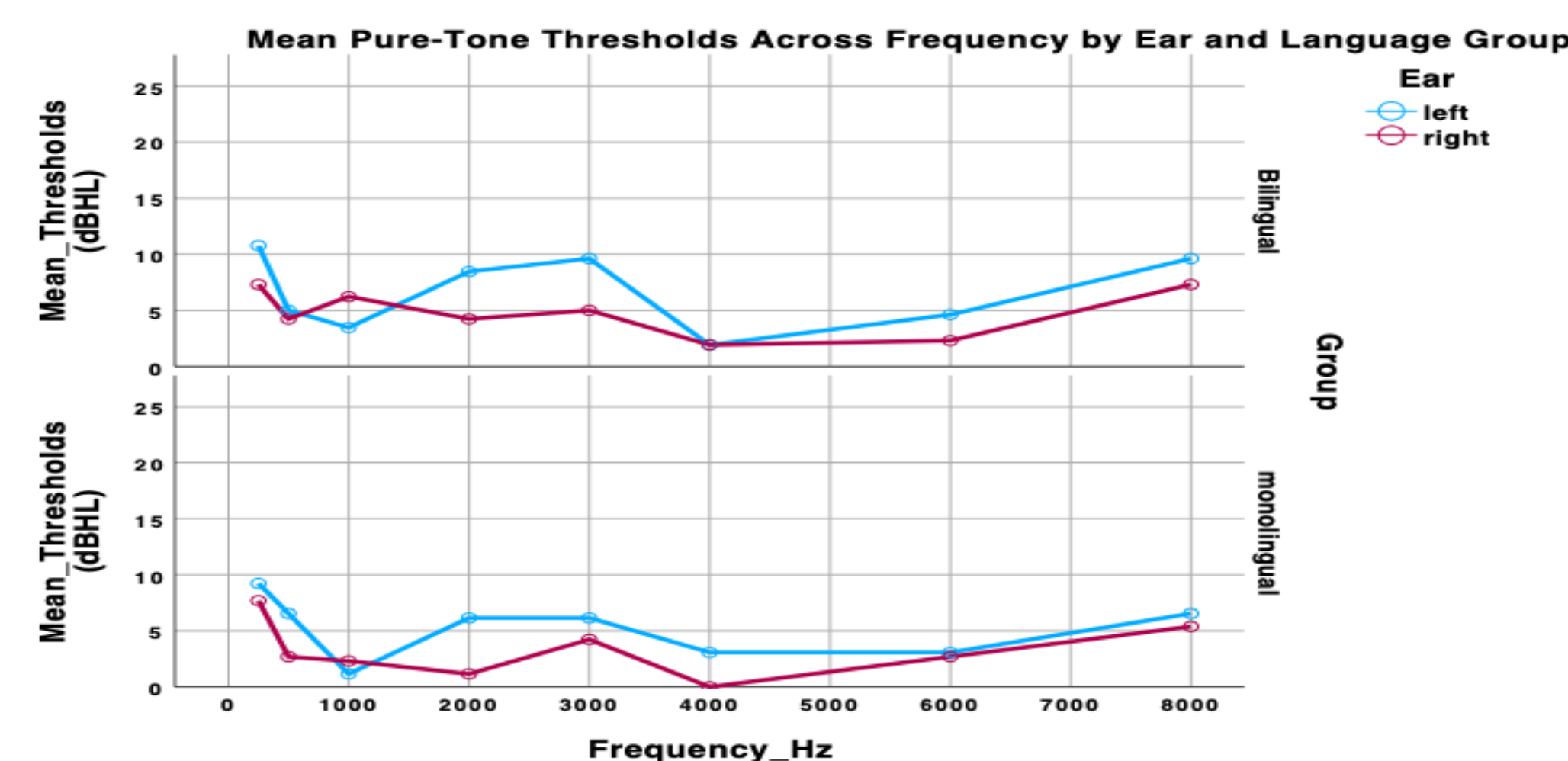


Figure 2. Mean air-conduction pure-tone thresholds (dB HL) across frequency (250–8000 Hz) for the left (blue) and right (red) ears of monolingual (bottom) and bilingual (top) participants.

## Experimental Tasks

### 1. Language background questionnaire

Participants completed a language background questionnaire (LEAP-Q).

### 2. Digit Span Task

Adaptive digit span task (2–9 digits)  
 Participants recalled sequences after a "recall" cue  
 Task ended when <3/5 trials were correct.  
 Measure of working memory capacity.

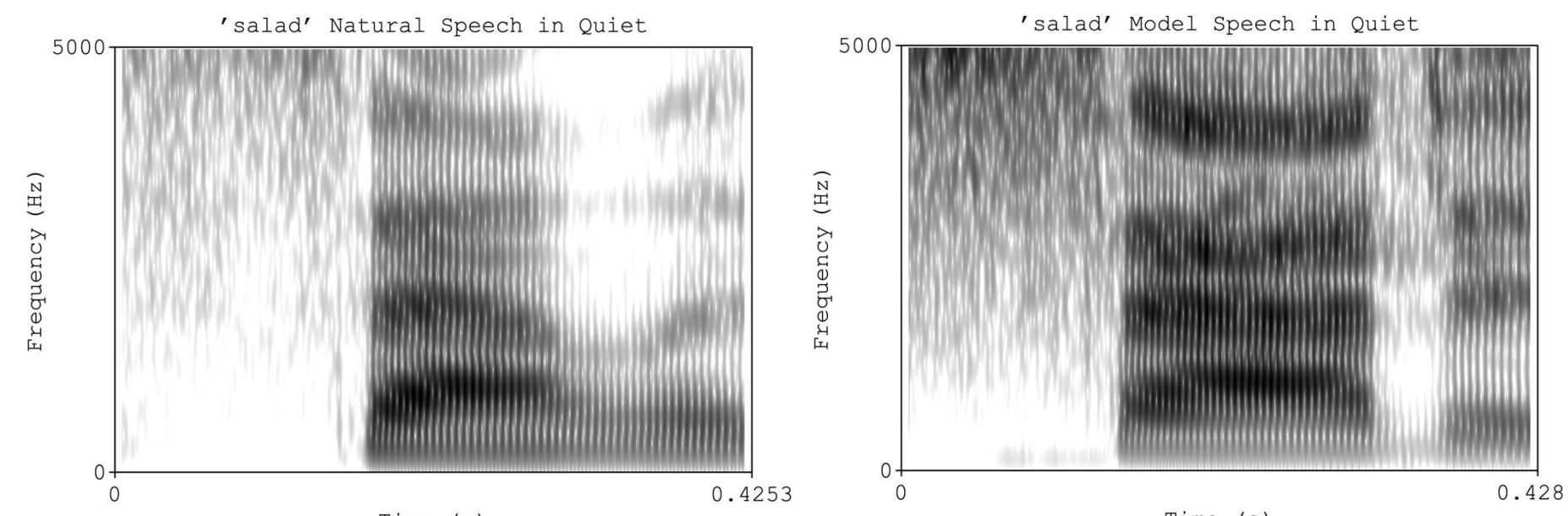
### 3. Artificial Accent Learning Task (Speech-in-Noise)

- Target stimuli sentences were short, grammatically correct, meaningful English sentences with low context support, designed to minimize reliance on top-down cues. Sentences systematically varied in complexity by containing 1, 2, or 4 accent features and were presented at 65dB HL SPL in a 12-talker babble noise.

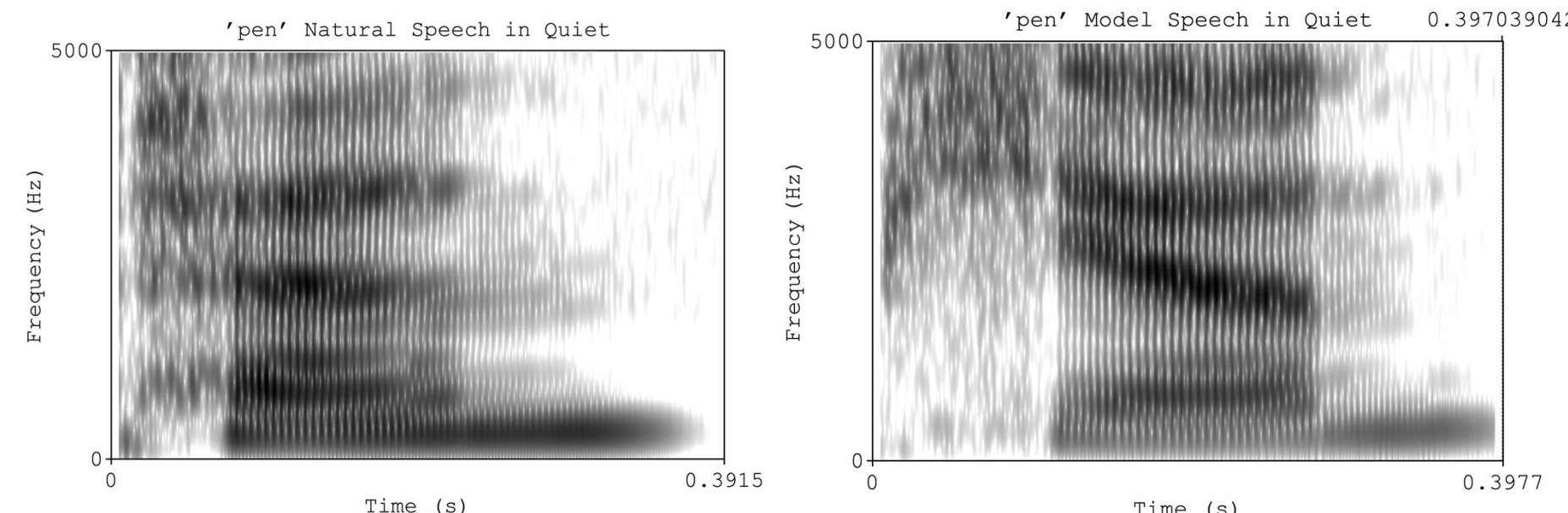
- Based on Spinu et al., (2020; 2023)

**Artificial Accent Features:** The novel accent differed from standard North American English in four ways:

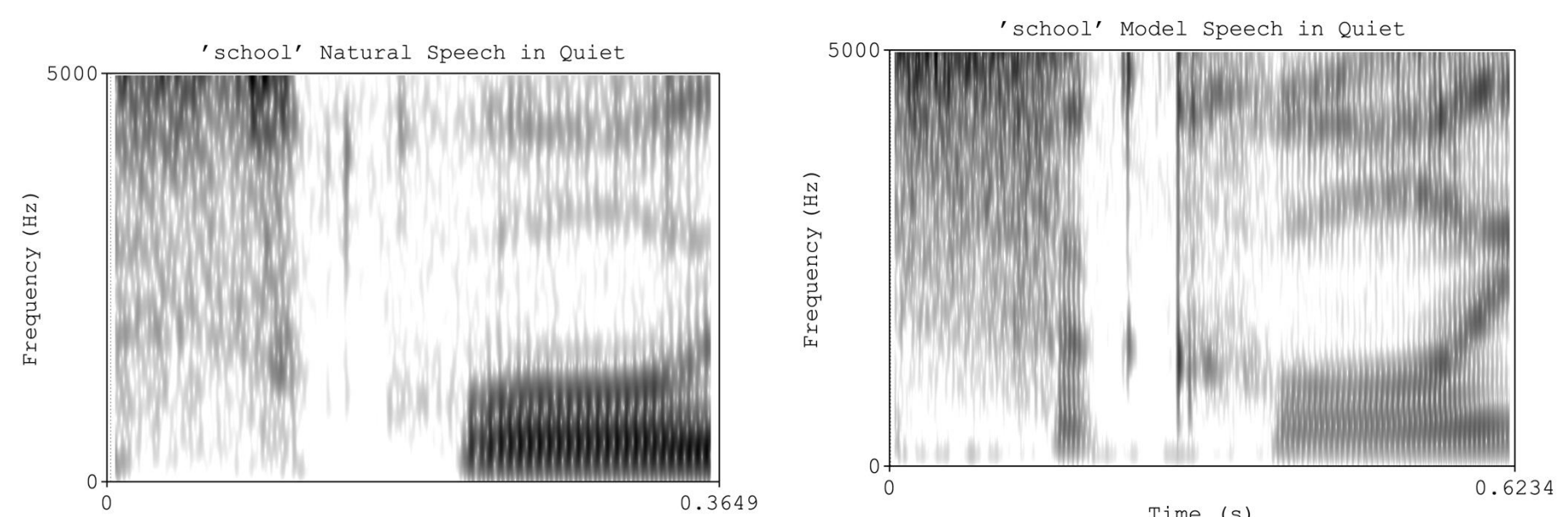
- Tapping:** /l/ → [r] (e.g., "salad" → [sarad])



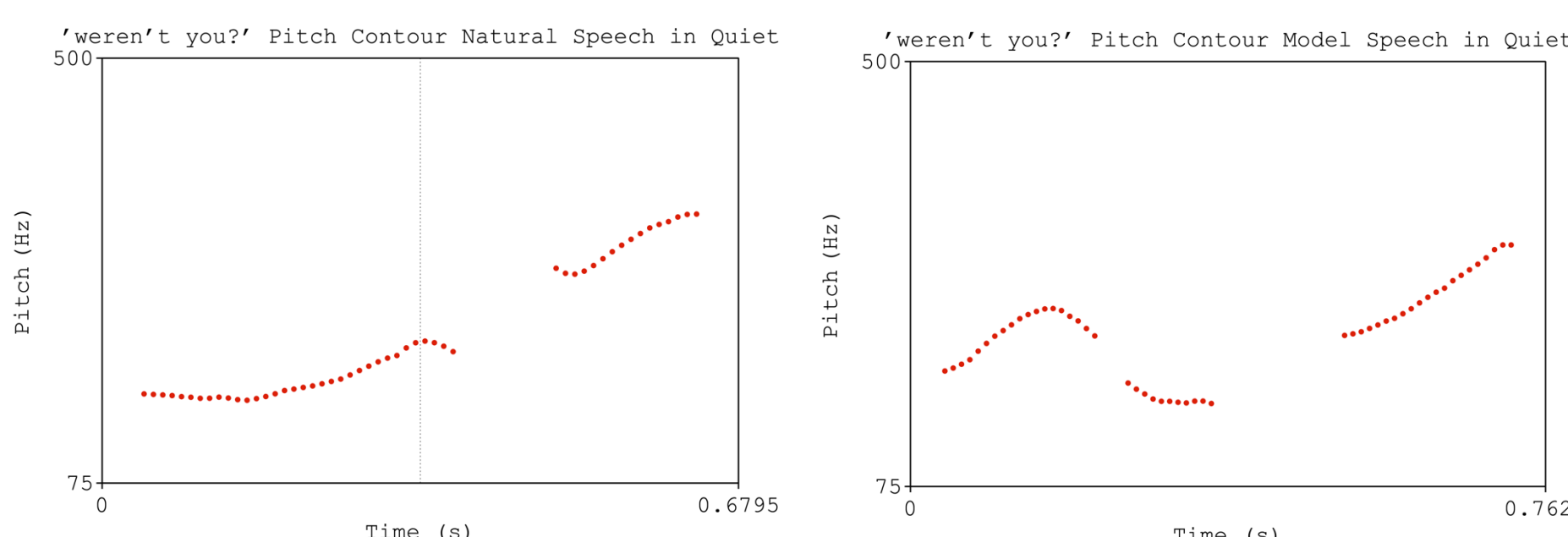
- Diphthongization:** /ɛl/ → [jɛ] (e.g., "pen" → [pjɛn])



- Epenthesis:** insertion of [ə] in /sC/ clusters (e.g., "school" → [səkhu:l])

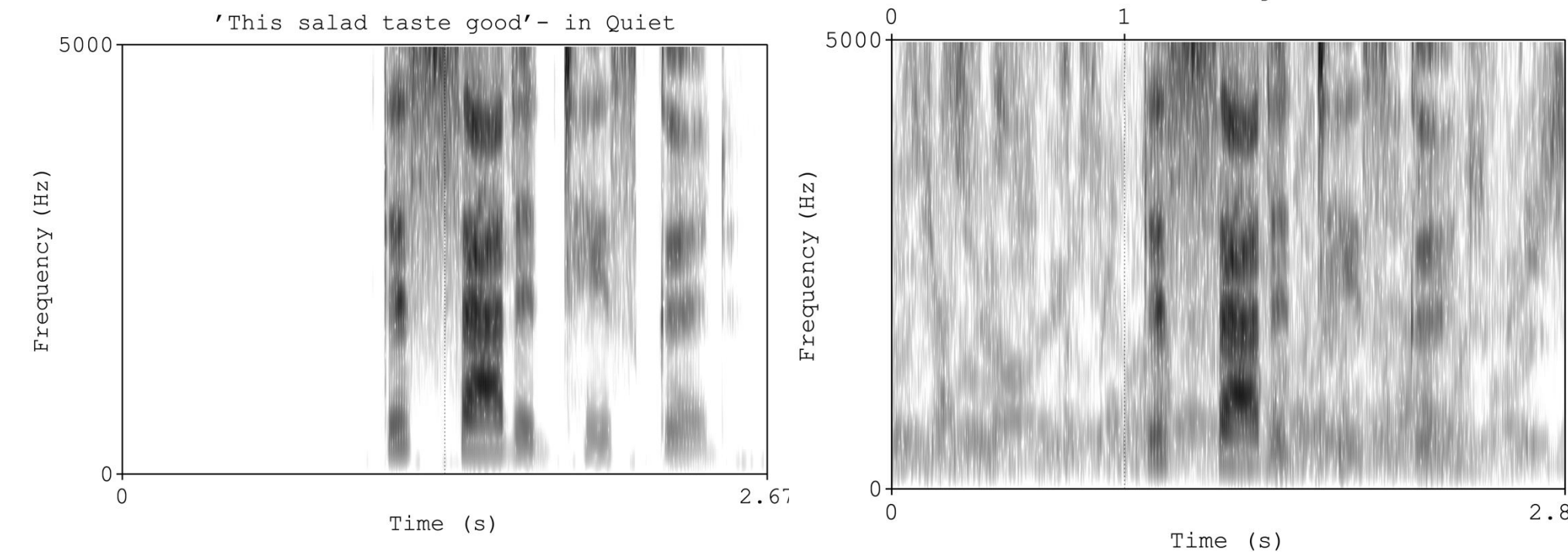


- Intonation:** Tag questions produced with a Mid–Low–High (MLH) contour



### Babble Background Noise Condition

- 12-talker babble; (LibriSpeech corpus)
- 6 male and 6 female speakers
- Signal-to-noise ratio +10 dB
- 1-second noise lead-in before each sentence.



### Task Procedure

- Baseline:** Participants read sentences in their natural English accent
- Training:**
  - Passive listening (no text)
  - Immediate imitation (with text)
- Testing:** Participants reproduced the accent from memory (no model).

## Results

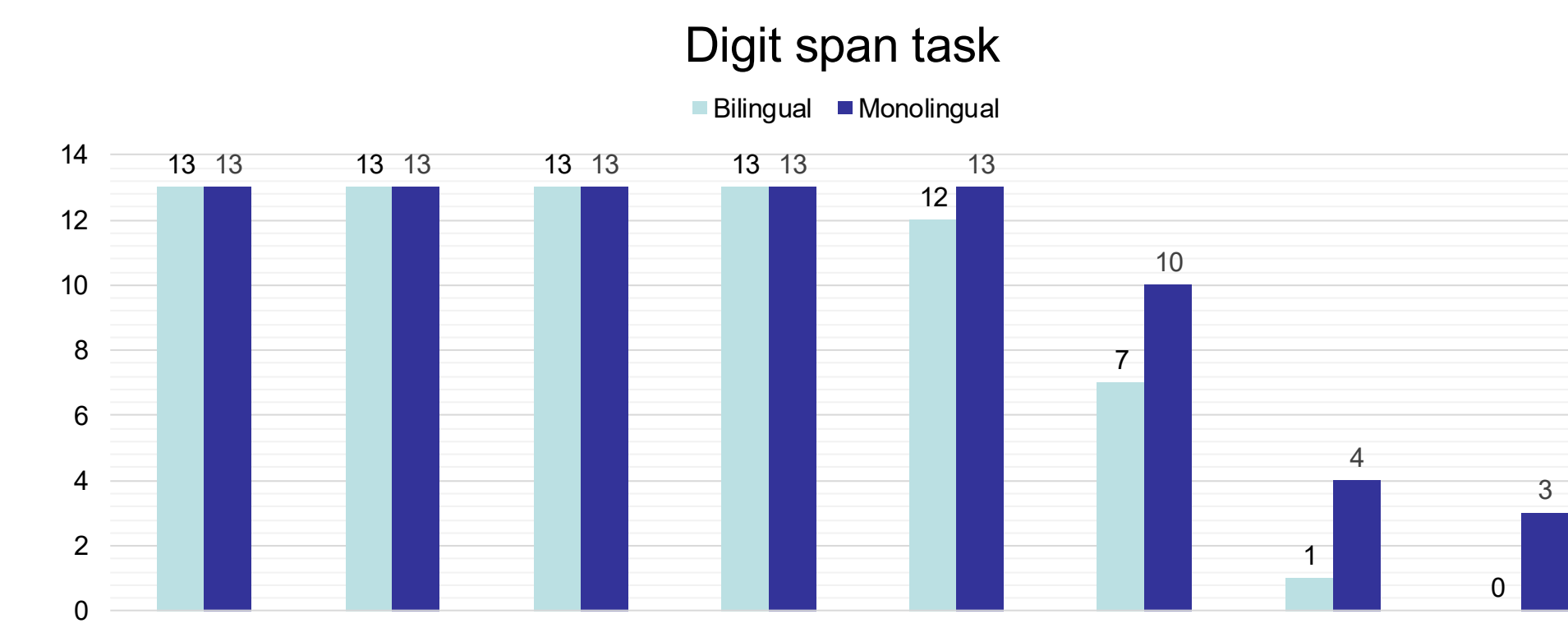


Figure 3. Number of monolingual and bilingual participants who successfully reached each list length on the digit span task.

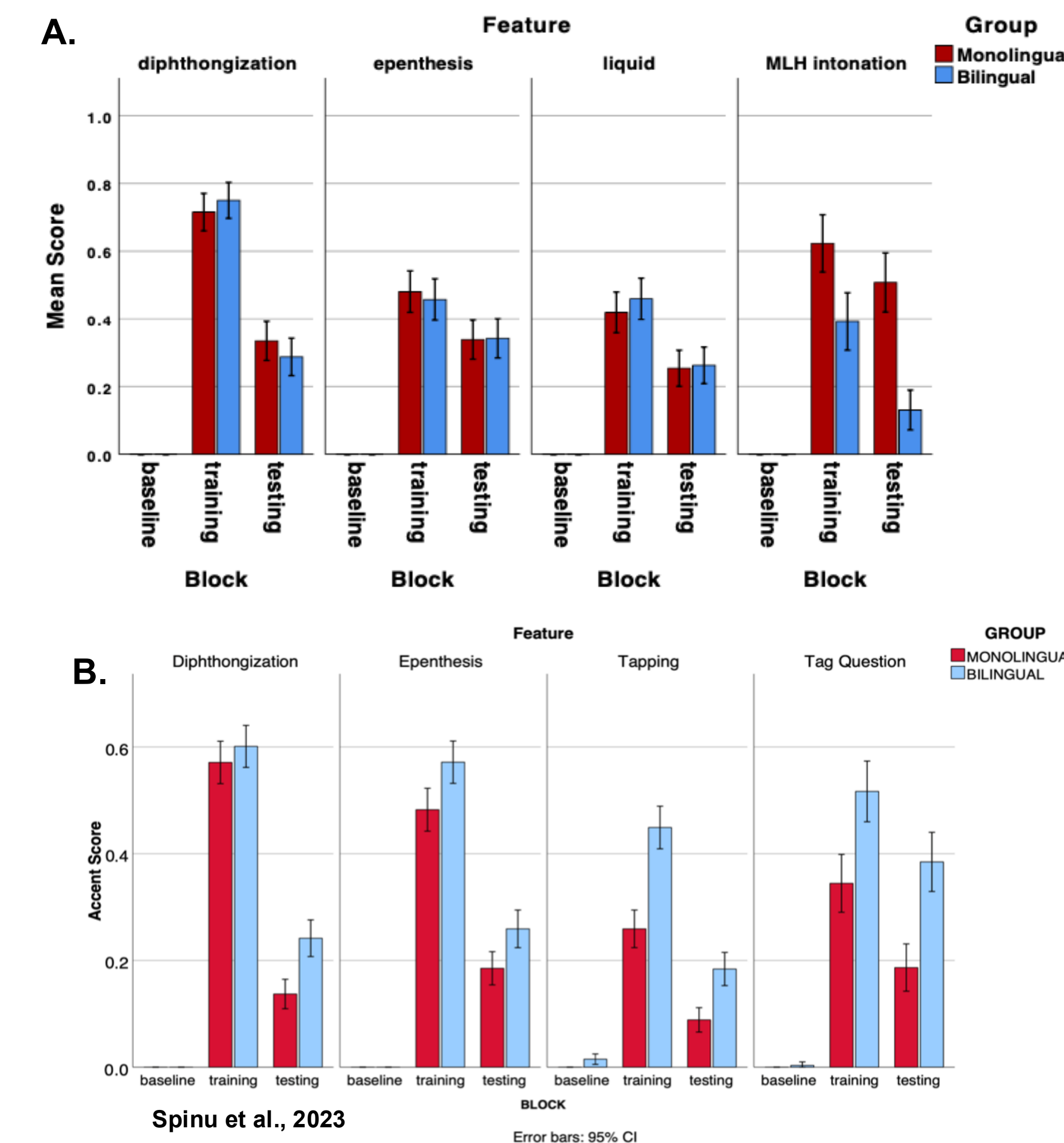


Figure 4. Mean accent score for each novel feature across Baseline, Training, and Testing phases. Table A: Shows results from the current study; Table B: Shows results from Spinu et al., (2023). Error bars represents 95% confidence intervals.

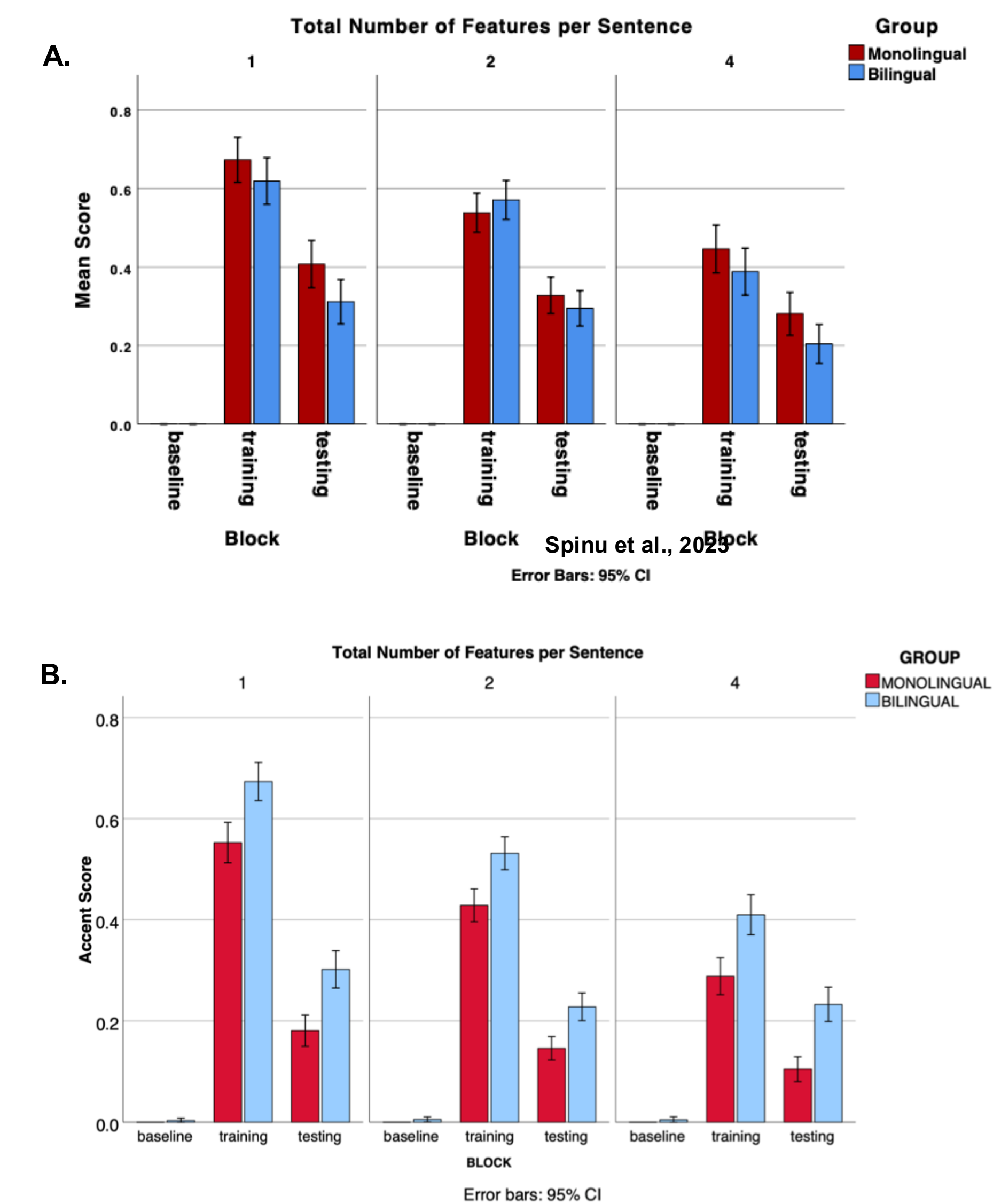


Figure 5. Mean accent scores for monolingual and bilingual participants across Baseline, Training, and Testing blocks, separated by the total number of accent features per sentence (1, 2, or 4). Error bars represent 95% confidence intervals. A. Current study; B. Spinu et al., 2023

## Summary

Statistical analyses were conducted using ANOVAs.

### Digit Span Task:

- Accuracy decreased with sequence length.
- Monolingual participants preformed slightly better than bilingual.
- Both groups demonstrated similar decline patterns.

### Accent Learning Task:

- Both groups showed learning across phases.
- Learning success was inversely proportional to the number of feature in a sentence.
- No bilingual advantage found under babble noise.
- Monolingual participants learned intonation better than Bilingual participants,  $F(1,5028) = 56.61, p < .001$ .

## Discussion

- Digit span results showed no meaningful bilingual advantage, and similar patterns across groups suggest that working memory did not drive accent learning differences.
- No bilingual advantage was observed in noise**, unlike previous findings in quiet conditions (Spinu et al., 2020, 2023).
- Background noise likely reduced the precision of acoustic encoding.
- Accent learning appears to rely on early perceptual processing.
- The bilingual advantage may depend on listening conditions, emerging in quiet but reduced under noise.
- A monolingual advantage was observed for intonation learning**, possibly due to a more stable prosodic system.
- These findings support a cascading effect, where degraded input at early stages impacts later learning and production.

Scan for references

