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Effects of speech competitors on encoding features of novel word-object pairs

Katherine M. Simeon¹ & Tina M. Grieco-Calub^{1,2}

¹The Roxelyn & Richard Pepper Department of Communication Sciences & Disorders, Northwestern University, Evanston, IL

²Hugh Knowles Hearing Center, Northwestern University, Evanston, IL



Background

Fast-mapping is the ability to map novel word-object pairs with very few exposures (Carey & Bartlett, 1978), and is thought to underlie language acquisition. However, language learning often happens in natural environments that contain competing sounds. Previous studies examining whether competing sounds affect fast-mapping yielded inconsistent results, likely due to methodological differences. In the present study, children were trained on novel word-object pairs, whereby the object was verbally labeled and associated with related attributes while moving across a computer screen (e.g., “This *modi* can bounce”). Children were then tested on their recognition and production of each novel label. **The present study investigates different methods for quantifying fast-mapping of novel word-object pairs in quiet and noise.**

Methods

Participants: Thirty-six children (N=18 females, age range 36.2–59.7 mos., mean 43.1 mos.) were recruited to participate in Study 1 (Open Recall). An additional six children participated in Study 2 (Tiered Recall; N=3 females, range 44.9–52.5 mos., mean 47.01 mos.). All participants were monolingual English speakers with no prior history of speech and language services. Three participants were excluded due to fussiness (N=2) and bilingual status (N=1). All procedures were approved by the Institutional Review Board at Northwestern University.

Stimuli

Target stimuli: Six novel disyllabic pseudo words were used for the novel labels (Horst & Hout, 2015) Target stimuli were scaled to yield an overall intensity level of 60 dB SPL.

Two-talker babble: Pre-recorded sentences from the Harvard IEEE corpus (Rothausen et al., 1969) spoken by an adult male and digitally overlaid. Sentences were scaled to yield an overall intensity level of 58 dB SPL.

Visual stimuli: Six novel objects for which there is no formal label, were selected to pair with the novel words. Two groups of three objects were generated and combined with the two word groups to create four different word-object pairings.

A. Novel labels in IPA

1	/paɪzə/	2	/kolat/
	/modi/		/vɜːrɔːks/
	/waso/		/tibu/

B. Novel objects



Procedure

Training: Participants were presented with a 3 by 1 object array on a 21.5" Dell touchscreen monitor and were instructed to choose one object to learn about. The selected object moved around the screen while a female talker described it. Participants were exposed to each word-object pairing twice and heard the label 8 times. Participants completed two training phases, one in quiet and one in the presence of two-talker babble (at a +2 dB SNR).



“Look at the **modi**!”
“This **modi** can bounce!”
This **modi** can jump around!”
“Do you want to play with the **modi**?”

Testing: Following each training phase, participants were either assessed with a forced choice or recall task, followed by whichever task was not administered first. Participants were randomly assigned to one of two test orders.

Forced Choice (Receptive)	Participants must select a given object from a presented object array.	Where is the modi ?
Open Recall (Expressive)	Participants must say the name of the novel object presented.	What is this?
Tiered Recall (Expressive, N=6)	Participants completed the open recall task. If incorrect, they were cued with the target label's initial phoneme. After repeating this procedure for all novel-objects, participants completed a closed set paradigm where they were presented with a 3-dot array. The experimenter pointed to each dot and said a label choice. The participant either produced or pointed to their choice.	Open Recall: What is this? Cue: It starts with a /m/ Closed Set: Is this a... mozer moso modi

Study 1: Children fast-map novel object pairs equally in quiet versus noise

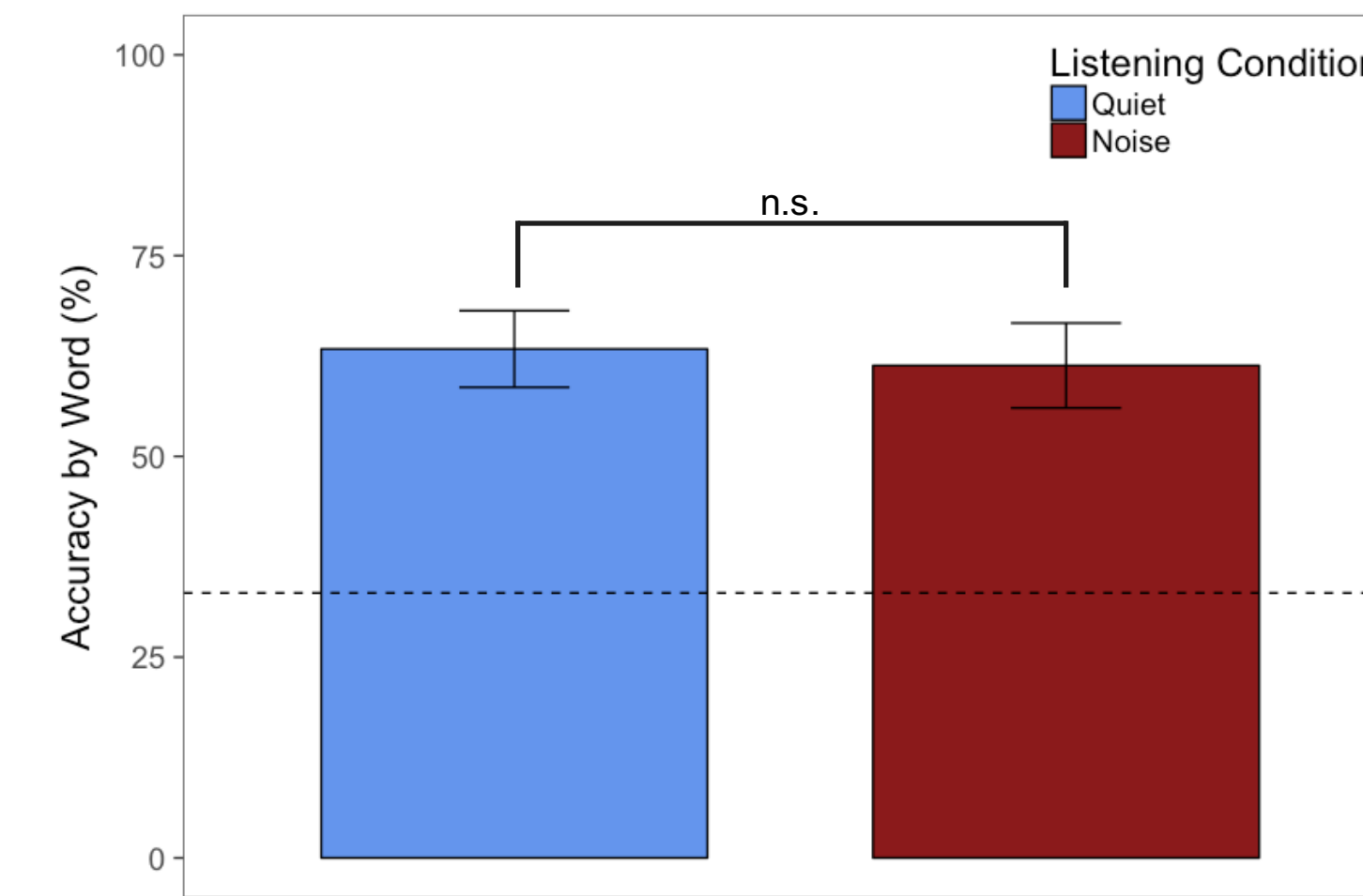


Figure 1. Accuracy (mean ± SE) on forced choice task. Participants accurately identified novel objects when presented with a novel label significantly above chance (black dotted line). However, participants' performance did not significantly differ in quiet (63.4% ± 4.7) versus noise (61.3% ± 5.2), suggesting that participants' ability to select the correct novel object given a novel label is not impacted by speech competitors.

Study 1: Open Recall yields floor performance in the presence of noise and quiet

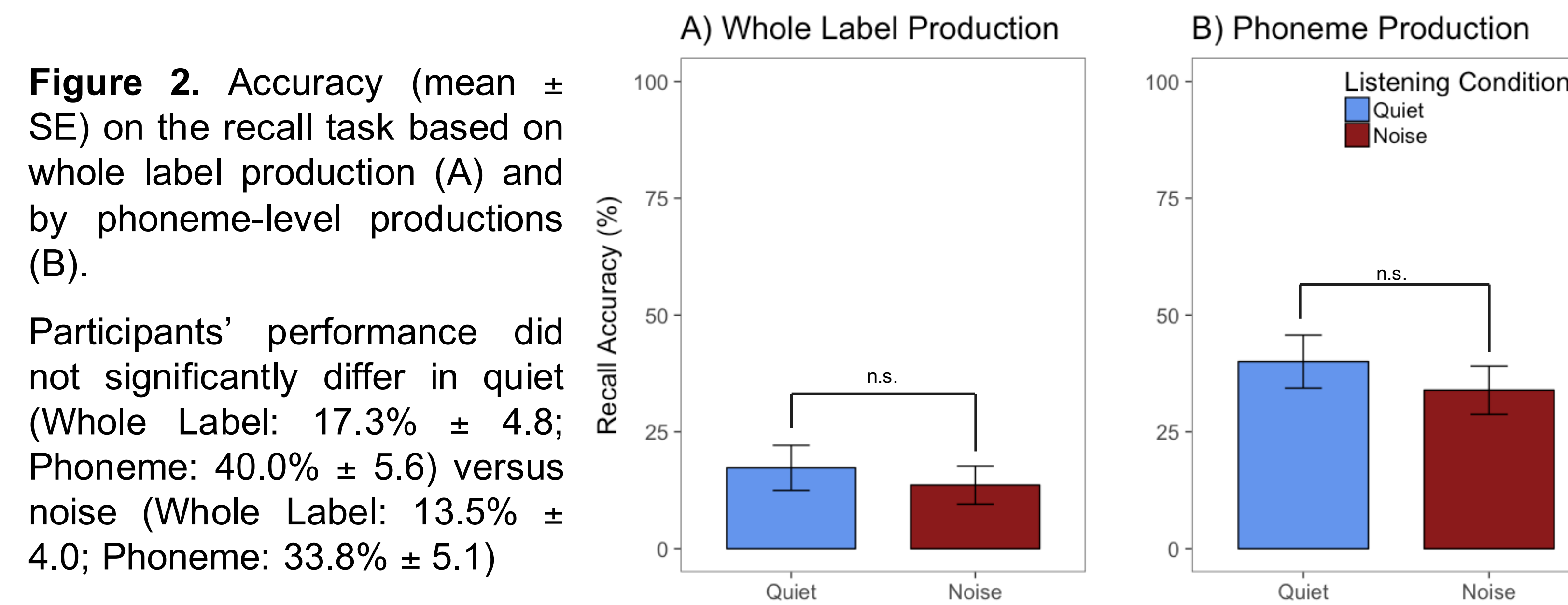


Figure 2. Accuracy (mean ± SE) on the recall task based on whole label production (A) and by phoneme-level productions (B).

Participants' performance did not significantly differ in quiet (Whole Label: 17.3% ± 4.8; Phoneme: 40.0% ± 5.6) versus noise (Whole Label: 13.5% ± 4.0; Phoneme: 33.8% ± 5.1).

The recall task was scored based on whether the participant produced the novel label correctly (whole label) and a separate score was given based on how many phonemes were produced correctly compared to the target novel label (phoneme). Seven participants were excluded from this analysis due to not responding across all recall prompts. Additionally, individual trials in Figure 2B were excluded if whole label productions were not attempted.

Study 2: Ability to recall semantic features may be impeded by speech competitors

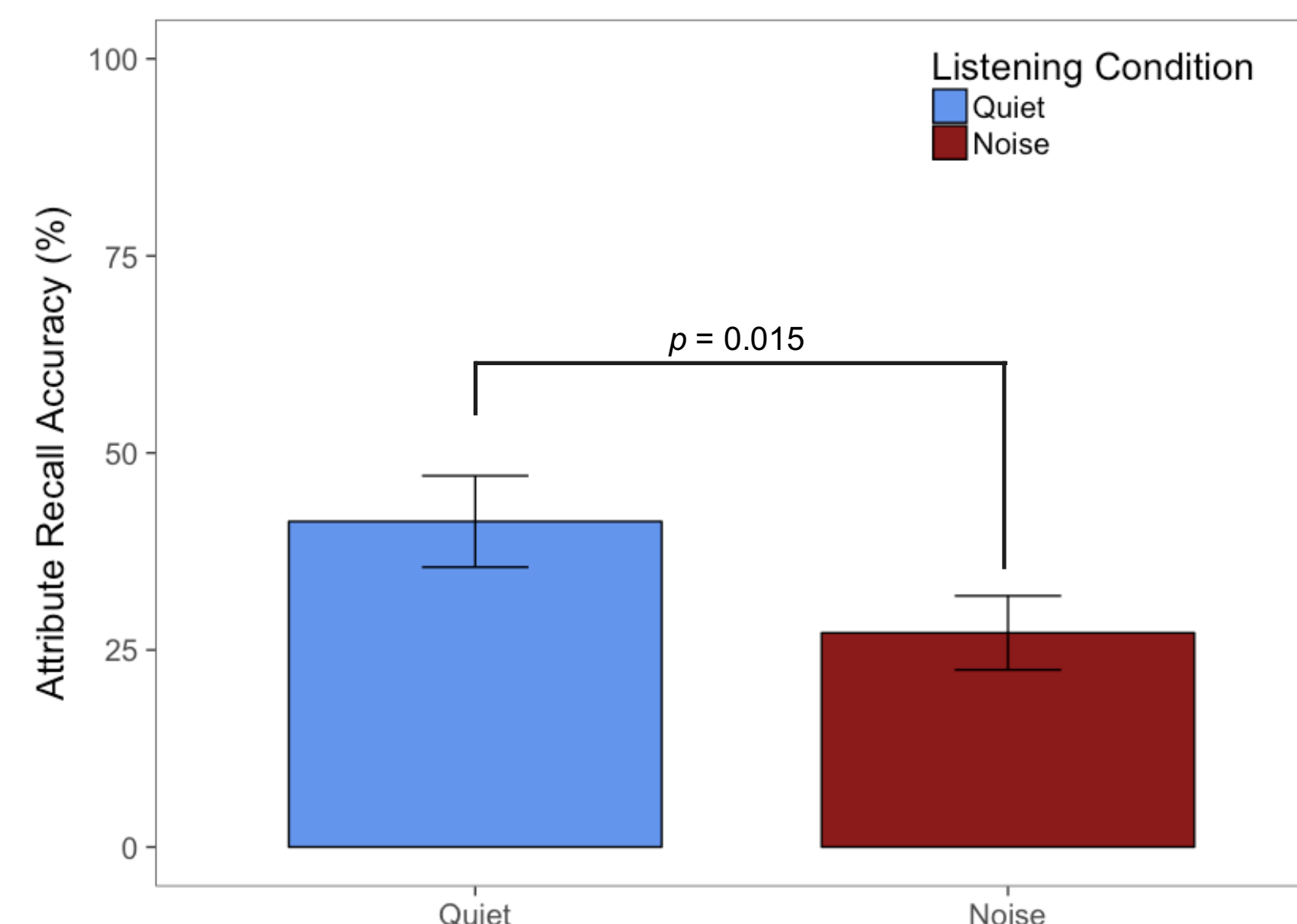


Figure 3. Ability to recall attributes (mean accuracy ± SE) for each novel word-object pairing was scored across the two different test orders. Attributes were verbs from the descriptive sentences about each novel object that were heard during the training phase (e.g., This *modi* can **bounce**). Trials were excluded if the child did not attempt to produce any attributes in both the quiet and noise conditions.

A paired t-test showed that the difference between attributes produced in quiet (41.3 ± 5.7) versus noise (27.1 ± 4.6) was marginally significant $t(22) = -1.97$, $p = 0.015$. This suggests that speech competitors may have the ability to disrupt the encoding of semantic features in novel label-object pairs.

Summary

In Study 1, children identified novel objects upon hearing the spoken word equally well in both quiet and in the presence of a speech competitor. However, Open Recall performance was at floor and may not be indicative of expressive recall skill. Study 2 employs a Tiered Recall task to better quantify expressive recall performance.

Using Tiered Recall to increase response rate

One limitation of the Open Recall task was the high amount of no responses during the task. “No response” in the present study is defined as the participant not attempting to produce an answer or saying “I don’t know” during the task. The Tiered Recall task attempts to improve how we quantify expressive recall (Gordon & McGregor, 2014).

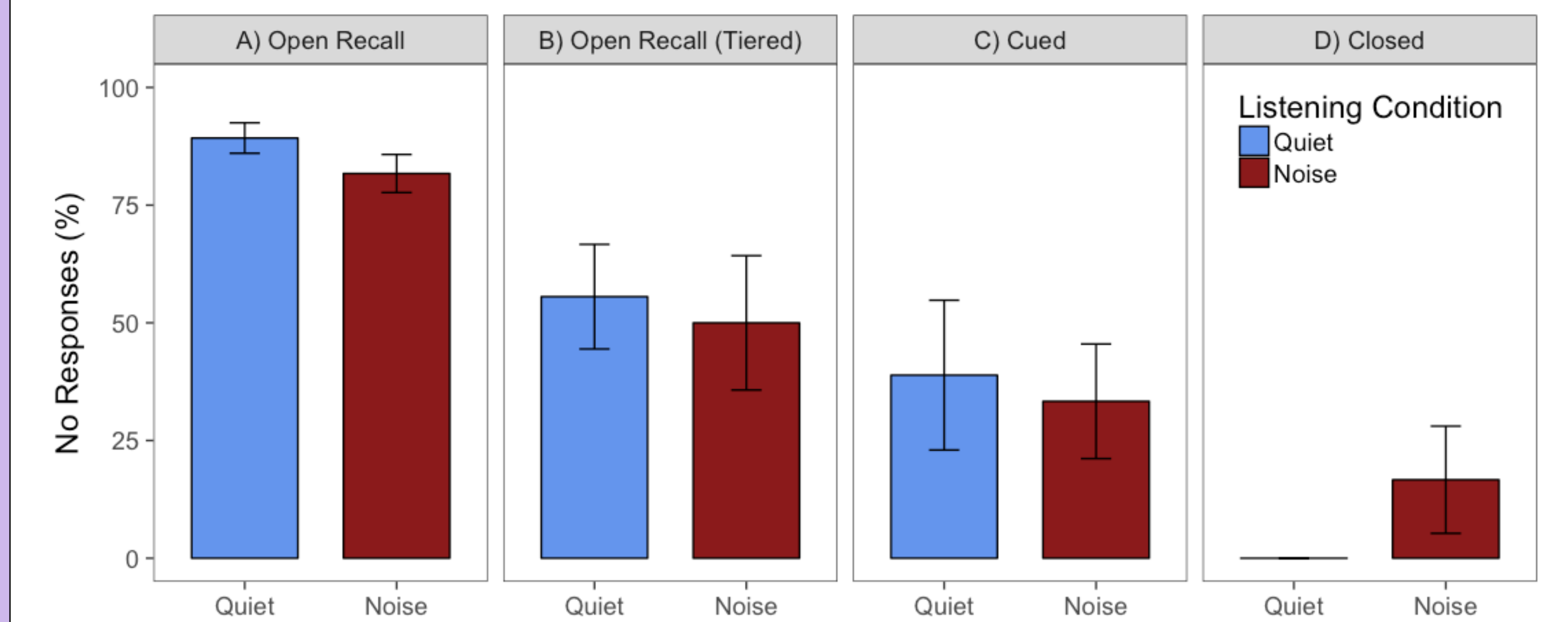


Figure 4. The rate of no responses (% mean ± SE), averaged across participants in Study 1 (Open Recall, Panel A; N = 36) and Study 2 (Tiered Recall; Panels B, C, & D; N=6). Providing scaffolding via the Tiered Recall Task appears to decrease the rate of no responses. Given the small sample size, we are unable to statistically test a difference in behavior between the quiet and noise conditions. Data collection for Study 2 is ongoing.

Study 2: Preliminary results for Tiered Recall

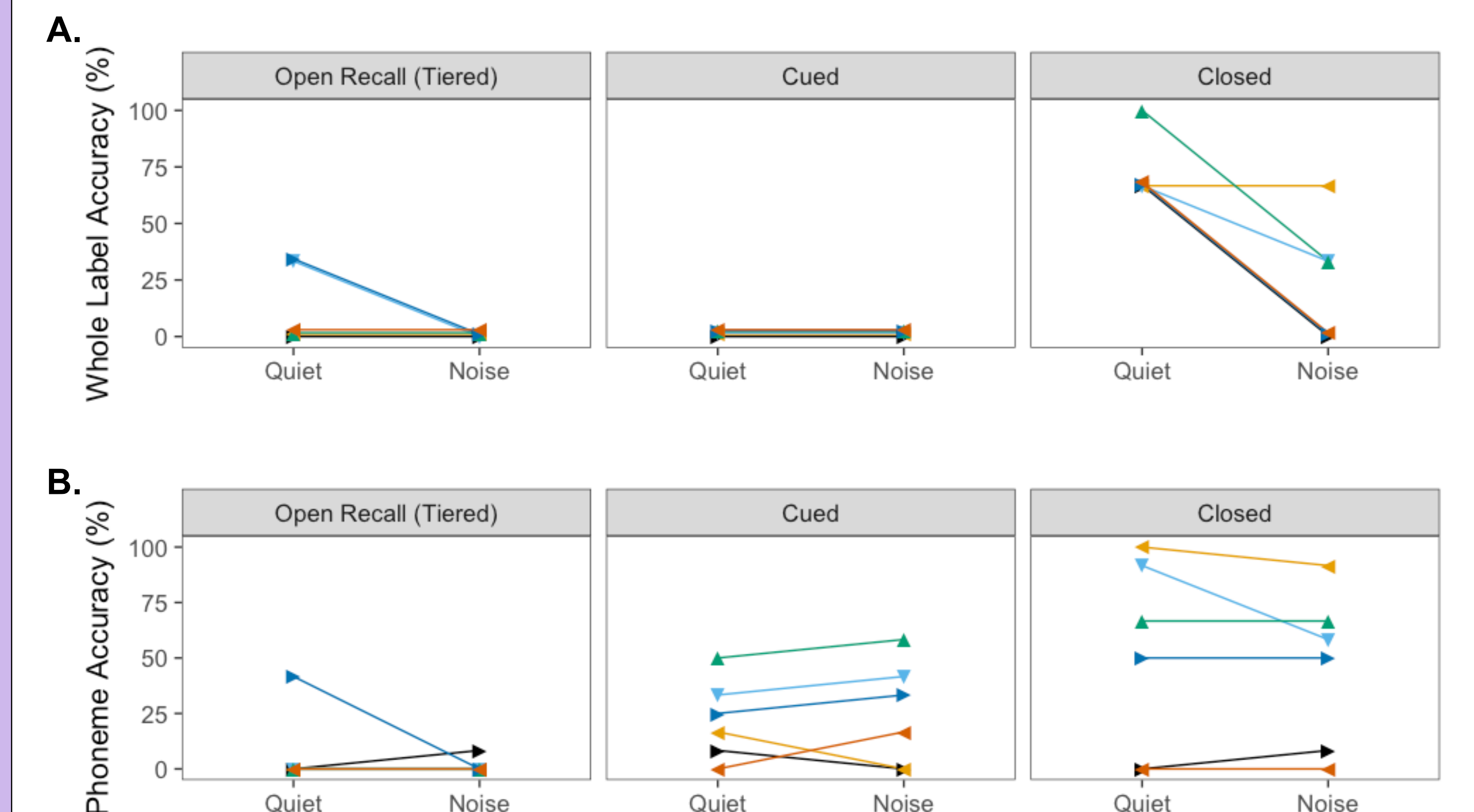


Figure 5. Individual accuracy for each Tiered Recall task (Open Recall, Cued, Closed), scored by Whole Label Production (A) and Phoneme Production (B).

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