

Introduction

Background

- Delayed auditory feedback (DAF) creates a delay between speaking and hearing your own speech. Some individuals remain fluent while others become remarkably disfluent ¹.
- DAF has been shown to elicit profound stuttering-like disfluencies, sound errors and slowing of speech in 30% of typical healthy speakers ².
- These broad individual differences in susceptibility to DAF remains unknown ^{3,4,5}.
- Preliminary work identified that highly susceptible individuals have slower oral reading rates under normal auditory feedback (NAF) ².
- Slower reading rates may indicate variability in reading ability and in susceptibility to altered auditory feedback.

The aim of this project was test whether reading ability is influenced by auditory processing in a large sample of young adults.

Methods

- Healthy adults (N = 41; Ages 18-65) completed reading and speaking tasks under NAF and DAF conditions (see *Figure 1*) in one 60-minute session.
- All participants completed: a hearing screening, the **Test of Word Reading Efficiency-2 (TOWRE-2)**, the non-word repetition subtest of the **Comprehensive Test of Phonological Processing-2 (CTOPP-2)**, the **Gray Oral Reading Tests (GORT-4)**, and the nonverbal intelligence subtest of the **Kaufman Brief Intelligence Test-2 (KBIT-2)** (see Table 1).
- For the speaking tasks, participants produced a sample of spontaneous speech, which was prompted by asking participants general elicitation statements.
- The **GORT-4** and spontaneous speech samples were recorded under each auditory condition (i.e., DAF and NAF). The entire session was video recorded.

Table 1. Descriptions of administered standardized tests.

| Test | What does it measure? |
|----------------|---|
| TOWRE-2 | Assesses an individual's sight word recognition (reading regular words) and phonemic decoding abilities (reading non-words). |
| KBIT-2 | A brief measure of verbal and nonverbal intelligence, the nonverbal intelligence subtest was used as a control measure in this study. |
| CTOPP-2 | Assesses an individual's phonological skills. The non-word repetition subtest was used in this study. |
| GORT-4 | Provides objective measures about an individual's oral reading abilities at various reading difficulties. |

Auditory feedback delay (250 ms) at approximately 80 dB SPL

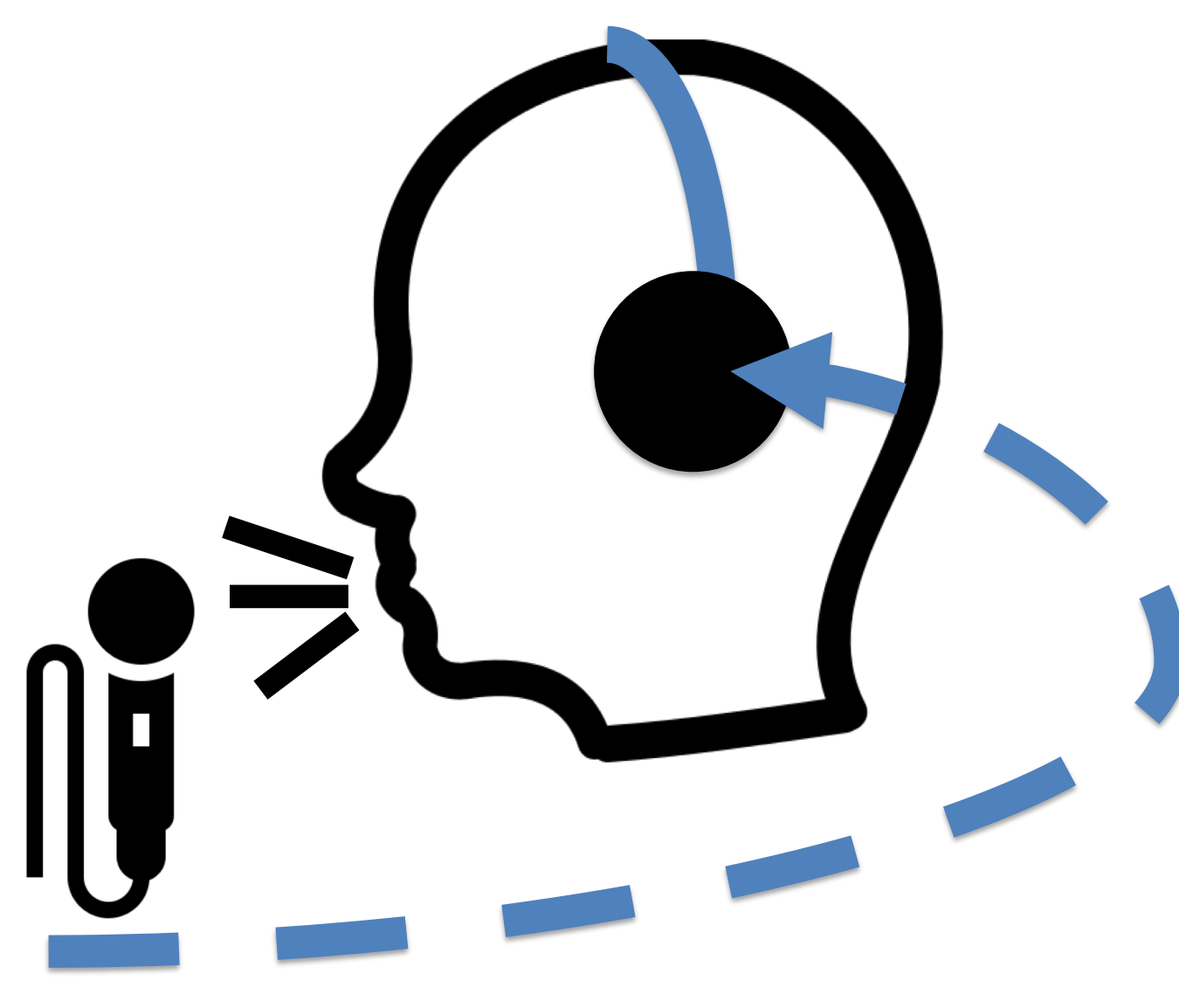


Figure 1. Delayed auditory feedback setup.

Analysis

- Stuttering disfluency rate in the DAF condition was used to identify low and high responders. *High responder* = speech during the reading passages contained 3% or more stuttering-like disfluencies (a cutoff for clinically significant stuttering). These disfluencies include prolongations, blocks and repetitions. Interrater reliability adhered to a 97% criterion for all recorded speech samples.
- A descriptive comparison of means and distributions was conducted for all measures.
- Independent *t*-tests for group differences ($p < 0.05$) between high and low responders and DAF and NAF conditions were run.

Results

- Speech rate was significantly lower under DAF vs. NAF - $t(14) = 11.87, p < 0.05$.
- Stuttering disfluency rate was significantly higher under DAF vs. NAF - $t(14) = -6.71, p < 0.05$.
- Non-word reading accuracy (i.e., phonemic decoding efficiency) was lower for high responders vs. low responders - $t(39) = -2.07, p < 0.05$.
- All other comparisons were *non-significant* (i.e., **KBIT-2**, **CTOPP-2** and **TOWRE-2** sight word efficiency).

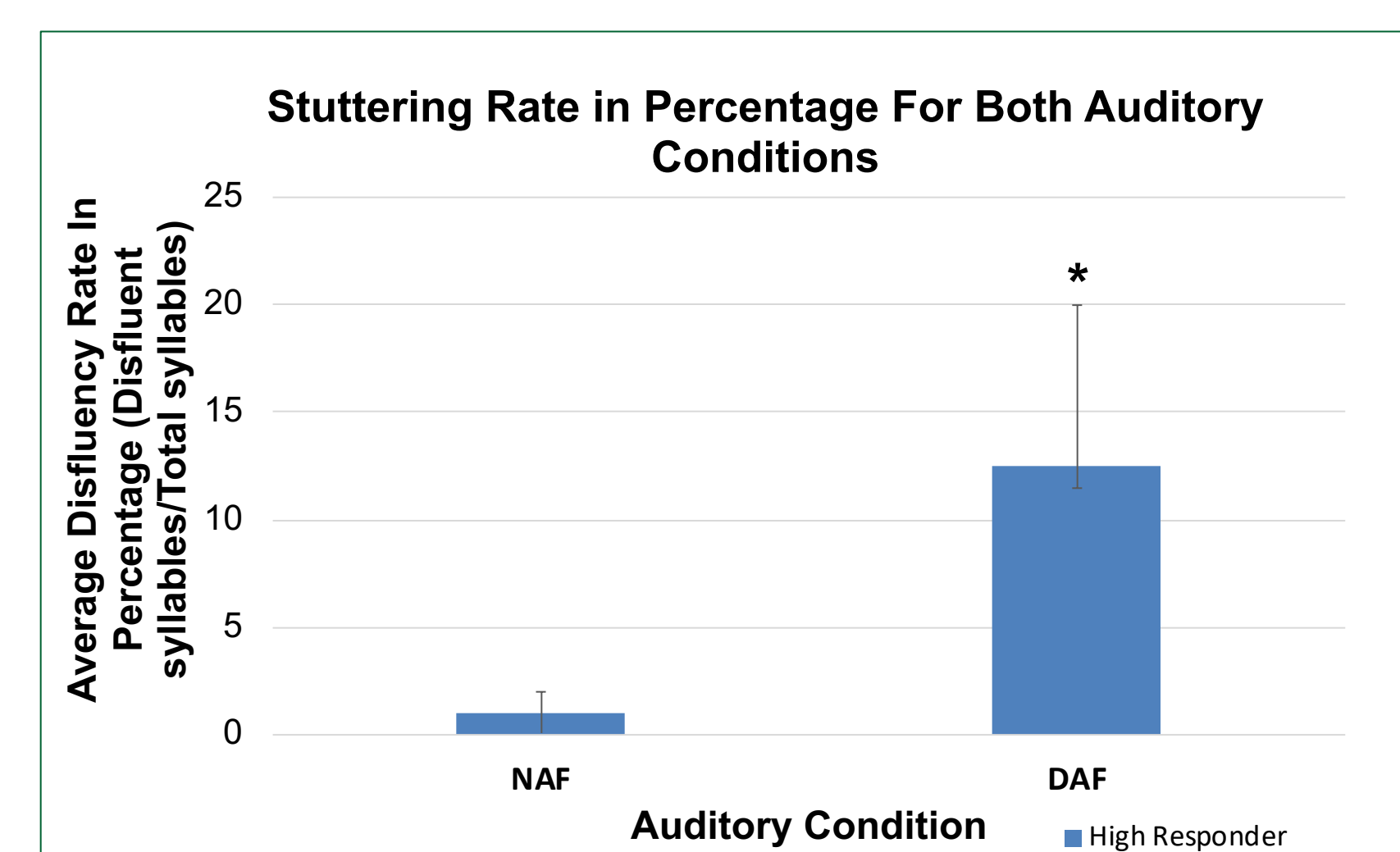


Figure 2. Average stuttering rate in percentage (disfluent syllables/ total syllables) for normal and delayed auditory conditions. * = $p < .05$

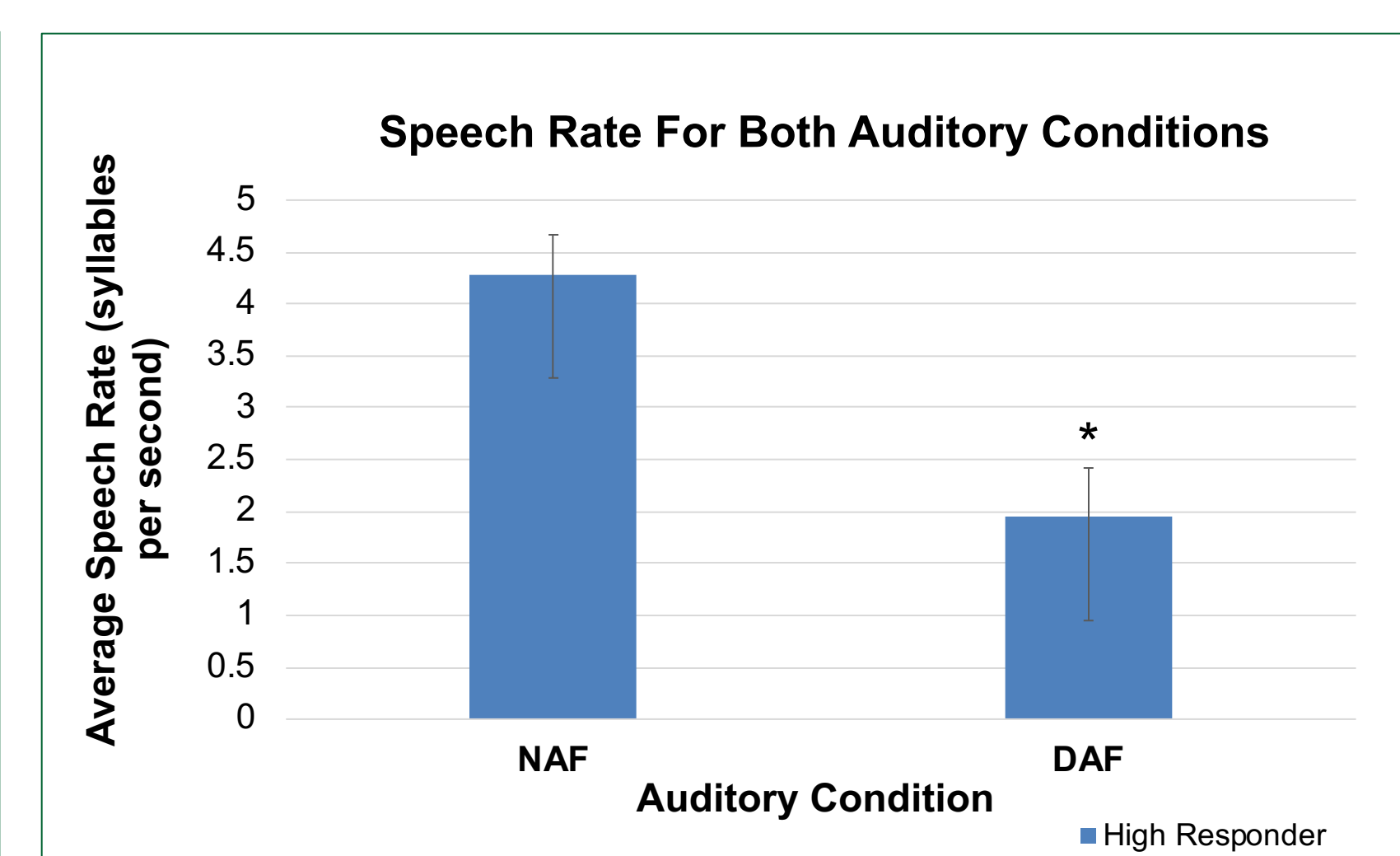


Figure 3. Speech rate (syllables per second) for normal and delayed auditory conditions. * = $p < .05$

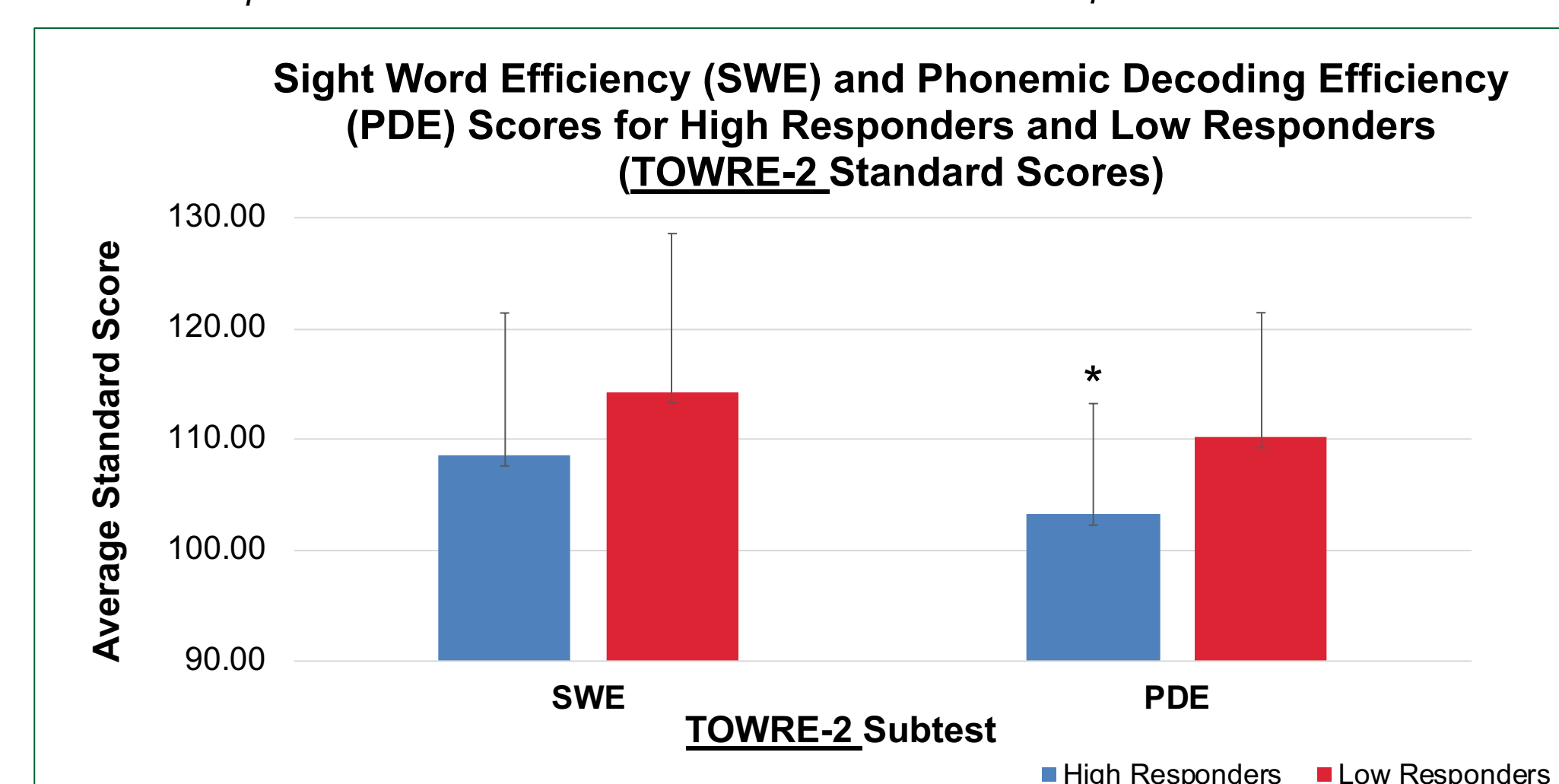


Figure 4. Comparison of **TOWRE-2** SWE and PDE standard scores for high and low responders. * = $p < .05$

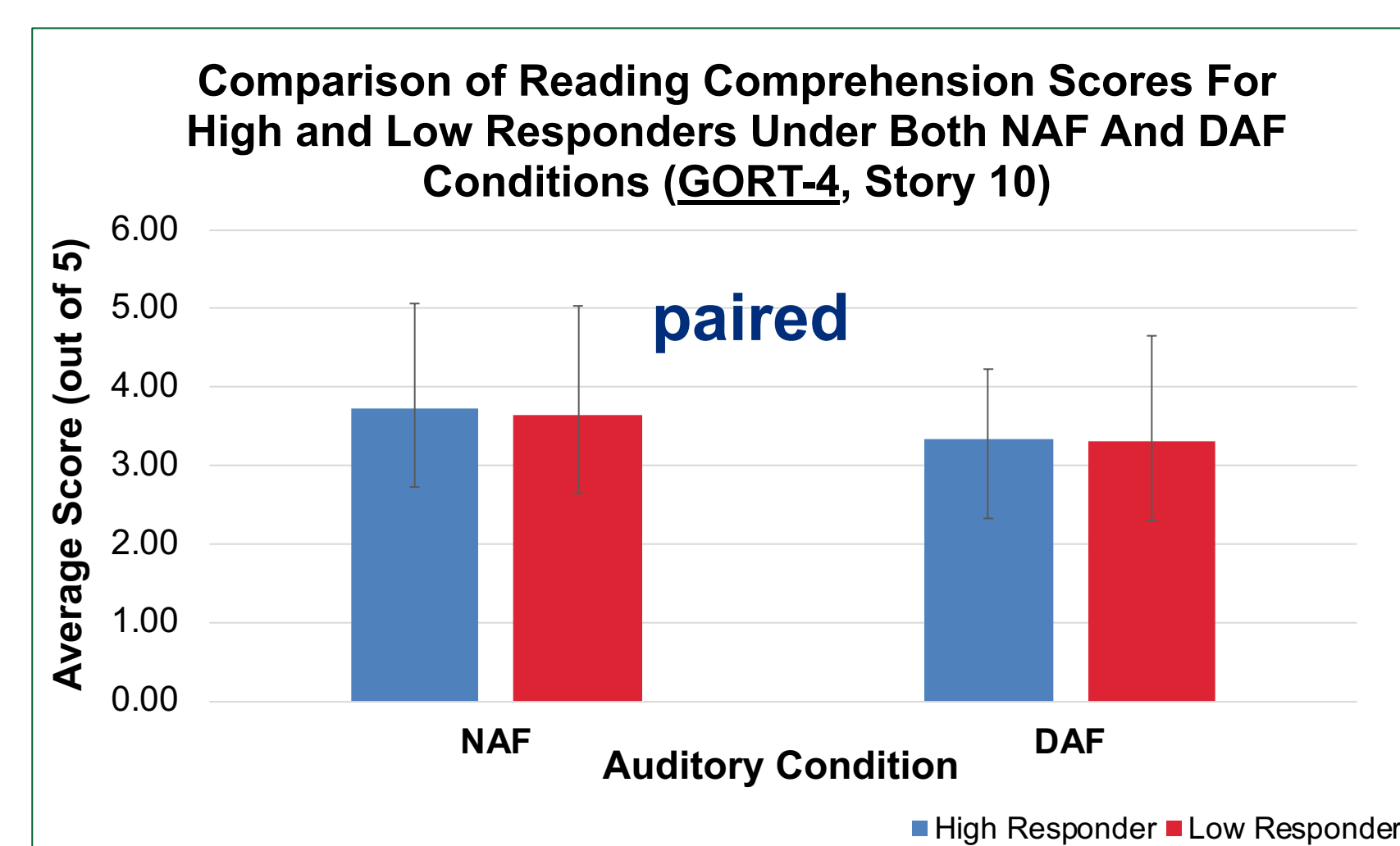


Figure 5. Comparison of **GORT-4** reading comprehension scores for high responders and low responders under both NAF and DAF conditions.

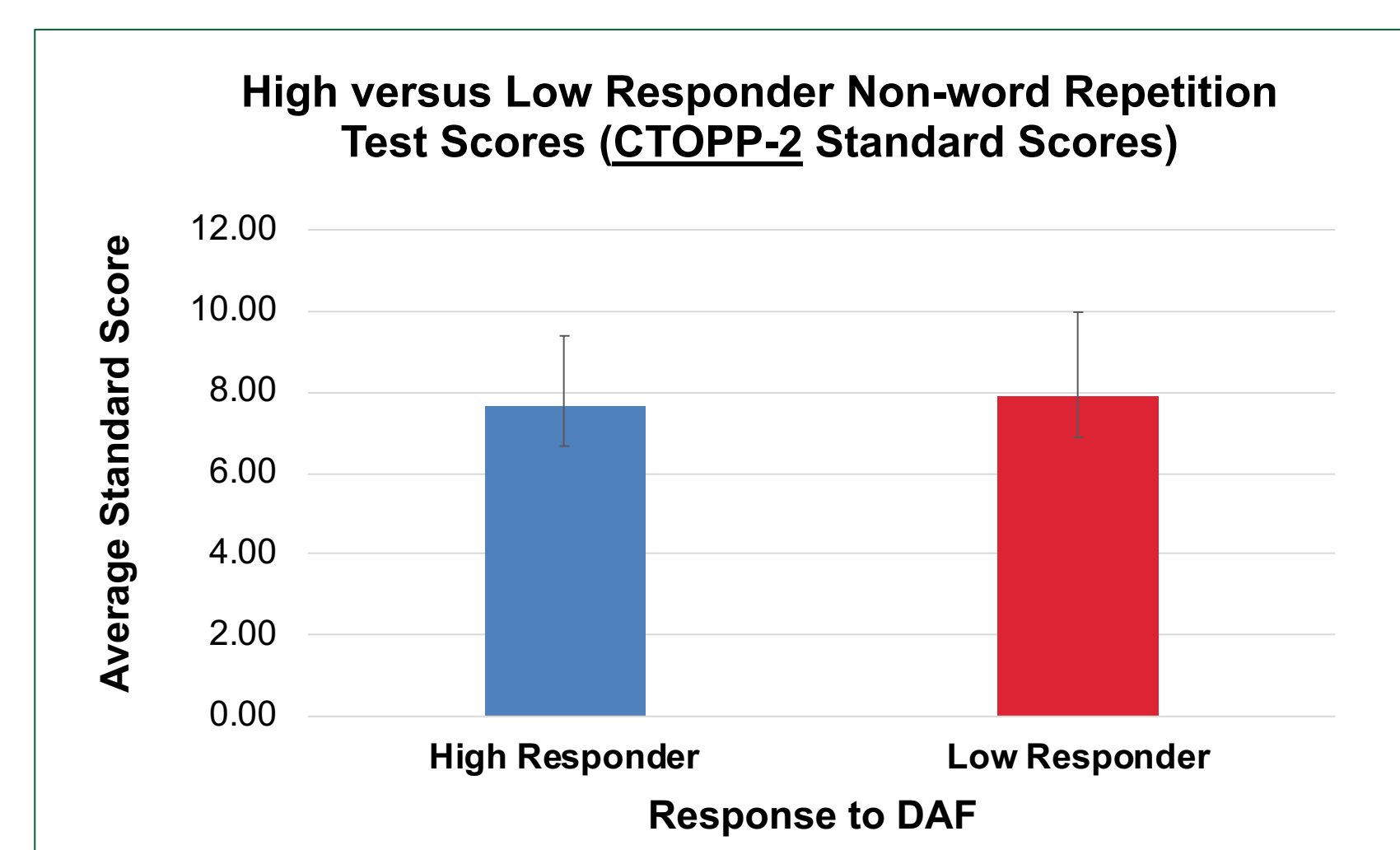


Figure 6. Comparison of **CTOPP-2** non-word repetition test standard scores for high and low responders.

Discussion

- The current results suggest preliminary evidence that individuals who are susceptible to DAF-induced disfluency have more difficulty pronouncing non-words. This hints at a potential link between phonological decoding and auditory processing.
- High responders performed similarly to low responders on tests of nonverbal intelligence, sight word reading and reading comprehension.
- The discrepancy between non-word sight reading (**TOWRE-2** PDE) and repetition of non-words (**CTOPP-2**) requires further investigation.
- Reading comprehension scores (**GORT-4**) were not significantly different under DAF. A slower rate of speech under DAF possibly allowed more time to remember and analyze the passage.

Conclusions/Limitations

- The DAF results and distribution of non-word reading responses warrant further analysis.
 - Potential outliers will require different statistical analyses and consideration of non-normality.
- High responders demonstrated lower scores for non-word reading that may indicate atypical phonological decoding.
 - Oral reading comprehension, non-word repetition, sight word reading and nonverbal intelligence were not associated with susceptibility to DAF.
- Ongoing work to explore the full range of DAF disfluencies and speech rate changes in the full participant group is underway.
- There is still minimal research exploring relationship between reading abilities and auditory feedback. This line of research has potential to advance the disciplines of communication, linguistics and emerging speech production technologies.

References

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