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Introduction

Certain types of modern hearing aid processing can provide subtle improvements in listening effort (LE; e.g., Bentler, Wu et al., 2008) that are not detected using conventional measures of listening performance. It has been suggested that evaluating LE in addition to speech understanding provides a more complete picture of hearing aid benefit than relying on measures of speech understanding alone. Though several types of validated measures have been used to quantify LE, time constraints and lack of specialized equipment or expertise might prevent typical audiologists from including some of these in their testing protocols. Two measures of LE that are relatively easy to administer and that can be administered simultaneously with a speech intelligibility measure are subjective ratings (RAT) and word-recall (REC) measures. We evaluated examples of these two types of measures regarding their suitability for inclusion in an audiologic test battery for evaluation of hearing aids.

The following questions were explored:

- Is speech understanding score independent of the LE measure?
- Do the RAT and REC measures provide the same information?
- Are both methods valid measures of LE?
- Which method is more sensitive to changes in listening demand presumed to impact listening effort?

Methods

30 normal hearers (21 females; ages 23-39) completed the Revised Speech Perception in Noise (R-SPIN) test at a single laboratory appointment. At the same time, to assess their LE they either rated their perceived effort using the rating scale at right or were asked to recall key words from the R-SPIN. Both methods for measuring LE were used with every participant. Testing was accomplished at several signal-to-noise ratios (SNRs) and with low and high context sentences.

LE Rating Scale

1. No effort
2. Very little effort
3. Little effort
4. Moderate effort
5. Considerable effort
6. Much effort
7. Extreme effort

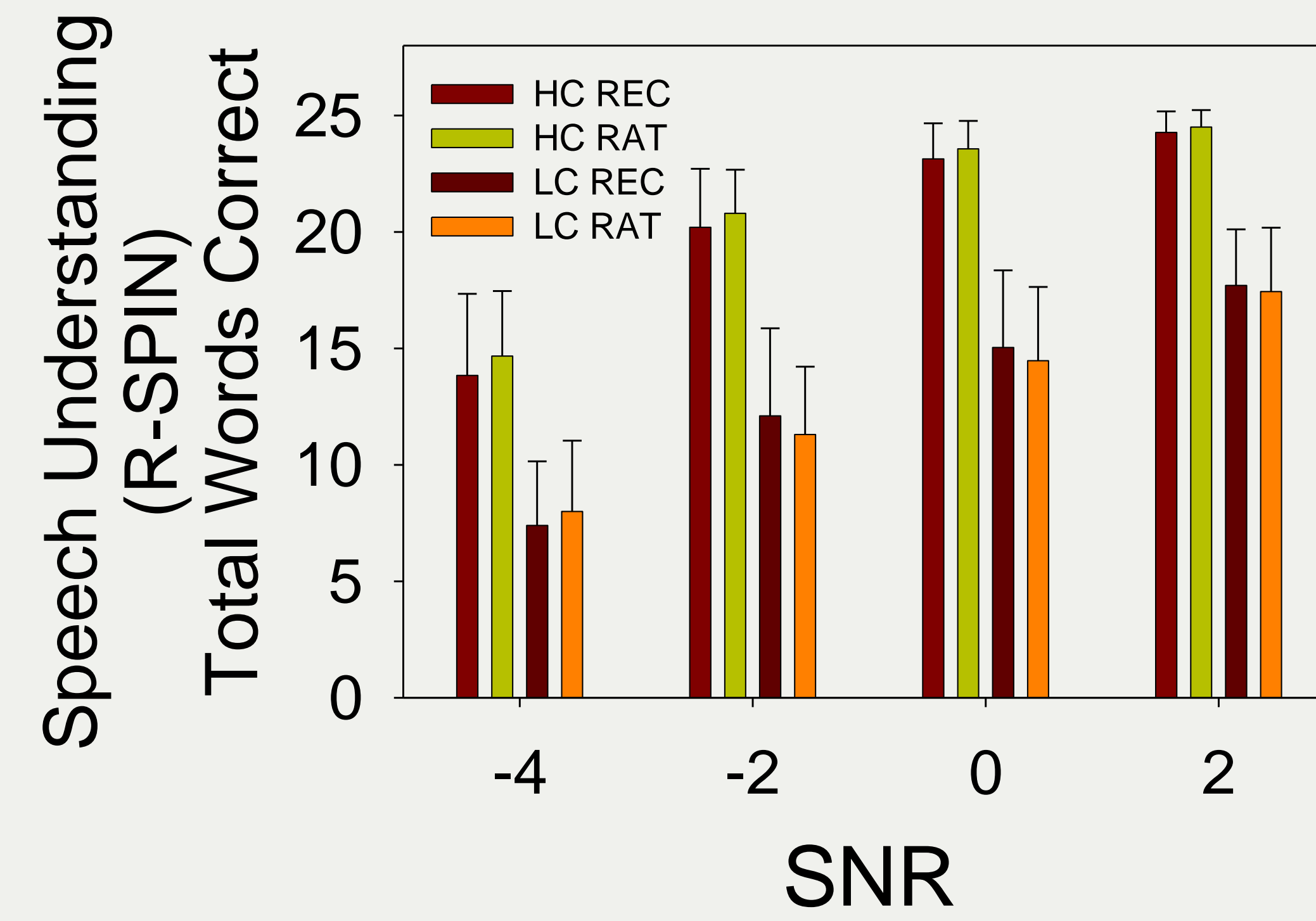
Acknowledgement

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A pdf version of the poster can be found at www.harlmemphis.org

Q & A

Is speech understanding score independent of the LE measure?

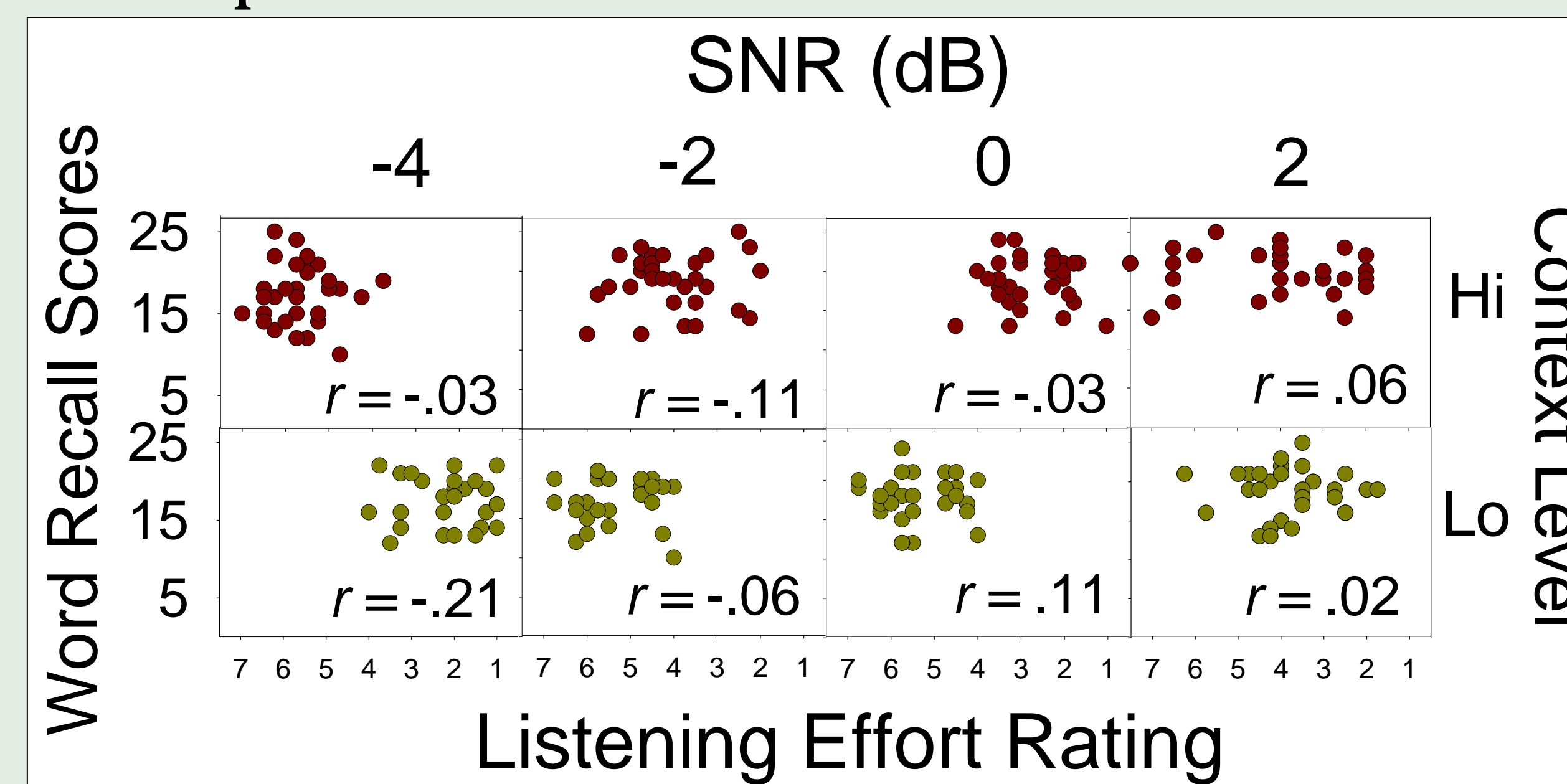


Results are based on separate repeated measure ANOVAs of speech intelligibility scores for high context (HC) and low context (LC) sentences.

- For high context (HC) sentences: **No.**
 - Speech understanding performance was better with the RAT method than with the REC method.
 - $F(1, 29) = 4.25, p < .05$.
- For low context (LC) sentences: **Yes.**
 - Speech understanding performance was independent of the LE measure
 - $F(1, 29) = .55, p > .05$.

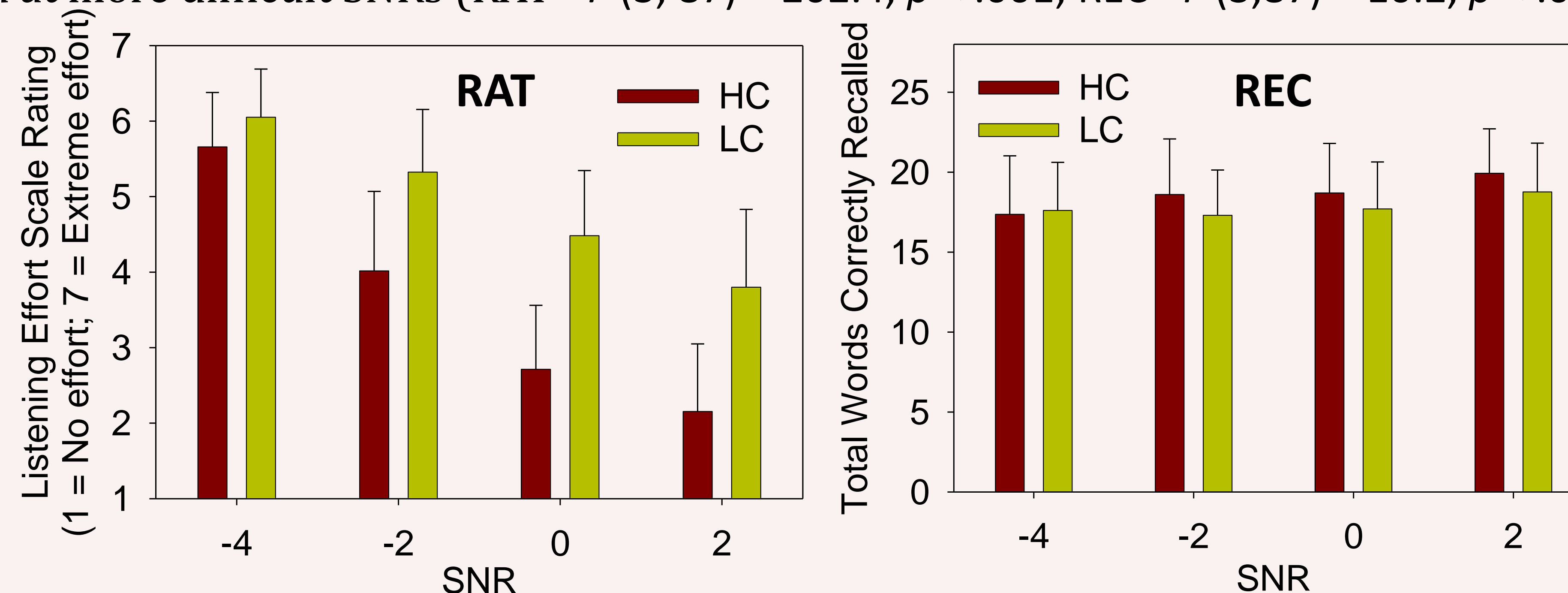
Do rating and word recall measures provide the same information?

- **No.** Weak associations between RAT and REC data indicate that the two measures did not assess the same underlying variable.



Are both methods valid measures of LE?

- **Yes.** Both measures of listening effort reflected more effort with lower context sentences (RAT - $F(1, 29) = 167, p < .001$; REC - $F(1, 29) = 19.6, p < .001$), and at more difficult SNRs (RAT - $F(3, 87) = 202.4, p < .001$; REC - $F(3, 87) = 10.2, p < .001$).



Results are based on separate repeated measure ANOVAs of listening effort scores for the subjective rating (RAT) and word recall (REC) LE methods.

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Which method is more sensitive to changes in listening demand?

- The **RAT method** was considerably more sensitive than the REC method across context-levels and SNRs.
- Table 1 shows that the RAT method demonstrated a greater effect of adding context at each tested SNR.
- This same type of result is seen in Table 2.

Table 1. Effect of increasing context level (low v high context; Cohen's d).

| Listening effort task | SNR (dB) | | | |
|-----------------------|----------|------|------|------|
| | -4 | -2 | 0 | +2 |
| REC | .07 | .41 | .33 | .4 |
| RAT | .58 | 1.39 | 2.07 | 1.71 |

Table 2. Effect of improving SNR (adjacent SNRs; Cohen's d).

| | Listening effort task | SNR (dB) | | |
|----|-----------------------|-----------|----------|---------|
| | | -4 vs. -2 | -2 vs. 0 | 0 vs. 2 |
| HC | REC | .35 | .03 | .42 |
| | RAT | 1.85 | 1.37 | .64 |
| LC | REC | .10 | .14 | .36 |
| | RAT | .99 | 1 | .72 |

Summary of Results

For normal hearers, both measures demonstrated results that reflected expected changes in LE with corresponding changes in listening demand. However, data obtained using the RAT method were considerably more sensitive to changes in listening demand than data obtained using the REC method.

Further, under some conditions, implementation of the REC method might result in more interference with speech intelligibility performance than the RAT method when both outcomes are measured simultaneously. The results of this study provide a rationale for preferring the RAT measure of LE over the REC measure.

Implications for hearing aid testing

Advancements in hearing aid technology might provide subtle improvements to daily listening that can not be detected using conventional hearing aid outcome measures. Measures of LE might demonstrate these improvements. Based on these results, the RAT measure seems more suited to this task than the REC measure. Future research should explore how variables such as age, cognition, and hearing loss might influence these results.

Reference

Bentler, R., Wu, Y., H. Kettle, J., & Hurtig, R. (2008). Digital noise reduction: outcomes from laboratory and field studies. *Int J Audiol*, 47, 447-60.