Optimal response format for microinteraction-based Ecological Momentary Assessment (micro-EMA)

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- Wu is currently a paid consultant of Meta Platforms, Inc.

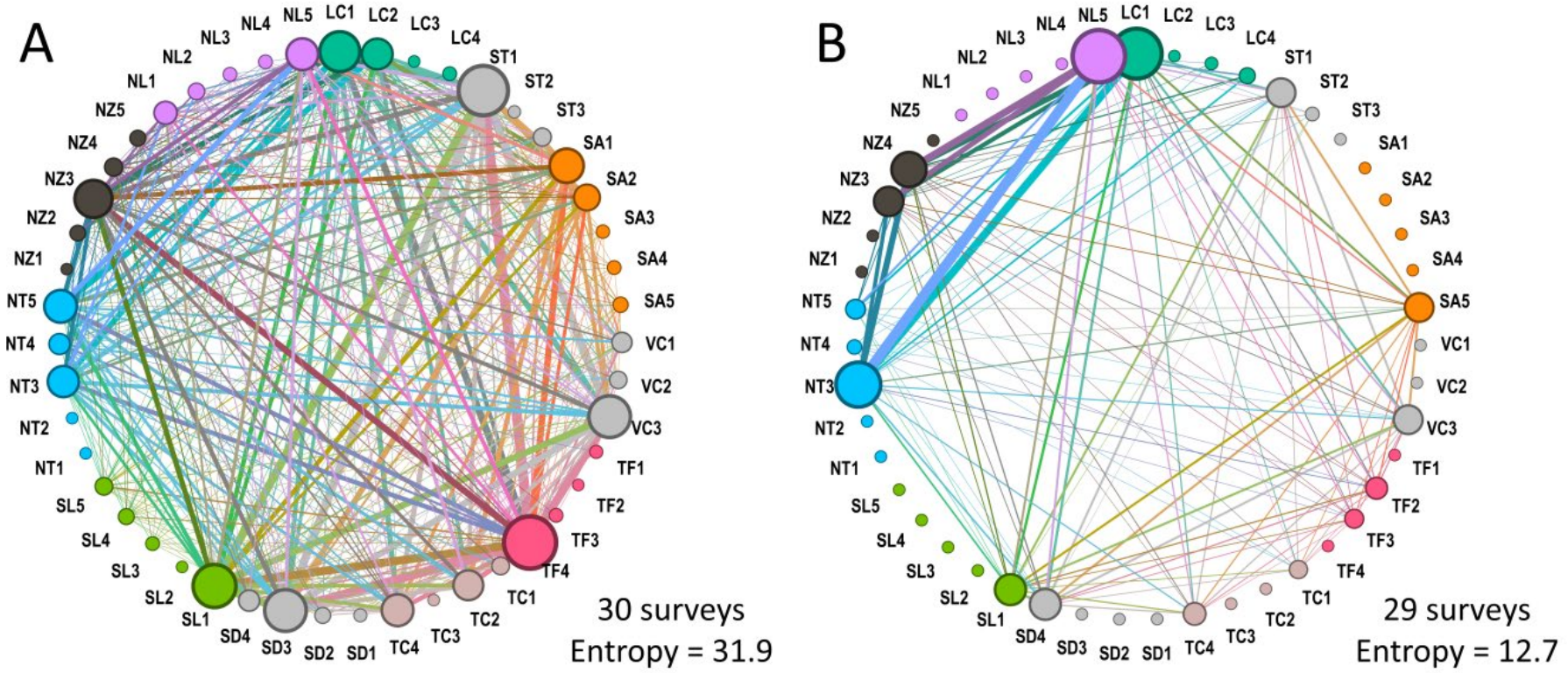
Ecological Momentary Assessment (EMA)

- A methodology involving **repeated** collections of **real-time** or **very recent** (i.e., momentary) data describing subjects' *experiences and context* in their **natural** (i.e., ecological) environments
  - Collect experience and context information
  - Less affected by recall bias

EMA in Hearing Research: An example

Entropy as a Measure of Auditory Environment Diversity: An Ecological Momentary Assessment (EMA) Approach

Yu-Hsiang Wu,[1] Elizabeth Stangl,[1] Camille Dunn,[2] and Jacob Oleson[3]



Disadvantages of smartphone-based EMA

- High burden on participants
  - Long surveys
  - Smartphone intrusiveness
- Low sampling rate provides limited data
  - E.g., 1 survey per hour
- Compliance decreases systematically in certain listening situations
  - E.g., noisy social events

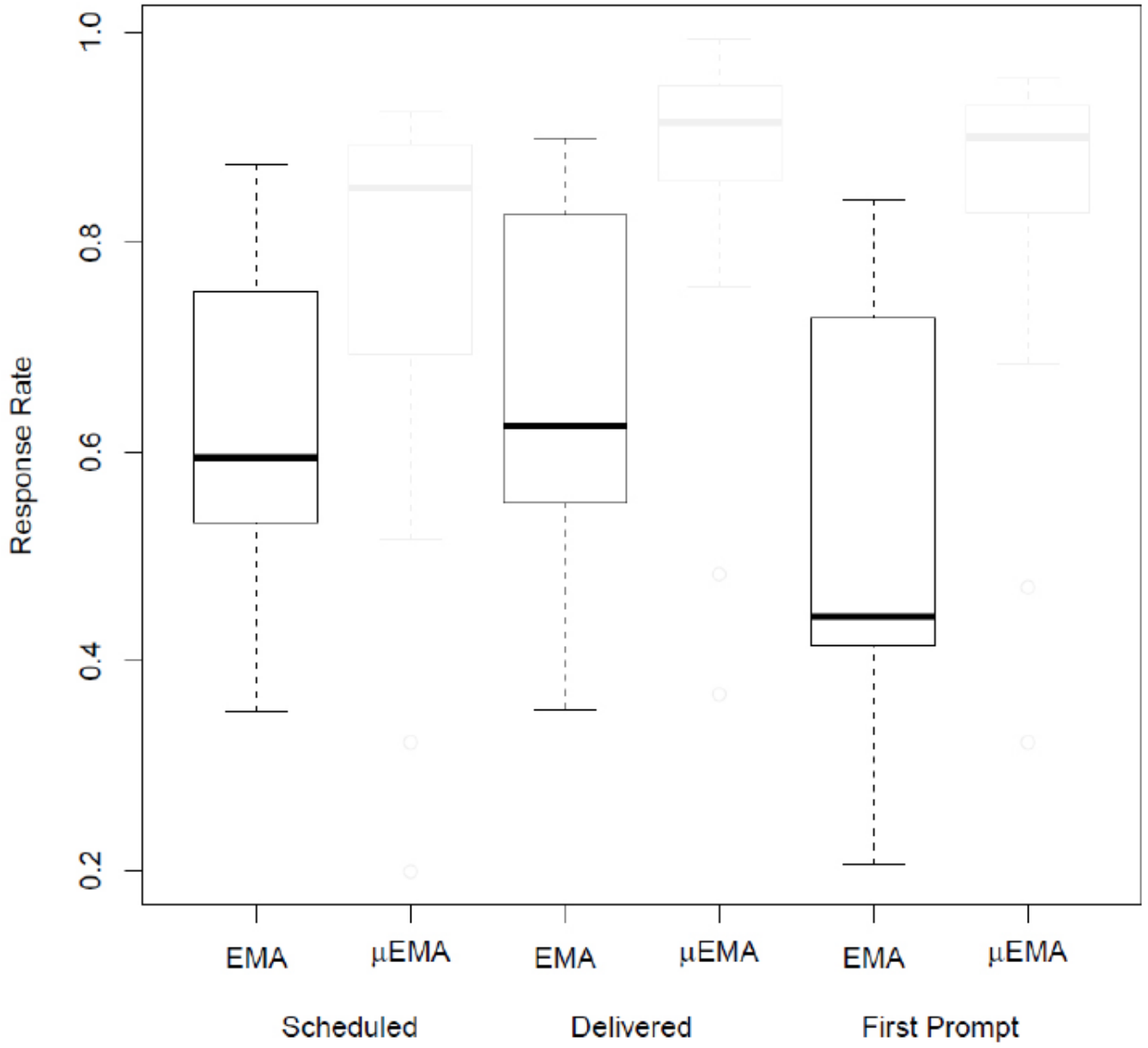
Microinteraction-based EMA (micro-EMA, µEMA)

- A type of EMA that **single-question** surveys are delivered through a smartwatch
- Can achieve a high survey sampling rate (e.g., 1 survey per 10 min)
- Less intrusive than a smartphone
  - Worn on the wrist, smaller, less questions, prompts can be answered in less than 5 seconds.

Micro-EMA: survey question

- Single-question survey
- Questions about perception/experience are prioritized
- Contextual data (e.g., sound level) can be collected from sensors (e.g., microphones) in the smartwatch, smartphone, and hearing aids

Micro-EMA in the Literature



Intille, Stephen, et al. "µEMA: Microinteraction-based ecological momentary assessment (EMA) using a smartwatch." *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. 2016.

Purpose of the current study

- The purpose of the study was to determine the best response format for micro-EMA.
  - Binary scale
  - 5-point scale
  - 10-point scale

Question: “Hearing Well?”

- Binary scale:
  - NA (not applicable)
  - No
  - Yes

- 5-point scale:
  - NA (not applicable)
  - Very Poor
  - Poor
  - Fair
  - Good
  - Excellent

- 10-point scale:
  - NA (not applicable)
  - 1 Very Poor
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10 XLNT


Good

Study Design

- 32 adults with hearing loss
  - 19 females, 13 males, mean age = 72.6 years (SD=5.9)
- SNR-50 calculated using HINT sentences
- Dual Task Paradigm
  - Task: Listen to HINT sentence in noise; respond to survey notification on watch; repeat back as much of sentences as possible.
  - Steady level background noise
  - Speech presented at -3, 0, 3, 6, and 9 dB SNR relative to the SNR-50
  - Baseline conditions: speech task only
- Repeat the tests one week later

Time:

Stimuls

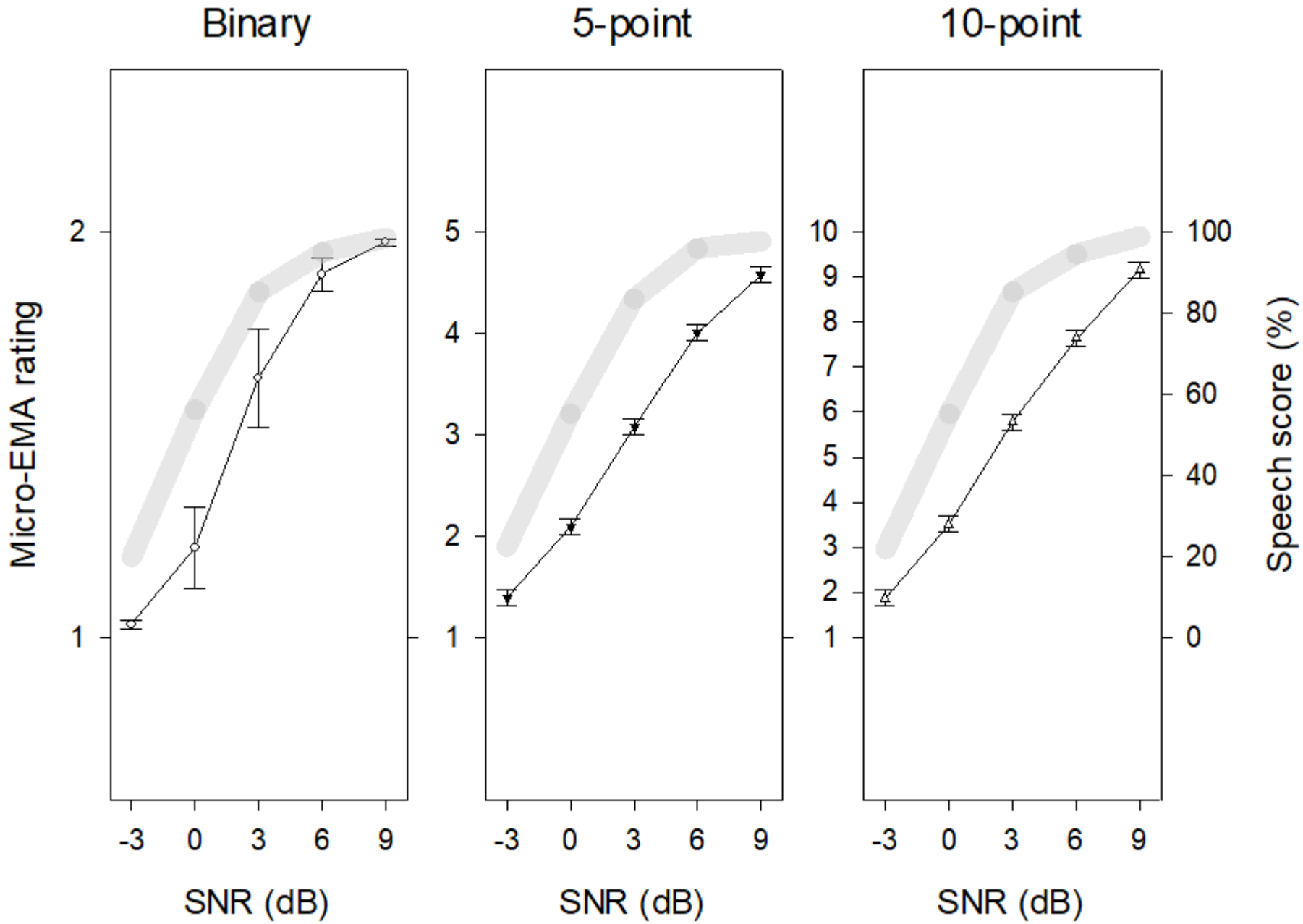
The boy did a handstand

Noise

Results

Validity, sensitivity, intrusiveness, and reproducibility

Validity


Binary
5-point
10-point
Micro-EMA rating
Speech score (%)
SNR (dB)
SNR (dB)
SNR (dB)
-3
0
3
6
9
1
2
1
2
3
4
5
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100

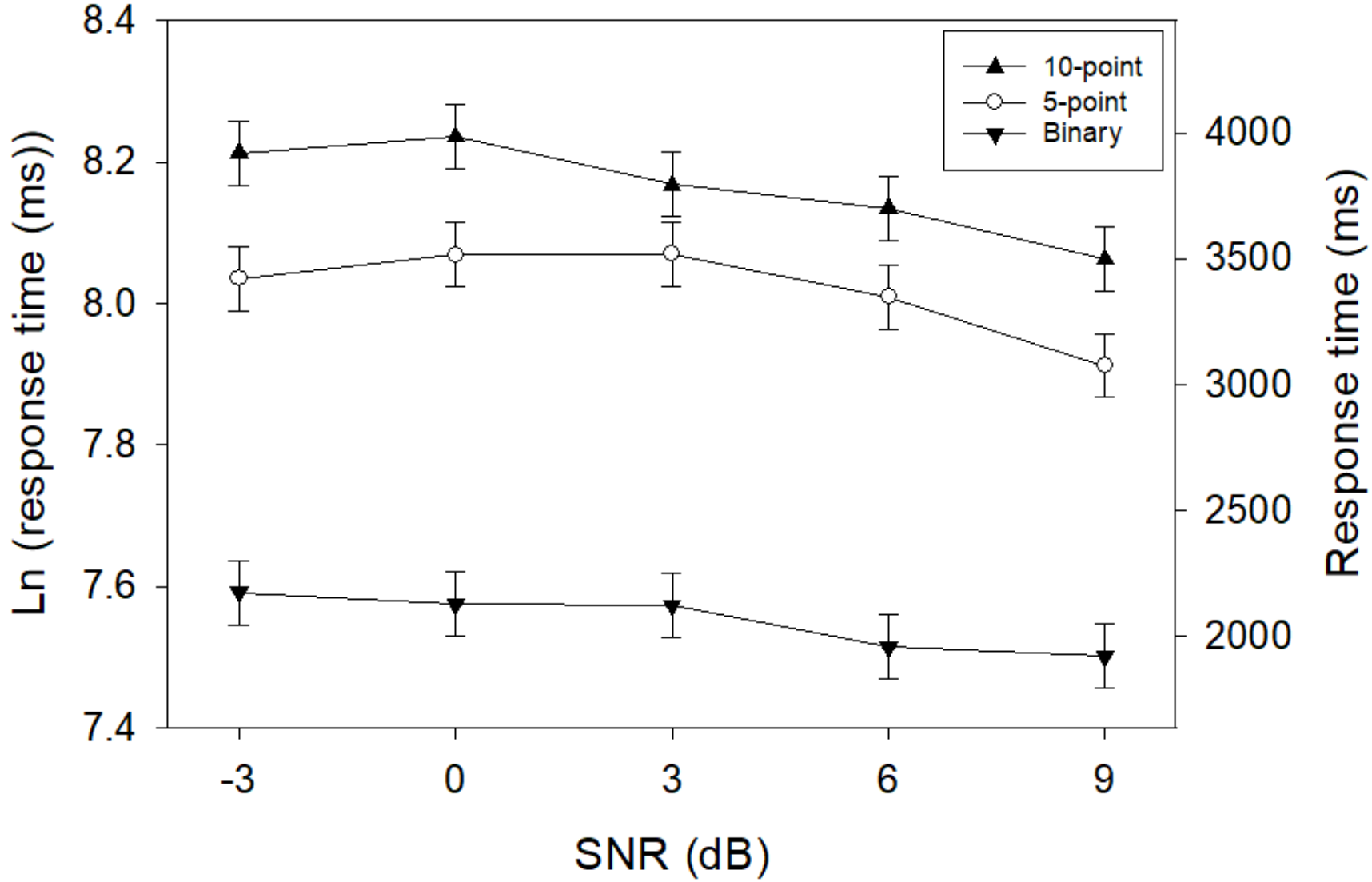
Sensitivity

- t-test statistics in comparing one SNR to the next
- A larger t statistic means a bigger relative change, i.e., more sensitive
- Binary has the smallest relative changes from one SNR to the next

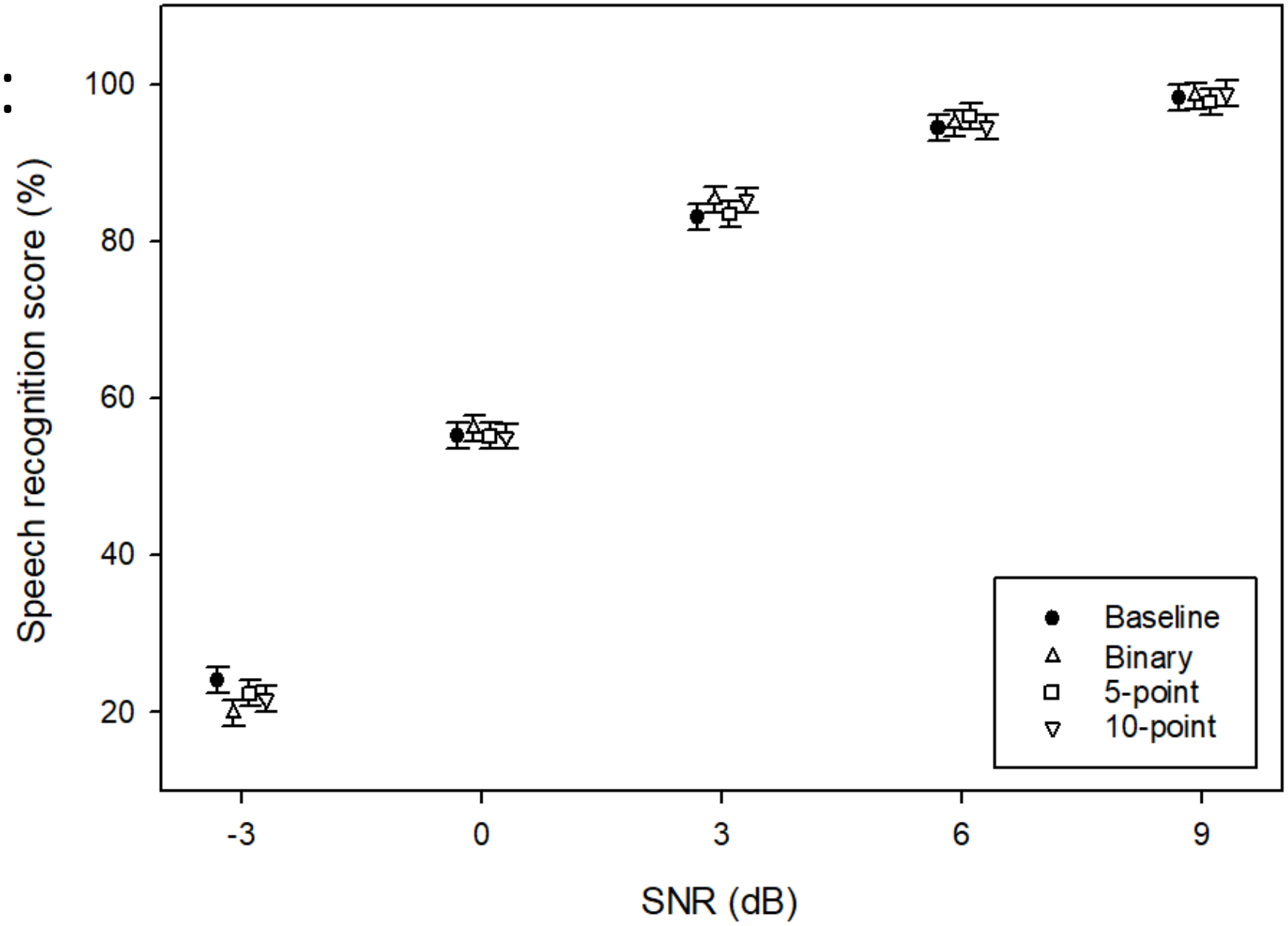
SNR		binary	5point	10point
-3	0	7.2	12.6	12.9
0	3	11.8	17.7	17.9
3	6	8.6	16.7	14.7
6	9	4.3	10.2	12

All p-values < 0.05

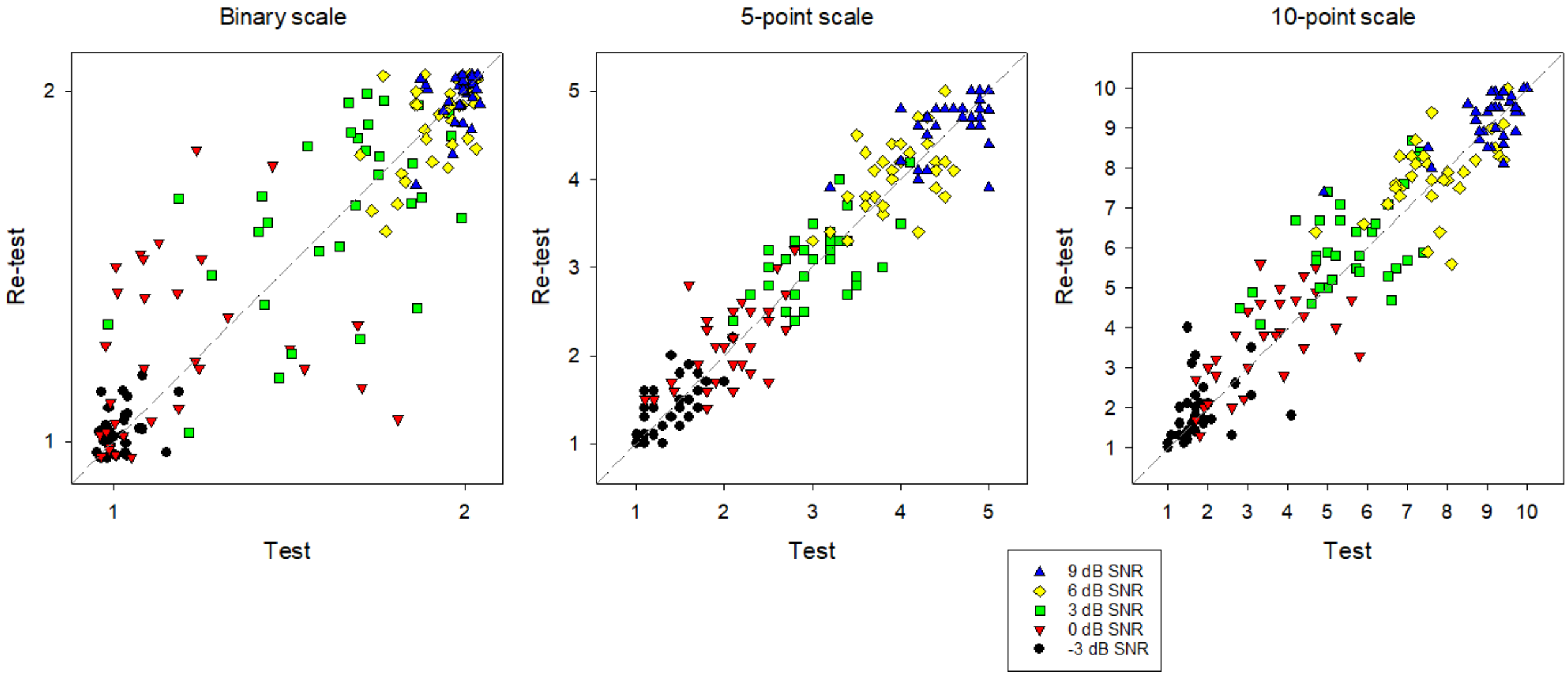
Intrusiveness: response time



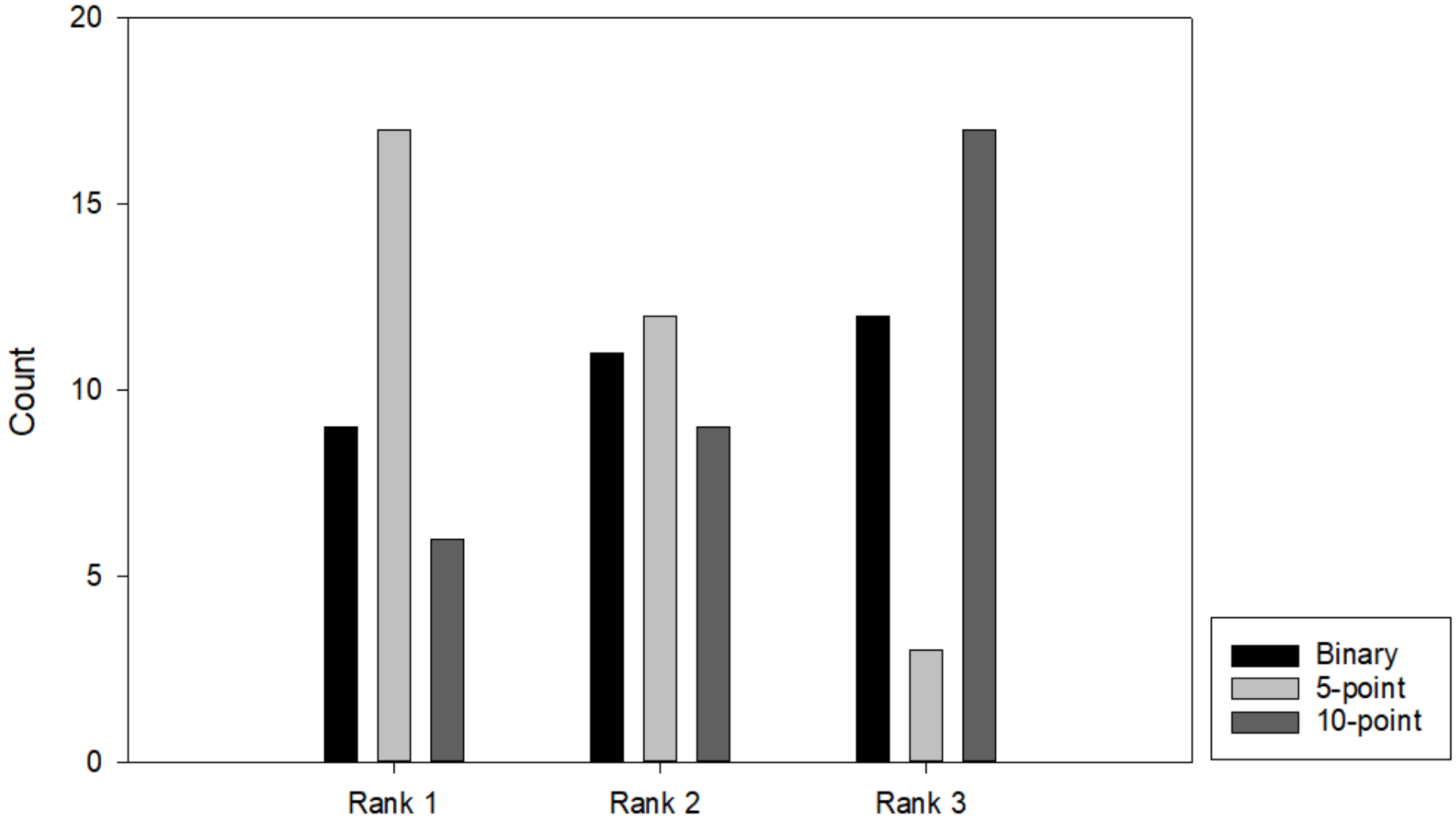
Intrusiveness: Impact on speech



Reproducibility



Preference ranking



Comments from participants

	Pros	Cons
Binary	• "Very simple with no real complexity to determine - strictly yes or no" • "Easier to make a decision"	• "Not enough differentiation to quantify degree of understanding of sentence" • "Too few choices"
5-point	• "Quicker and the choices seemed to fit how I felt about how I heard the sentence." • "5 is not as nuanced but is faster than 10"	• "Felt the most generic and the least effective" • "Not as nuanced as 10-choice"
10-point	• "It gave a good range of answers" • "Easier to zero in on a rank"	• "Too many choices-more difficult to adjust the watch. Takes too much time."

Summary

- All three response formats are valid.
- Although the binary scale was less intrusive (shorter response time), it was less sensitive in detecting rating differences across SNRs and was less reproducible.
- The 5-point scale had high sensitivity and reproducibility and was most preferred by the participants.

Conclusion and limitations

- Based on the lab results, the 5-point scale is the most reasonable selection for micro-EMA
- However, it is unclear if this is the case in the real world.
- We are currently conducting a field trial to determine the feasibility of micro-EMA in hearing research.

Thank you!

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