Wait what? The Interaction Between Some Cognitive Abilities and Context Benefit

Seren M. Avenilla, Matthew J. Goupell, Anna R. Tinnemore

Department of Hearing and Speech Sciences, University of Maryland, College Park, MD

INTRODUCTION

- When listening to speech in noisy settings, the brain may rely on surrounding sentence context to aid in sentence understanding and/or identification of a degraded word (e.g., Moss & Marslen-Wilson, 1993).
- Variations in cognitive processes like working memory and inhibition ability may predict the listener's reliance on the context surrounding a degraded target word (e.g., Wingfield et al., 1994).
- The position of the degraded target word within the sentence may also interact with reliance on the surrounding context.
  - **Working memory** load changes depending on whether the target word appears at the beginning or end of the sentence.
  - **Inhibition** of the immediately perceived target word versus the context may change as the position of the target word changes.

RESEARCH QUESTIONS

- Will context effect increase if the target word appears at the beginning of the sentence?
- Does poorer working memory ability increase reliance on sentence context?
- Does stronger inhibition ability decrease reliance on sentence context?

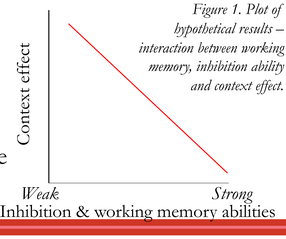

Figure 1. Plot of hypothetical results – interaction between working memory, inhibition ability and context effect.

METHODS

Participants

- 35 participants with normal hearing in at least their better ear (pure tone thresholds ≤ 25 dB HL 250-4000 Hz)
  - Ages 20-77 (years), Mean Age=49.1, 31 female

Stimuli

- Target words
  - 4 step continuum ranging from "deer" to "tear"
- Six sentences (3 with the target word at the beginning of the sentence)
  - Two predicted the target word "tear."
  - Two predicted the target word "deer."
  - Two did not predict either target word.
- Stimuli were degraded to simulate cochlear implant processed speech.
  - Background noise was added behind the target word at a -10 dB signal to noise ratio (SNR).

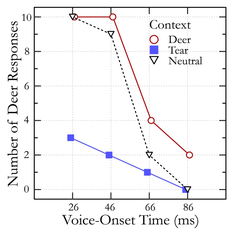

Figure 2. Example plot of a participant's deer responses across the 3 sentence contexts (deer, tear, and non-predictive/neutral).

Procedure

- Task: two-alternative forced-choice task
- Conditions:

6 sentence contexts × 4 continuum steps × 10 trials = 240 trials

RESULTS

Working memory and inhibition ability alone do not predict reliance on sentence context.

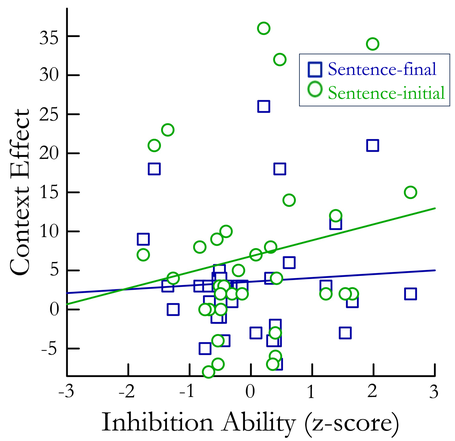

Figure 3. Correlation between context effect and inhibition ability, separated by target word position (initial vs final).

- Greater context effect in the sentence-initial position (p=0.011).
- Inhibition ability did not predict context effects (p>0.05).
- No significant interaction between inhibition ability and target word position on context effects (p>0.05).
- Regression analysis
  - r^2=0.0043 (final)
  - r^2=0.0342 (initial)

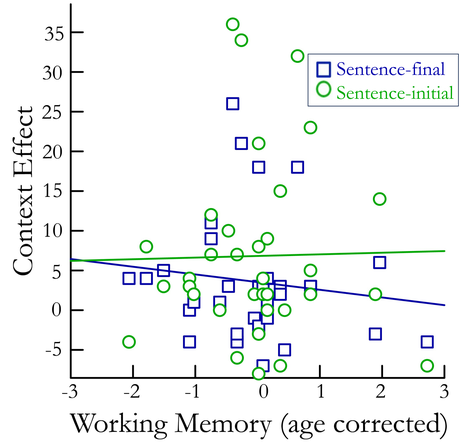

Figure 4. Correlation between context effect and working memory ability, separated by target word position (initial vs final).

- Greater context effect in the sentence-initial position (p=0.01).
- Working memory did not predict context effects (p>0.05).
- No significant interaction between working memory and target word position on context effects (p>0.05).
- Regression analysis
  - r^2=0.017 (final)
  - r^2=0.0003 (initial)

METHODS (cont.)

Procedure (cont.)

- Participants also completed the NIH Toolbox Word List Sort Working Memory Assessment and Stroop Color-Word Test (test of inhibition ability).
- Calculating context effect:
  - (Total in Deer – Total in Neutral)
    +
  - (Total in Neutral – Total in Tear)

Total Deer responses	Deer: 26 Tear: 6 Neutral: 21
Context Effect	(26 – 21) + (21 – 6) = 20

Figure 5. Example showing the calculation of total context effect using example data in Figure 6.

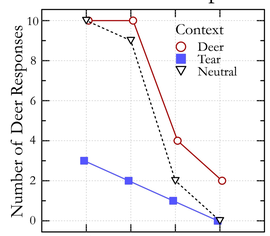

Figure 6. Example data.

CONCLUSIONS

- Context effect is greatest when the target word is at the beginning of the sentence.
- Neither working memory nor inhibition ability alone predict reliance on context.
- No significant interaction between working memory or inhibition abilities and target word position were found.
- Working memory and inhibition abilities may still contribute to the brain's reliance on context, likely in conjunction with other cognitive processes.

FUTURE DIRECTIONS

- Examine whether there is an interaction between other cognitive processes and reliance on context, like processing speed.
- Explore the interaction between hearing loss and context effect.
- Observe the impact of different SNRs on context reliance.

REFERENCES

Moss, H. E., & Marslen-Wilson, W. D. (1993). Access to word meanings during spoken language comprehension: Effects of sentential semantic context. Journal of Experimental Psychology: Learning, Memory, and Cognition, 19(6), 1254–1276. https://doi.org/10.1037/0278-7393.19.6.1254

Wingfield, A., Alexander, A. H., & Cavigelli, S. (1994). Does Memory Constrain Utilization of Top-Down Information in Spoken word Recognition? Evidence from Normal Aging. Language and Speech, 37(3), 221-235. https://doi.org/10.1177/002383099403700301

ACKNOWLEDGEMENTS

The authors would like to thank Pallavi Atluri, Erin Doyle, Milana Klopouh, and Vanessa Reyes for their help with data collection. This research was supported by NIH-NIDCD R01-DC-020316 (MJG) and by NIH-NIDCD T32-DC-00046 (ART).