



# Assistive text captioning offsets the effects of background noise on speech memory

Brennan R Payne<sup>1,2</sup>, Jack Silcox<sup>1</sup>, Amanda Lash<sup>3</sup>, Sarah H Ferguson<sup>4</sup>, & Monika Lohani<sup>5</sup>

<sup>1</sup>Dept. of Psychology, University of Utah; <sup>2</sup>Neuroscience Program, University of Utah; <sup>3</sup>Dept. of Psychological Sciences, Whittier College

<sup>4</sup>Dept. Of Communication Sciences and Disorders, University of Utah; <sup>5</sup>Dept. of Educational Psychology, University of Utah

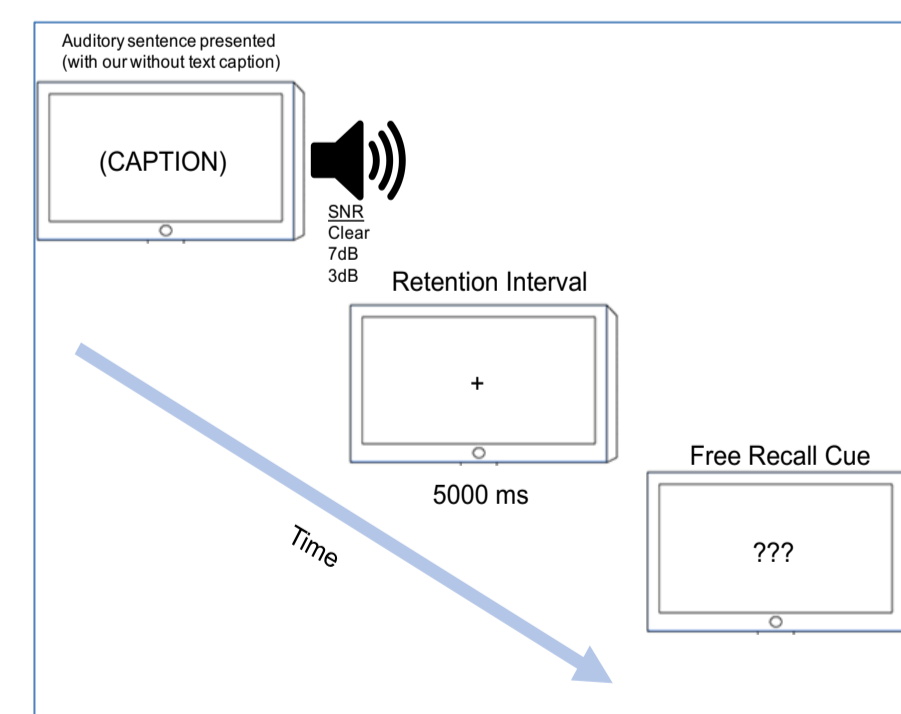
## Motivation and Background

- Text captioned speech improves word recognition and perceived intelligibility in adults with hearing loss [1-3].
- Even when speech is intelligible, listening effort can negatively impact subsequent memory [4].
- Can text captions improve recall and recognition memory for propositionally dense sentences in acoustically challenging listening environments? (Exp 1)
- Are the effects of text captioning on memory differentially beneficial among older adults with hearing loss? (Exp 2)

## Method

- **Sentence recall paradigm** (e.g. 5, 6).
- **Stimuli:**  $n = 90$ , propositionally dense 18-word sentences. (e.g., The Central Georgia Railroad used to be the most complete and elegant railroad complex in the United States). Single female native English speaker.
- **Background Noise** (Speech-shaped background noise): 3 conditions
  - No Noise, +7dB SNR, +3dB SNR
- **Caption Condition:** No Captions or cumulative multi-word text captions
  - Captions presented in cumulative moving window paradigm (3-word chunks) with caption onset time at speech offset of last word in each chunk.

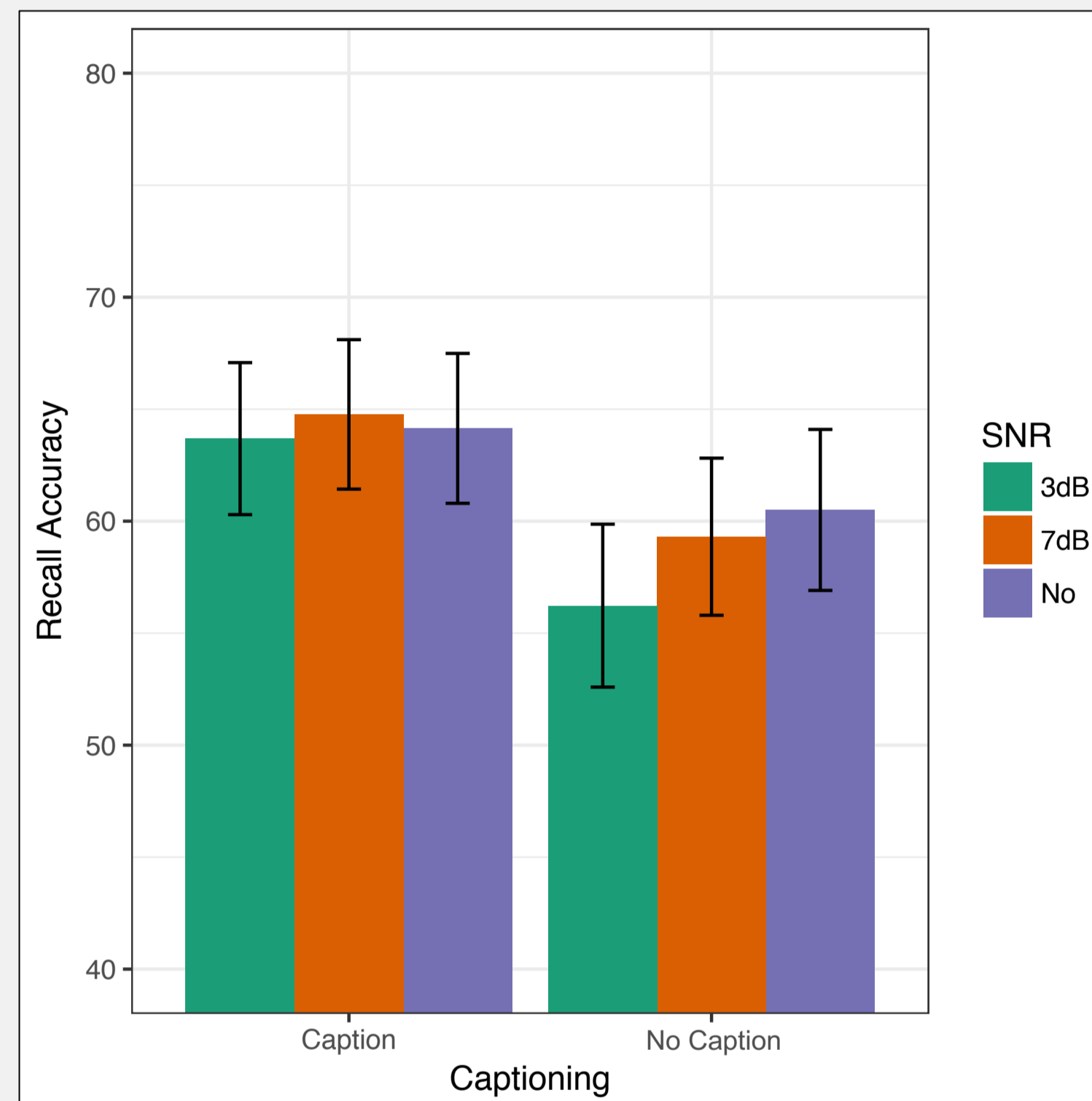
### Caption Example



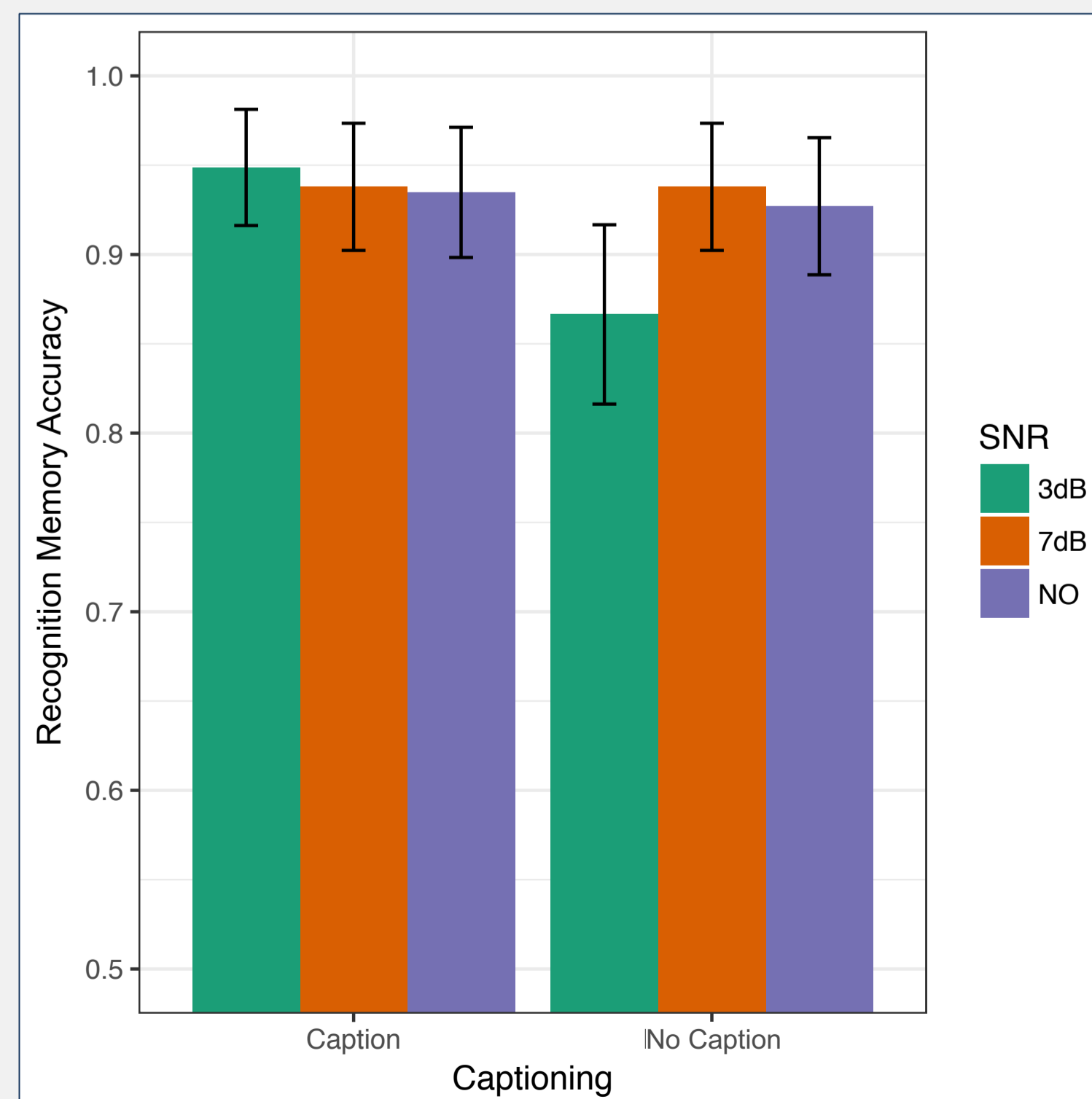
- **Outcomes:** (1) Free recall (% words correct), reported after each sentence; (2) Delayed recognition memory accuracy (reported after end of each block of 45 sentences). Semantically-related foil items were included in recognition memory task [7].
- **Analysis:** Linear mixed-effects models with maximal random effects across subjects [8]. Likelihood ratio tests for statistical inference on fixed effects.

## Experiment 1: Young Adults

- Sample:  $N = 48$  self-reported normal hearing adults.
- Mean age: 22.89 (range: 18 – 34).
- No reported hearing loss, visual impairment, or neurological disorder.



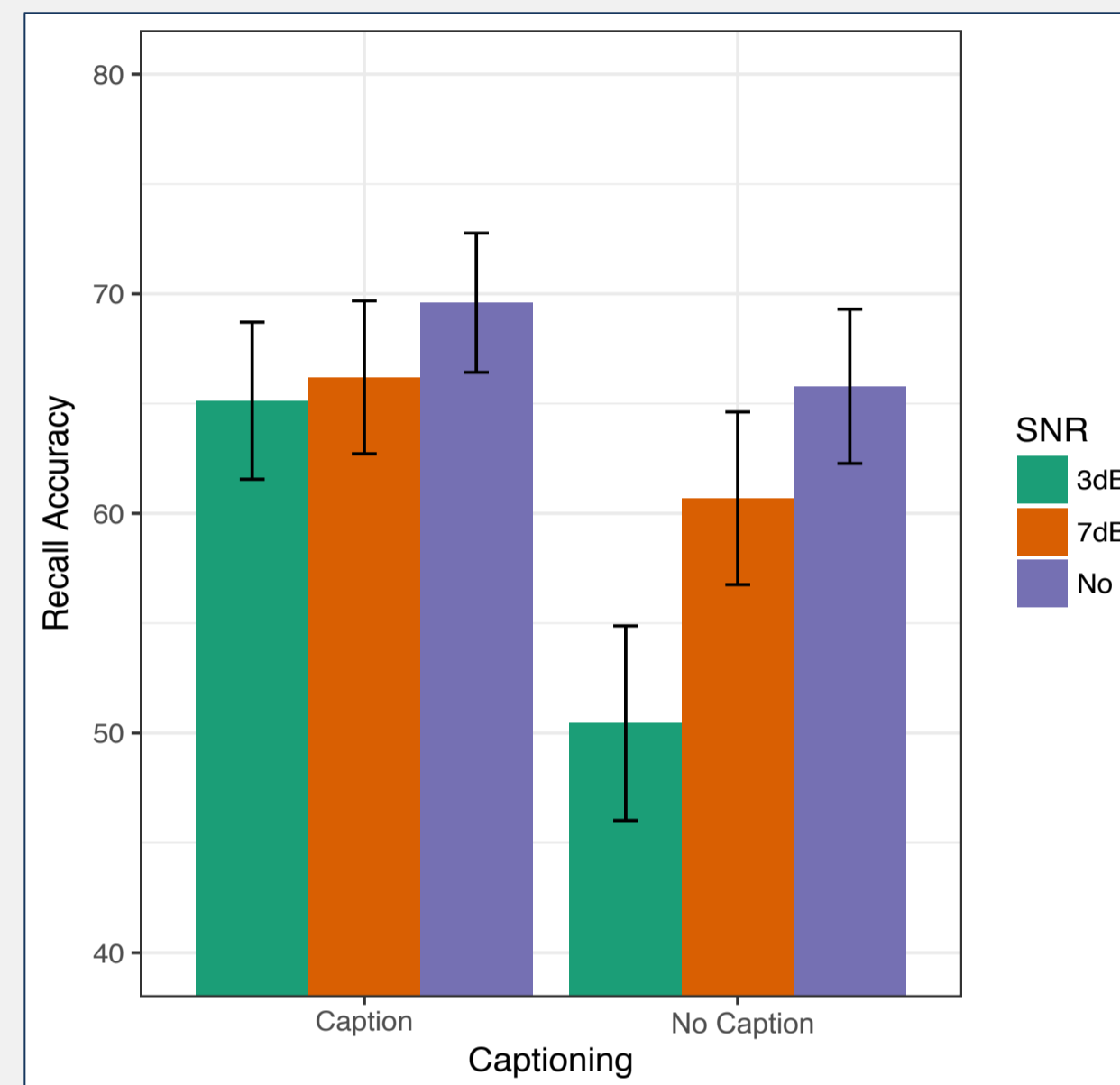
Caption x Noise:  $\chi^2(2) = 8.60, p < .05$   
Caption benefit in 3 dB SNR condition = 6.14,  $d = .36$



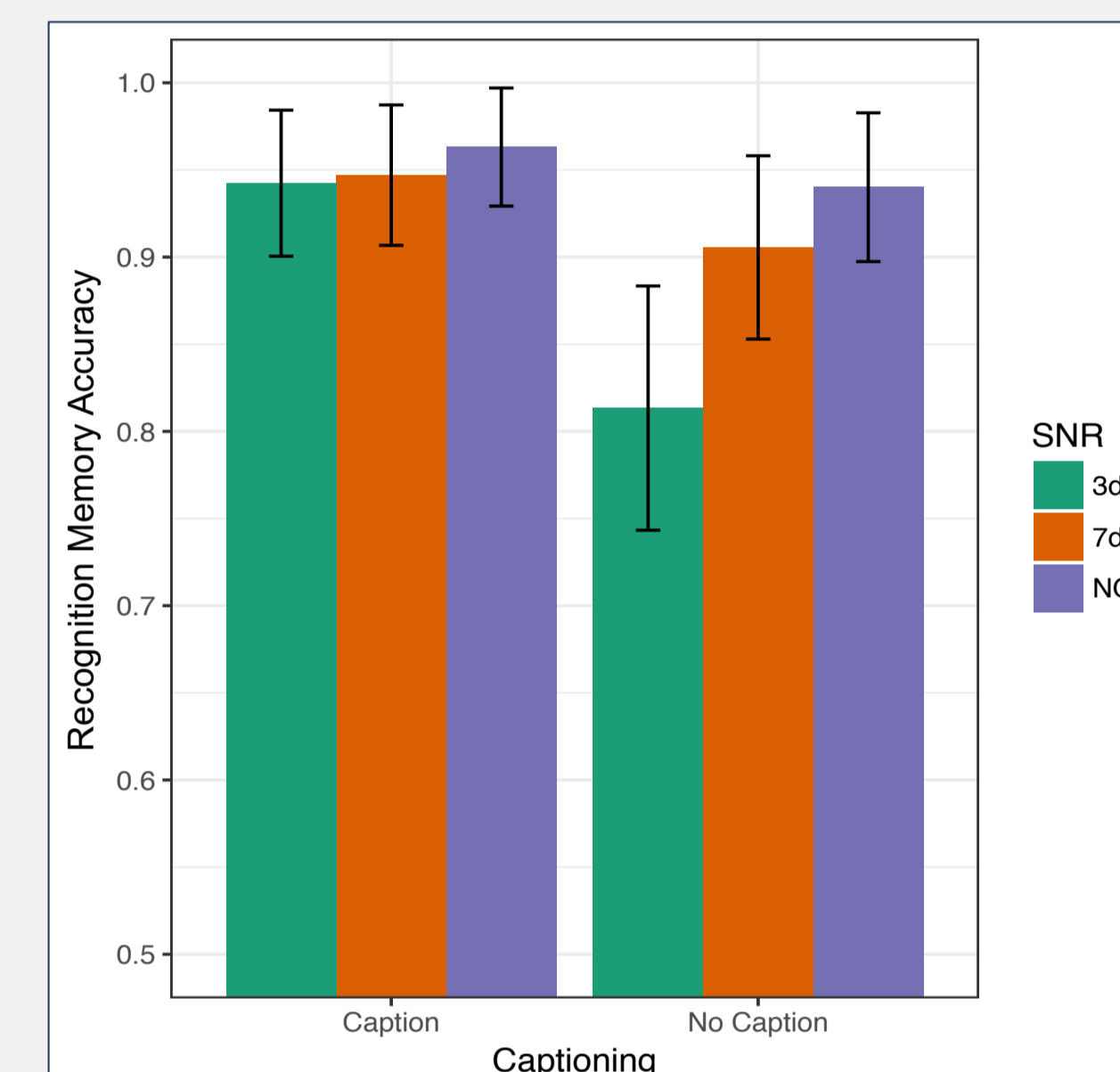
Caption x Noise:  $\chi^2(2) = 20.44, p < .0001$   
Caption benefit in 3 dB SNR condition = 8.23,  $d = .75$

## Experiment 2 Results : Older Adults

- Sample:  $N = 31$  older adults.
- Mean age: 71 (range: 61 – 80).
- Mean high-frequency PTA (1, 2, 4kHz) in better ear: 22 dB HL (range: 10-40).

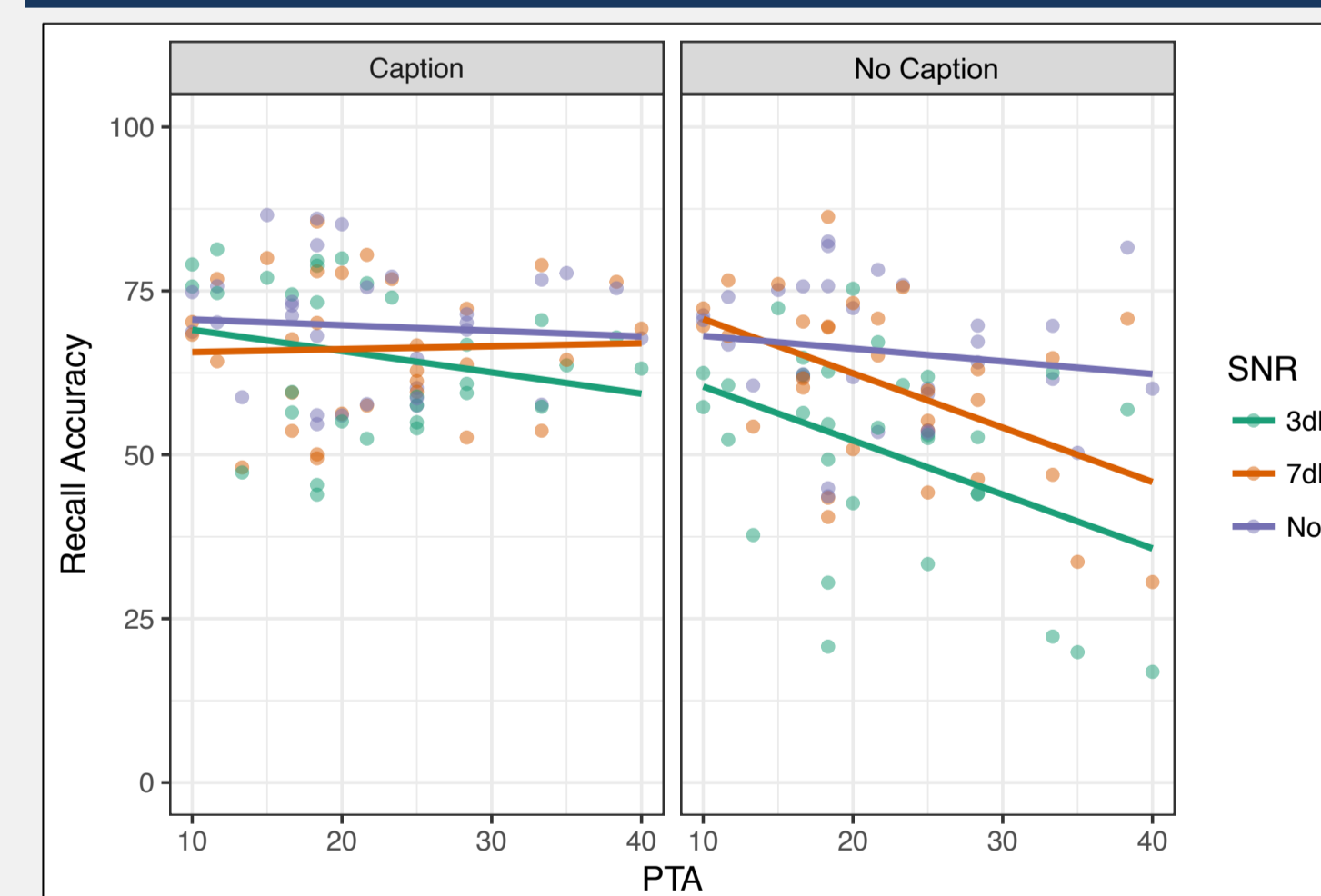


Caption x Noise:  $\chi^2(2) = 33.46, p < .001$   
Caption benefit in 3 dB SNR condition = 14.7 percentage-points,  $d = 1.10$



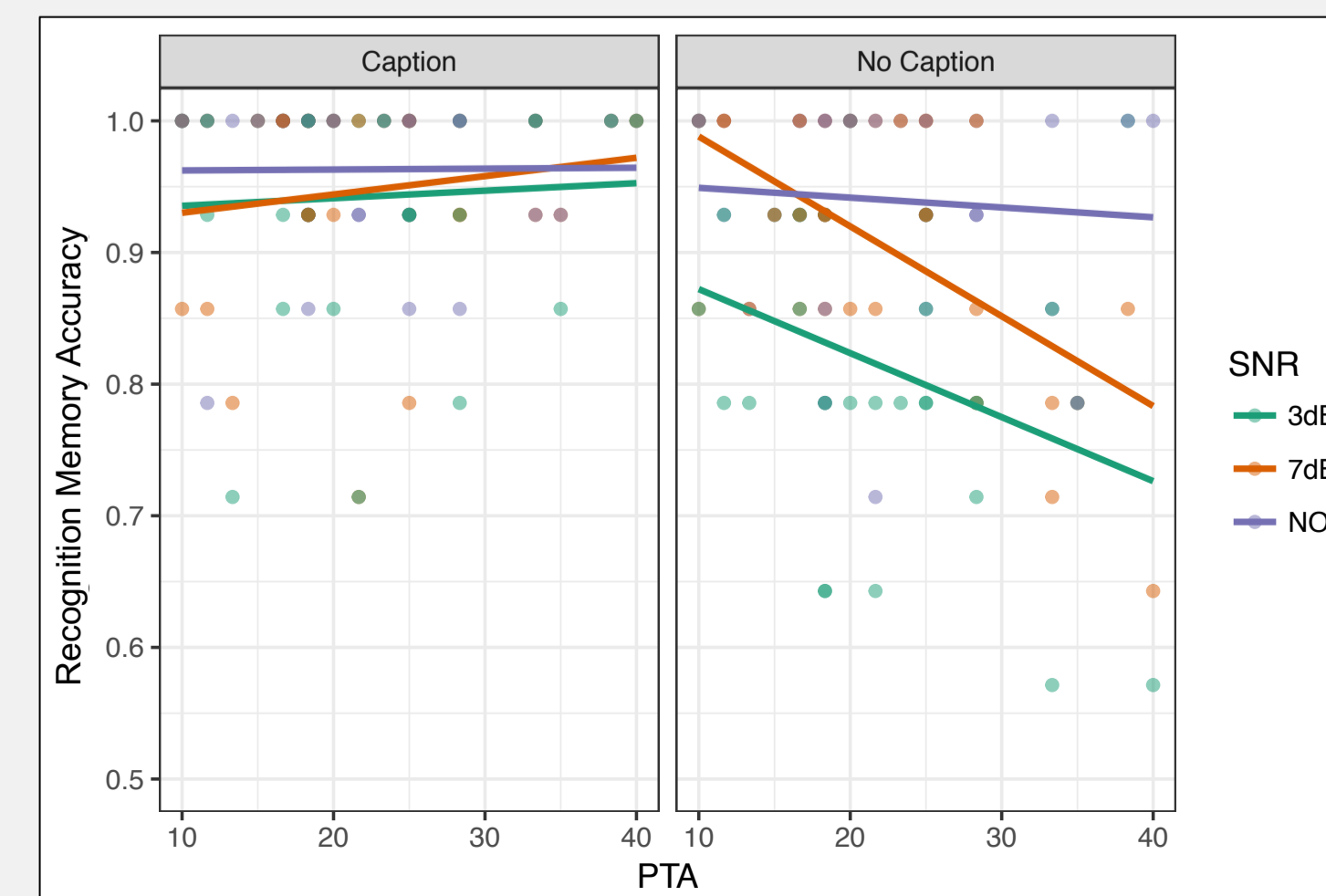
Caption x Noise:  $\chi^2(2) = 19.20, p < .0001$   
Caption benefit in 3 dB SNR condition = 12.9 percentage-points,  $d = 1.31$

## Interactions with Hearing Level



Effect	df	$\chi^2$	p-value
Caption	1	0.57	0.45
Noise	2	4.56	0.1
Hearing Level	1	1.9	0.17
Caption x Noise	2	12.73	0.002
Caption x Hearing Level	1	5.59	0.02
Noise x Hearing Level	2	5.81	0.05
Caption x Noise x Hearing Level	2	10.58	0.005

- No text captions: robust effects of hearing loss on speech recall in low SNR.
- Hearing loss effects attenuated with addition of text captioned speech.



Effect	df	$\chi^2$	p-value
Caption	1	0.03	0.87
Noise	2	0.83	0.66
Hearing Level	1	0.11	0.74
Caption x Noise	2	5.4	0.07
Caption x Hearing Level	1	5.69	0.02
Noise x Hearing Level	2	0.38	0.83
Caption x Noise x Hearing Level	2	5.8	0.06

- No text captions: hearing loss predicts reduced recognition memory.
- Text captioning eliminates effects of hearing loss on recognition memory.

## Summary & Conclusion

- Findings from both experiments converged in showing reliable improvements in speech memory with assistive text captioning.
- Although effect sizes were largest among OA with hearing loss, the benefits of text captioning for subsequent memory were even apparent in YNH listeners.
- We replicated the negative influence of background noise on speech memory, with highly consistent results across both experiments in recognition and recall.
- In Exp 2, effects were more pronounced among OA with hearing loss.
- Most critically, we found evidence for interactions between hearing loss, acoustic challenge, and text captioning, such that the negative effects of increased noise and hearing loss on speech recall and recognition were largely attenuated with text captioned speech.
- These benefits were substantial in some cases (e.g., for recall, where OAs showed a ~15 percentage-point improvement in memory with captions in the most acoustically challenging situation).
- Findings suggest promising benefits of text captioning for improving speech memory in effortful listening situations.

## References

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## Funding and Contact

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Correspondence: [brennan.payne@psych.utah.edu](mailto:brennan.payne@psych.utah.edu)