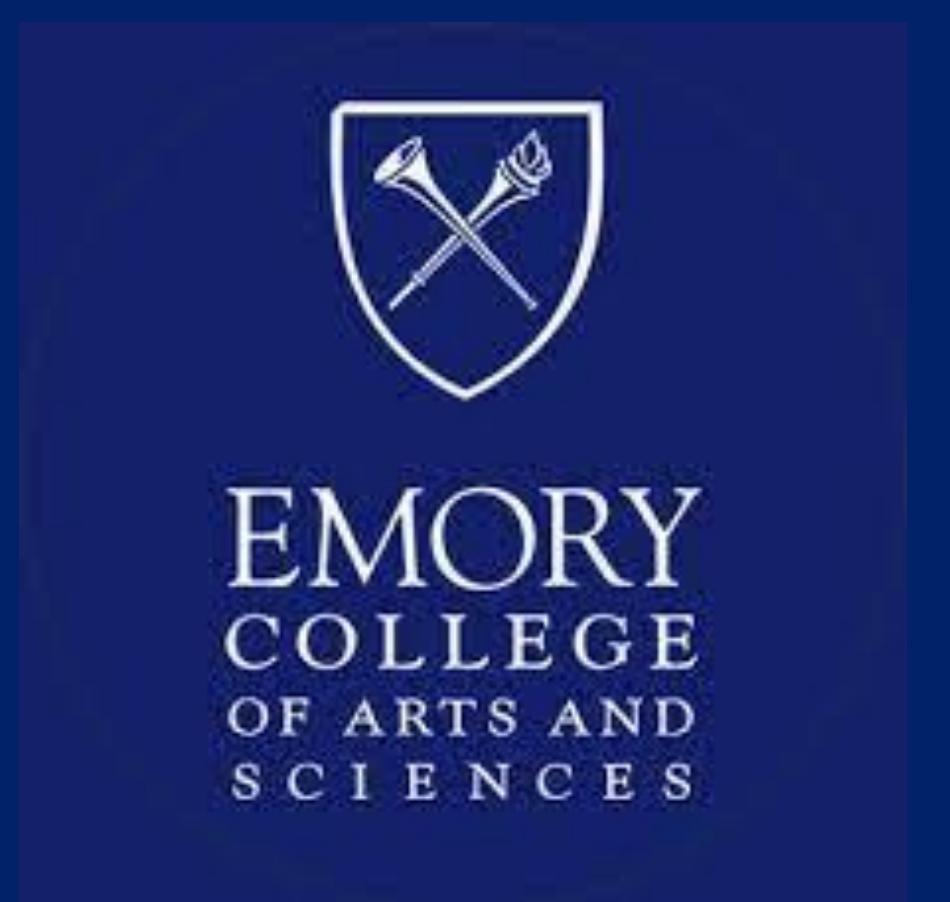


The Effects of Cognitive Effort and Post-Encoding Emotional Arousal on Recognition Memory Performance

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Background

- Emotion tends to enhance memory, known as the emotional enhancement of memory effect¹
- **Post-encoding emotional arousal** presents emotional stimuli after encoding and has been shown to enhance memory for neutral stimuli²
- Greater **cognitive effort** (the proportion of available cognitive capacity allocated to a given task) has been shown to enhance memory recall³
- However, one study found that physiological arousal enhanced memory for weakly encoded information more than it did for strongly encoded information⁴
- Interestingly, the interaction between **cognitive effort** and **post-encoding emotional arousal** has yet to be studied

Aims and Hypotheses

- To determine if words and word pairs encoded with high **cognitive effort** will have enhanced recognition memory performance relative to the words and word pairs encoded with low **cognitive effort**, regardless of condition
 - a. Prediction: high effort > low effort
- To determine if the negative condition will have enhanced recognition memory performance for the words and word pairs encoded with low **cognitive effort** relative to the neutral condition words and word pairs encoded with low cognitive effort
 - a. Prediction: negative low effort > neutral low effort

Methodology

- Final: n = 22 participants
- Neutral words were selected from the Glasgow Norms based on arousal, valence, concreteness, imaginability, and familiarity⁵

Encoding day 1

- word and word pair tasks followed by 2, 3 minute negative (e.g. gore) or neutral (TED Talk) video clips
- Encoding presentation: 30 pairs, 60 words, 30 pairs, 60 words, 30 pairs
- Participants were instructed to create a sentence or image in their mind for each word and an association for each word pair and then rate whether it was easy, hard, or if they were unable to do so
- “Easy” rating represented low-**cognitive effort** and “hard” rating represented high-**cognitive effort**

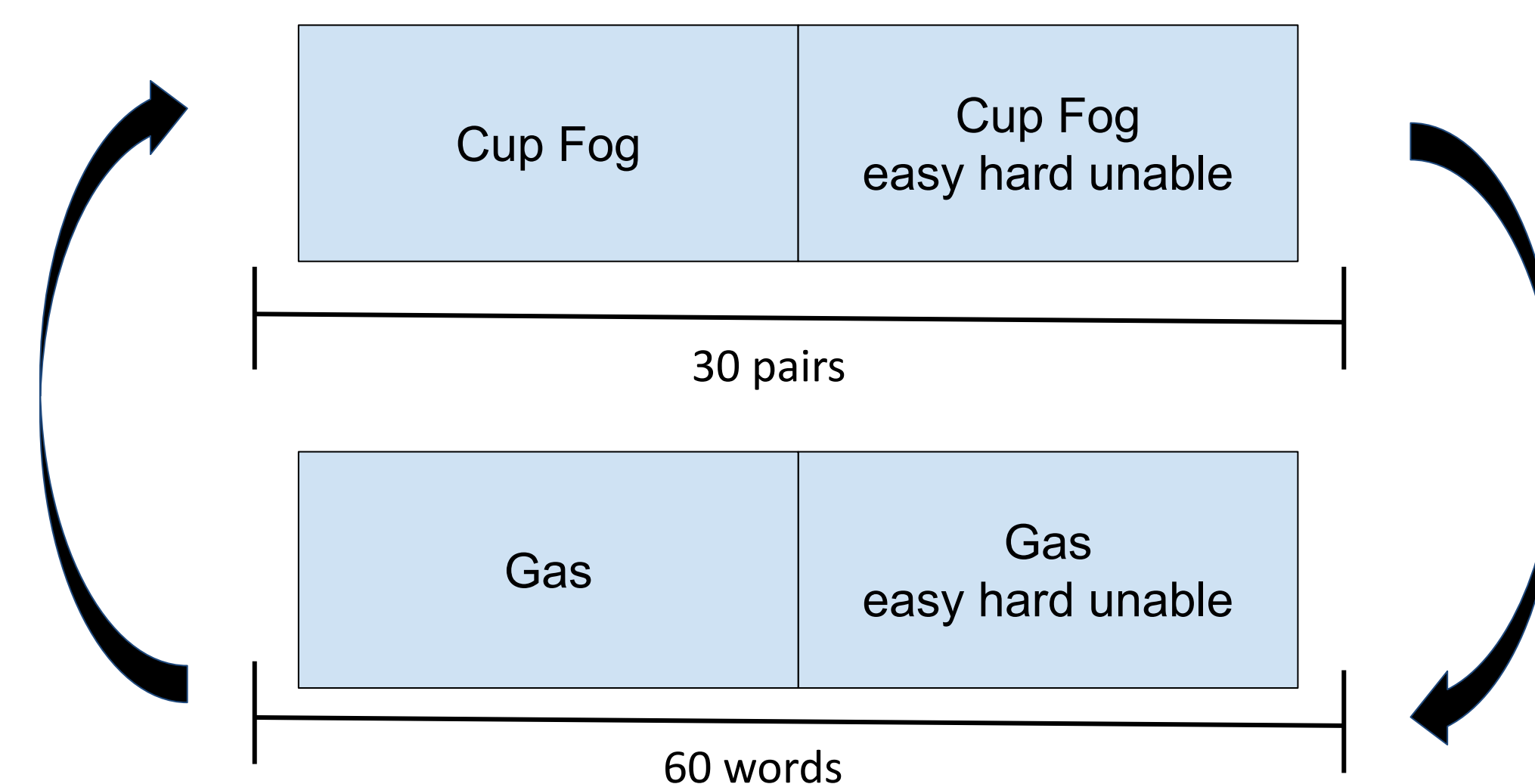


Fig 1. Encoding task day 1

Retrieval day 2

- 24 hours after encoding, participants completed a recognition memory task
- Total: 60 intact pairs and 30 recombined; 120 targets and 60 lures

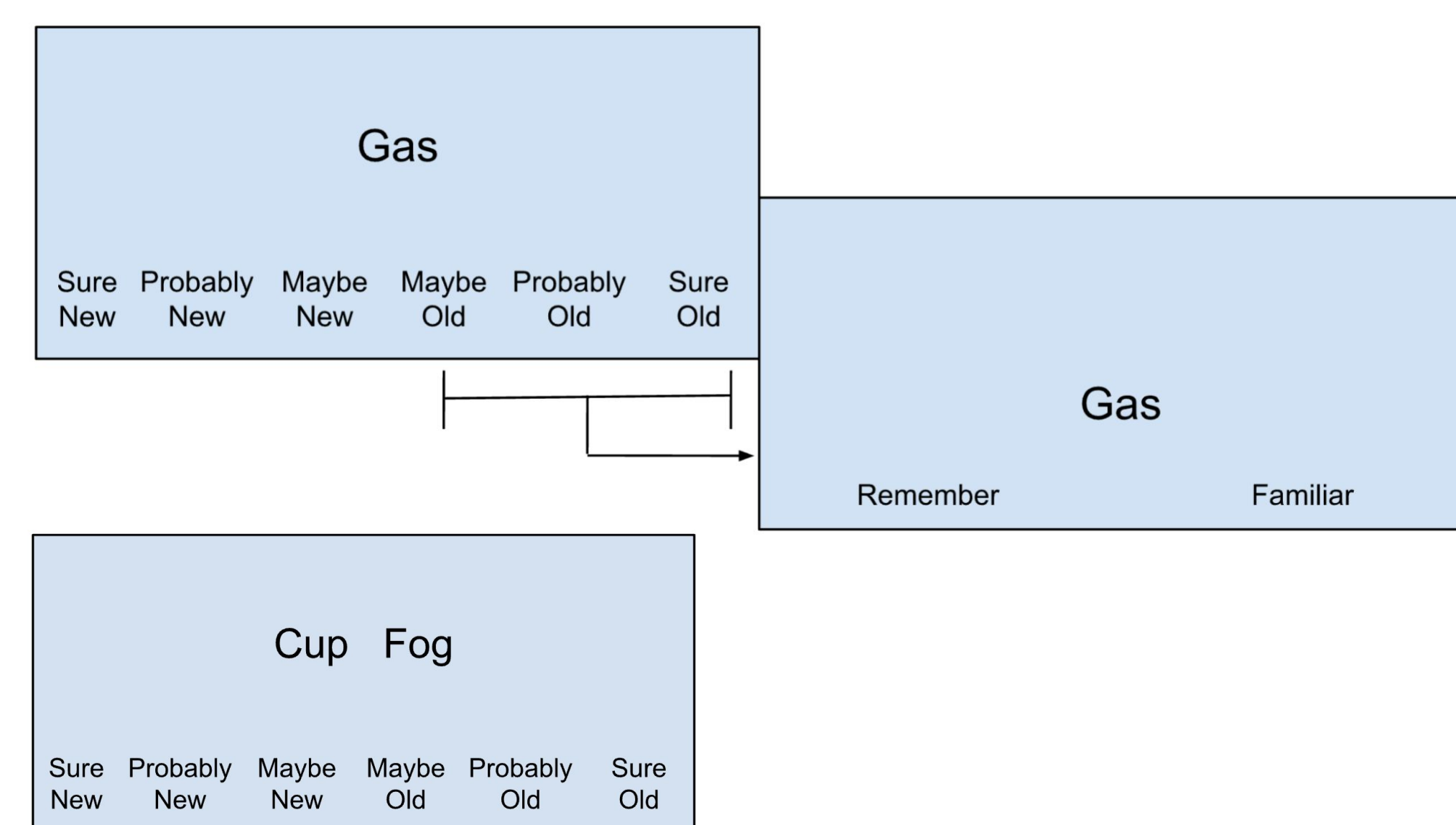
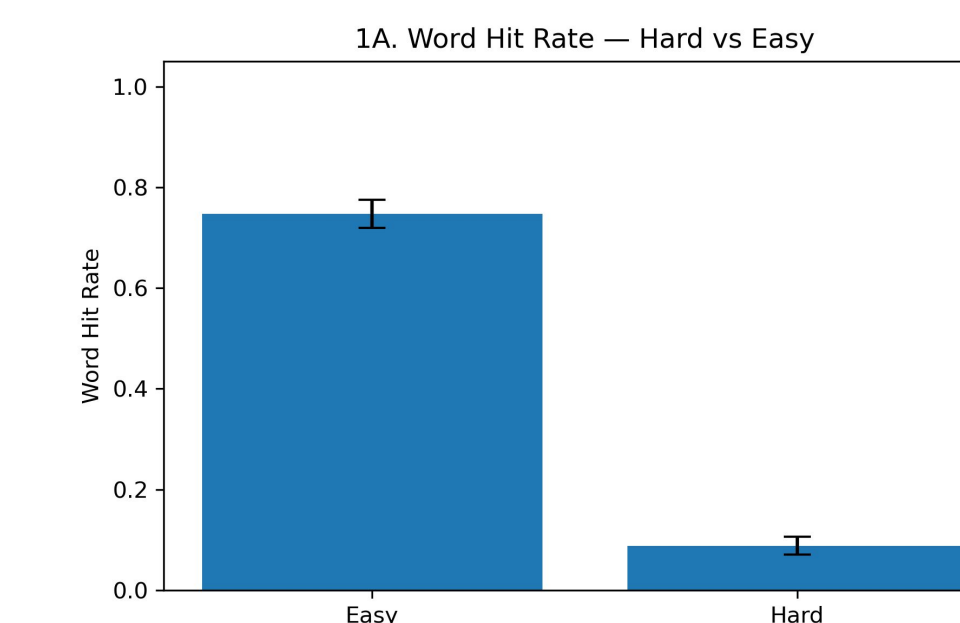


Fig 2. Retrieval task day 2

Results

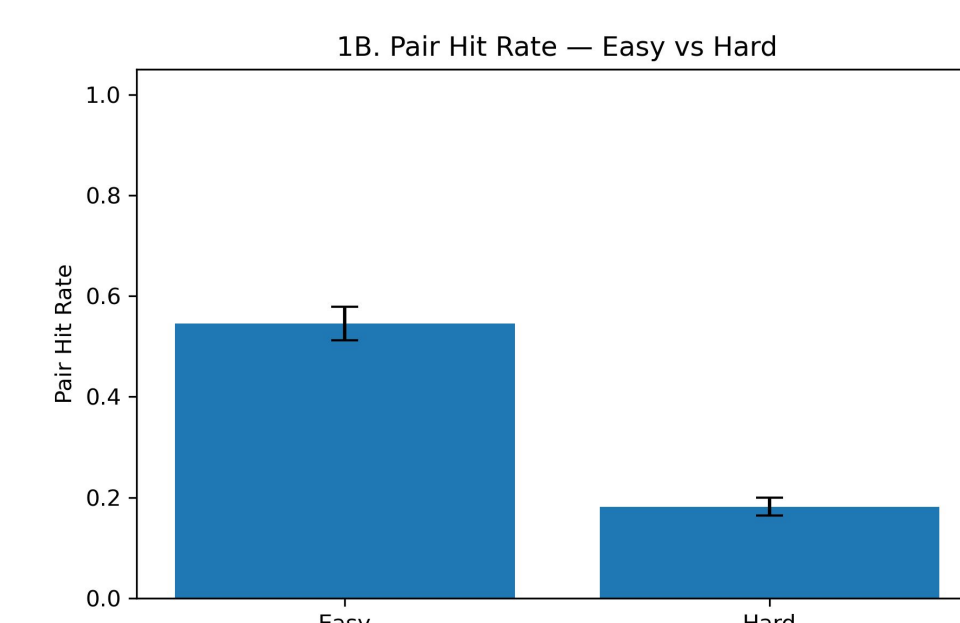
1. Low- effort (easy) and high-effort (hard) hit rate across conditions

1A. Word Hit Rate



Recognition memory performance for easy words was enhanced relative to hard words ($p < 0.001$)

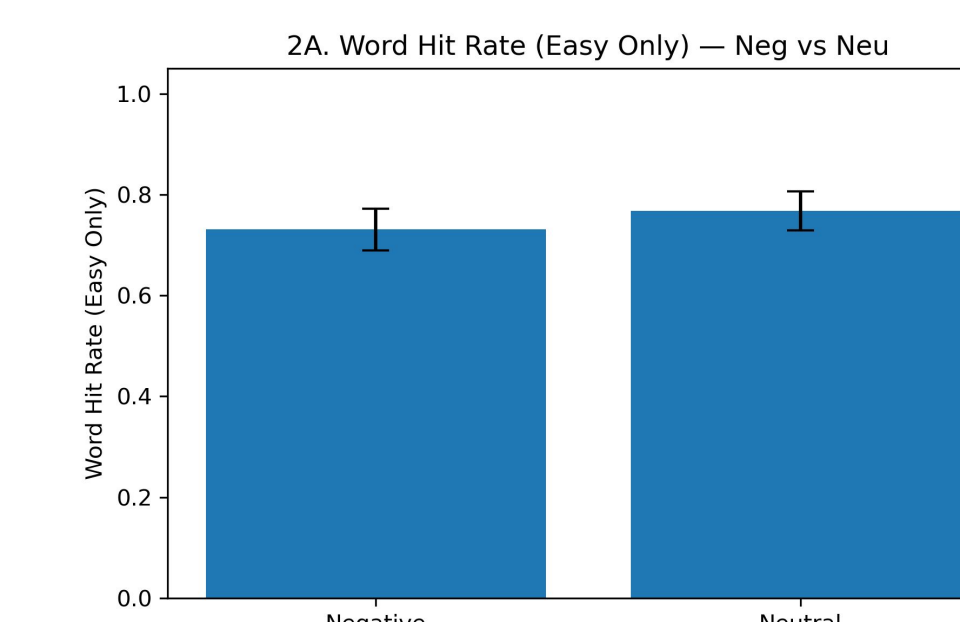
1B. Pair Hit Rate



Recognition memory performance for easy pairs was enhanced in comparison to hard pairs ($p < 0.001$)

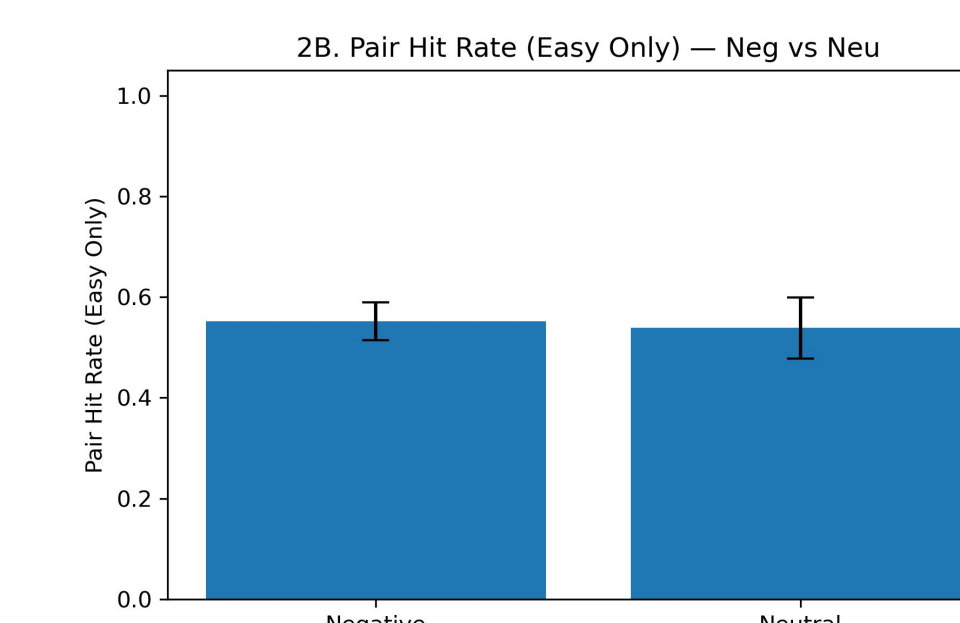
2. Condition comparison of the effect of emotion on low-effort (easy) hit rate

2A. Word Hit Rate



Recognition memory performance for easy words was not enhanced in the negative condition relative to the neutral condition ($p = 0.521$)

2B. Pair Hit Rate



Recognition memory performance for easy word pairs was not enhanced in the negative condition relative to the neutral condition ($p = 0.872$)

Discussion and Conclusion

- Recognition memory performance for low-effort words and word pairs (“easy”) was enhanced relative to low-effort words (“hard”), while they are not enhanced by emotions.
 - a. Partially consistent with research supporting that greater **cognitive effort** employed during encoding results in enhanced memory. The reverse result for pairs could be due to the interaction with **post-encoding emotional arousal** or the association task.
- Recognition memory performance for low-effort words (“easy”) was not enhanced for the negative condition relative to the neutral condition.
- The lack of significance in words could be due to the use psychological arousal (shock), rather than emotional arousal⁴

Future Direction

- Combine behavioral data with physiological data and survey responses
- Application in research on improving and developing learning and memory strategies

References

1. Ack Baraly, K., Hot, P., Davidson, P., & Talmi, D. (2016). How Emotional Arousal Enhances Episodic Memory. In J. H. Byrne (Ed.), *Learning and Memory: A Comprehensive Reference* (2nd ed.). Elsevier BV.
2. Nielsen, K.A., D. Yee, & K.I. Erickson. (2005). Memory enhancement by a semantically unrelated emotional arousal source induced after learning. *Neurobiology of Learning and Memory* 84, 49-50
3. Mitchell, D. B., & Hunt, R. R. (1989). How much “effort” should be devoted to memory? *Memory & Cognition*, 17(3), 337-348. doi: 10.3758/BF03198472
4. Dunsmoor JE, Murty VP, Davachi L, Phelps EA. (2015). Emotional learning selectively and retroactively strengthens memories for related events. *Nature*, 520(7547), 345-8. doi: 10.1038/nature14106
5. Scott GG, Kellie A, Becirspahic M, Yoo B, Sereno SC. (2019). The Glasgow Norms: Ratings of 5,500 words on nine scales. *Behav Res Methods*, 51(13), 1258-1270. doi: 10.3758/s13428-018-1099-3
6. Dunsmoor JE, Murty VP, Davachi L, Phelps EA. (2015). Emotional learning selectively and retroactively strengthens memories for related events. *Nature*, 520(7547), 345-8. doi: 10.1038/nature14106

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