

## Introduction

### Background

- Music can induce emotion in its listeners through many different mechanisms, such as emotional contagion<sup>3</sup>.
- Music is commonly used as a mood regulator in everyday listening<sup>5</sup>.
- Music also commonly evokes autobiographical memories. When this occurs, we may additionally re-experience the emotions of the original memory<sup>2</sup>.

### Research Questions

- We aim to understand whether music can be used to modulate human emotional memories during their recollection.
- Which neural systems are critical in supporting music's interaction with emotional memories?

### Motivations

- The modulation of emotional, potentially maladaptive, autobiographical memories is a key component for treatment of mood-related disorders such as depression or PTSD<sup>4</sup>.
- Results of this study will provide insight into the development of musical memory protocols as clinical tools for mood-related disorders.
  - Could music be further used as a mood regulator to alter how humans remember negative past events?

## Prior Results (Pilot Study)

### Overview

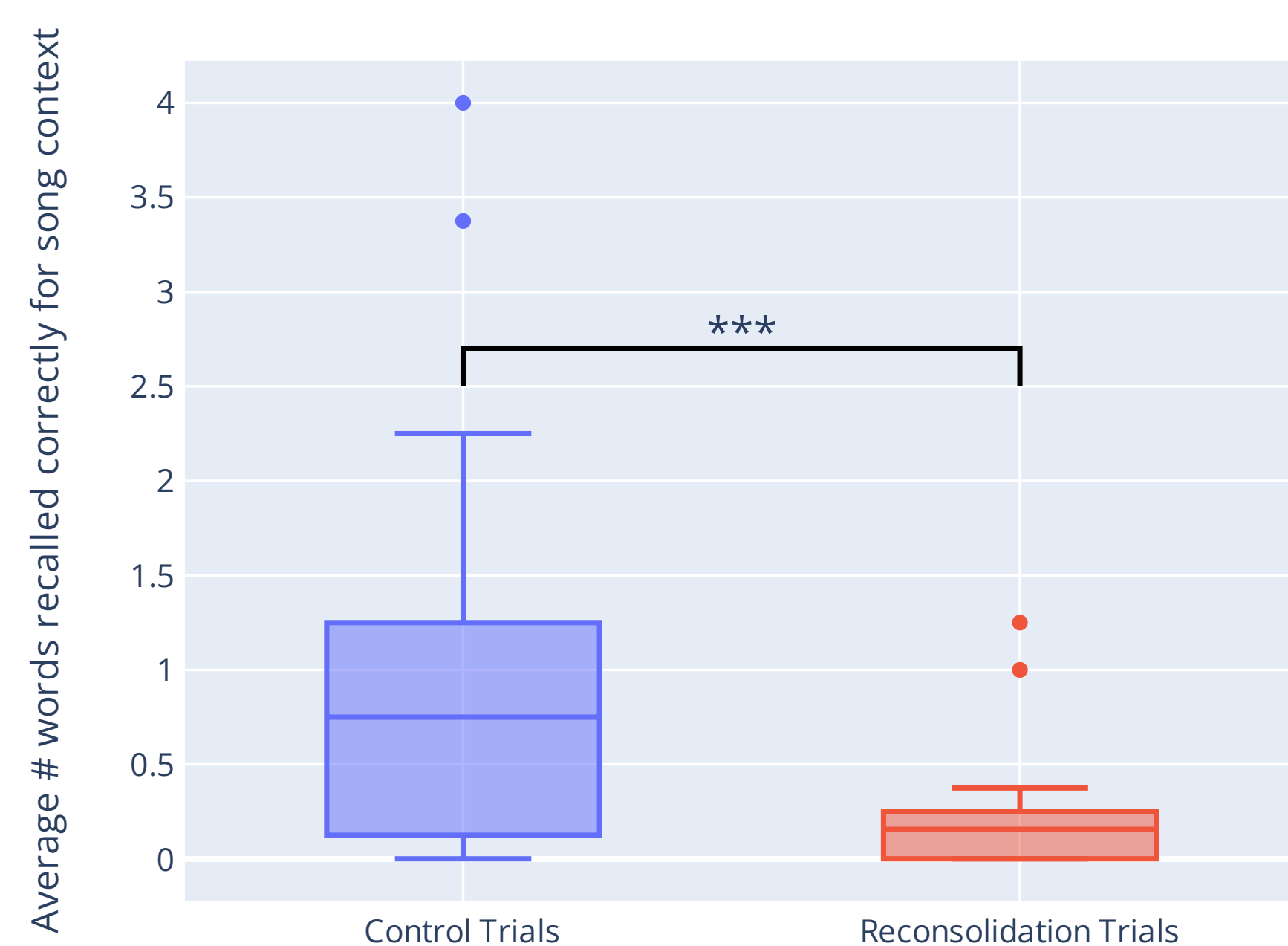
- In previous work, we conducted a behavioral pilot study under a similar 3-day paradigm as the current work which explored music as a contextual link when modulating emotional memory.

### Prior Methods

- In a story-making task, participants (N = 26) created and memorized fictional autobiographical episodes using provided emotion-laden words from the ANEW<sup>1</sup> dataset paired with emotional music "contexts" from the Film Soundtracks<sup>6</sup> dataset.
- Episode-music pairings were created and memorized on both days 1 and 2, with some of the same music contexts re-presented on day 2 (reconsolidation trials) while others were left as controls (presented on day 1 only).

### Results

- Day 1 memories showed significant memory interference from day 2 trials which re-presented the same music with new episodes (reconsolidation trials), compared to control episodes omitted from music-based memory manipulation ([t(25) = 4.1, p < 0.001]).
- This suggests music was acting as an associative link between day 1 and 2 episodes.

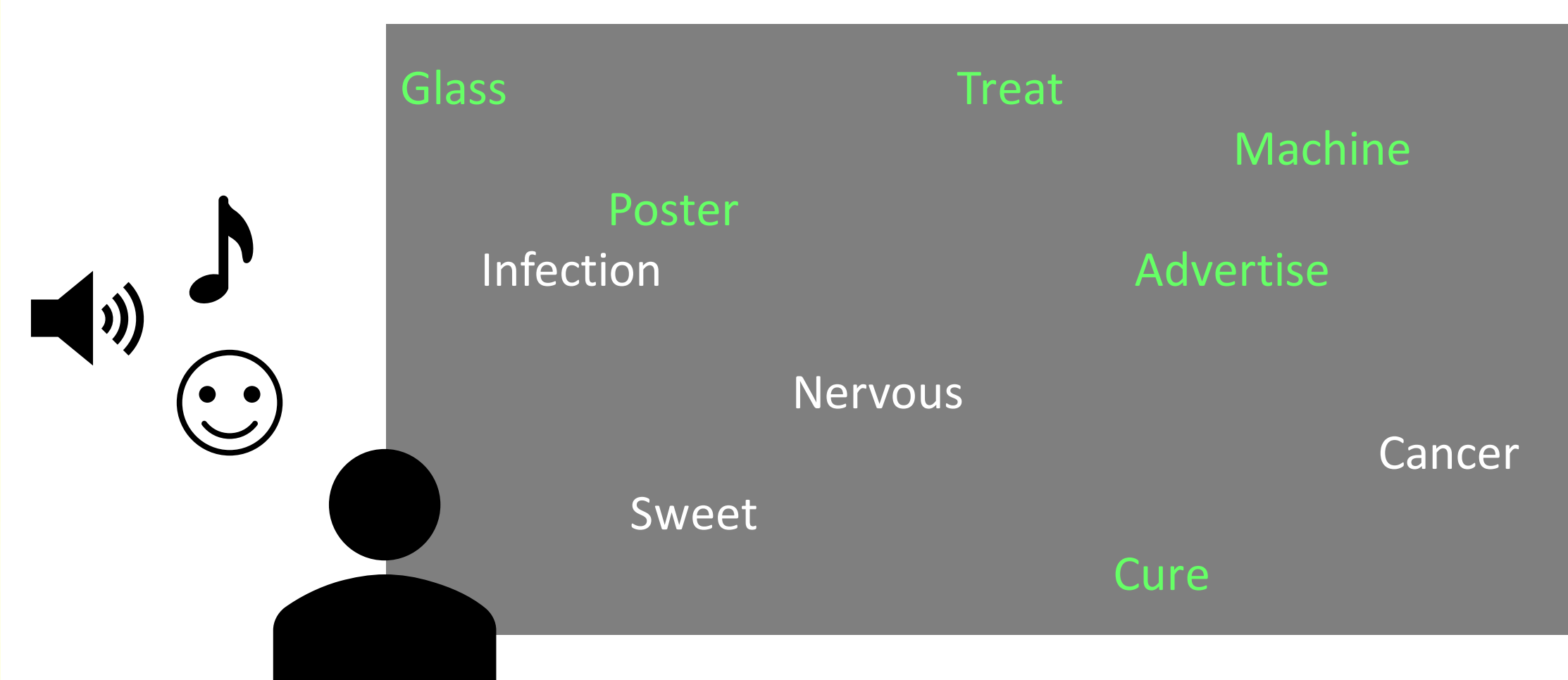


## Current Method

**Day 1:** Guided imagery task where participants experience 15 neutral-valence episodes.

After finishing the preliminary paperwork and handing it back to the reception lady, I sat back down in the waiting area of the clinic. I had already been waiting for 10 minutes, so I decided to go get something from the vending machine. Out of boredom, I stopped and stared at my reflection in the glass surface of the machine. After a moment, I put my money in and got a drink. I noticed a poster next to the vending machine advertising the clinic's services and doctors' experiences. As I was reading it, I heard someone finally call my name.

**Day 2 (+ fMRI):** Word selection task (neutral words from Day 1 episodes + emotional lures) with positive, negative, or no music.



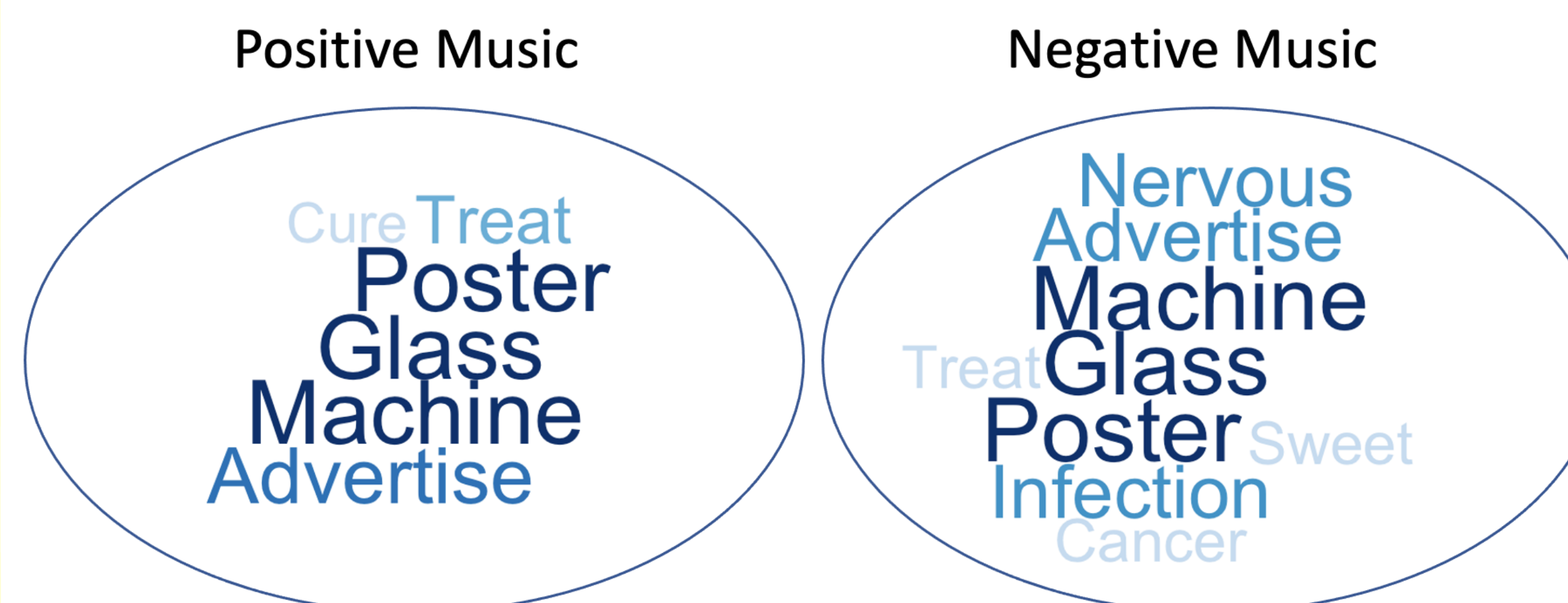
**Day 3:** Cued recall and recognition tests.

## Episode Recollection with Music (Day 2)

### Current results (N = 8)

- On day 2 participants were asked to recall and re-experience each story based on cue (neutral) words on the screen (mixed with emotional lure words) paired with randomly selected background music or silence.

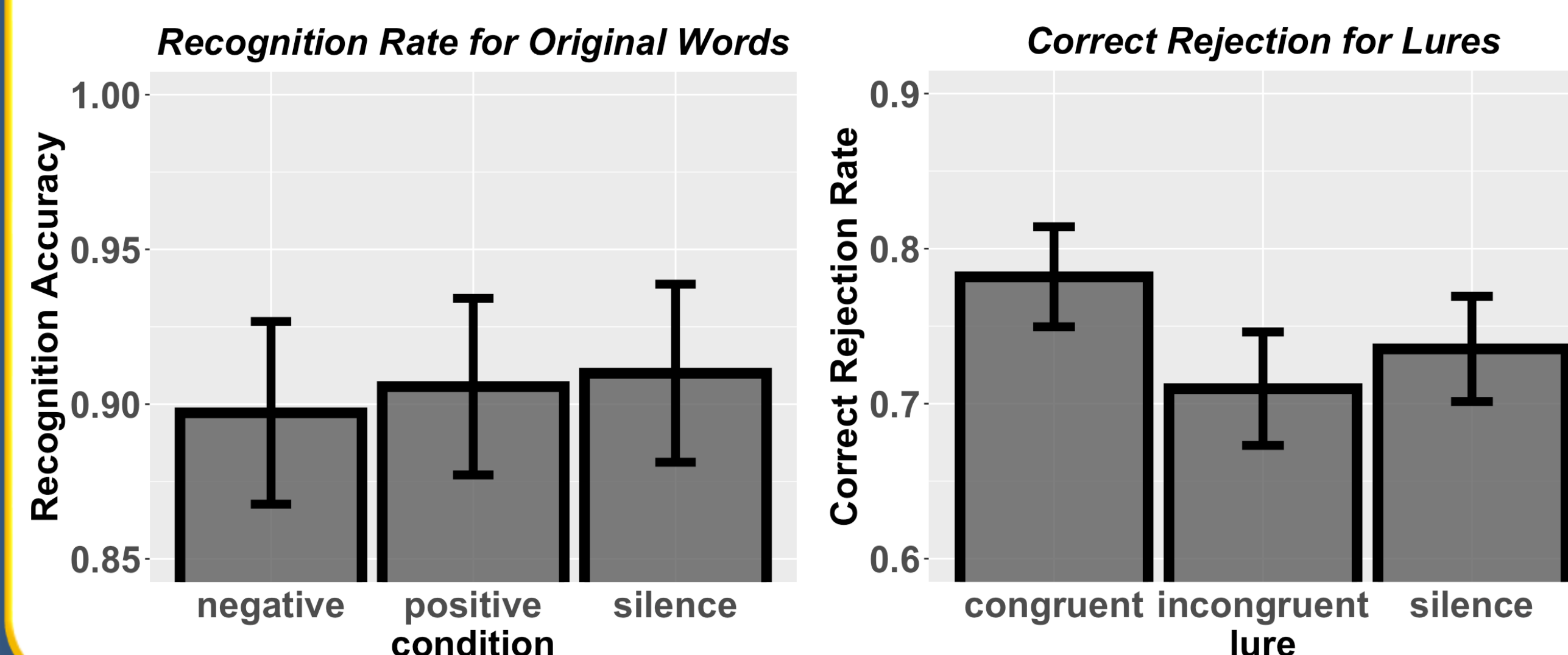
Frequency analysis (N = 8) of words selected for one story (full text below) under different music conditions



**ORIGINAL STORY:** After finishing the preliminary paper work and handing back to the reception lady, I sat back down in the waiting area of the clinic. I had already been waiting for 10 minutes, so I decided to go get something from the vending machine. Out of boredom, I stopped and stared at my reflection in the glass surface of the machine. After a moment, I put my money in and got a drink. I noticed a poster next to the vending machine advertising the clinic's services and the doctors' experiences. As I was reading it, I heard someone finally call my name.

## Word Recognition (Day 3)

- Randomly selected words (original words, lures from day 2, or novel words) were presented. Participants must decide if the word is from an original story.
- **Successful recognition for original words:** silence condition showed slightly better recognition rates than emotional conditions.
  - Music intervention on day 2 might interfere with recollection of details from the original story.
- **Successful rejection for emotional lures:** participants were more likely to reject lures that were congruent to the background music (e.g., negative lures when presented with negative music)
  - Congruent music switched the attention to the congruent lures and participants had a better memory of that lures being presented on day 2 specifically.
  - Psychology of memory: one needs to memorize to reject.



## Future Plan and Conclusion

- We aim to collect fMRI and behavioral data from 40 participants.
- Day 2 MRI predictions**
  - We predict to see more activation in emotion-related brain areas (e.g., orbitofrontal cortex, amygdala and hippocampus) for the emotional music conditions than silence. We hypothesize that emotional music will activate a broader brain network which will lead to day 3 recollection with more new details (lure words).
- Day 3 recall NLP & sentiment analysis**
  - We predict stories that are recollected with emotional music on day 2 (compared to silence) will be recalled with more emotional details and fewer neutral details.

### Conclusion

- Music listening during episodic memory recollection might modulate memory accuracy and induce integration of new emotional components with the old memory.
- Our preliminary results suggested possibility of using music and its emotional feature to modulate human perception on their emotional episodic memory.

1. M. M. Bradley and P. J. Lang, "Affective Norms for English Words (ANEW): Instruction Manual and Affective Ratings," Technical Report C-1, The Center for Research in Psychophysiology, University of Florida, p. 49, 1999.
2. K. Jakubowski and A. Ghosh, "Music-evoked autobiographical memories in everyday life," Psychology of Music, vol. 49, no. 3, pp. 649–666, 2021.
3. P. N. Juslin, "From everyday emotions to aesthetic emotions: Towards a unified theory of musical emotions," Physics of Life Reviews, vol. 10, no. 3, pp. 235–266, 2013.
4. R. D. Lane, L. Ryan, L. Nadel, and L. Greenberg, "Memory reconsolidation, emotional arousal, and the process of change in psychotherapy: New insights from brain science," Behavioral and Brain Sciences, vol. 38, E1, 2015.
5. T. Schäfer and P. Sedlmeier, "From the functions of music to music preference," Psychology of Music, vol. 37, no. 3, pp. 279–300, 2009.
6. J. Vuoskoski, W. Thompson, D. McIlwain, and T. Eerola, "Who Enjoys Listening to Sad Music and Why?" Music Perception, vol. 29, no. 3, pp. 311–317, 2012.