Multi-Modal Memory Dataset: High-Density fMRI Sampling of Human Memory

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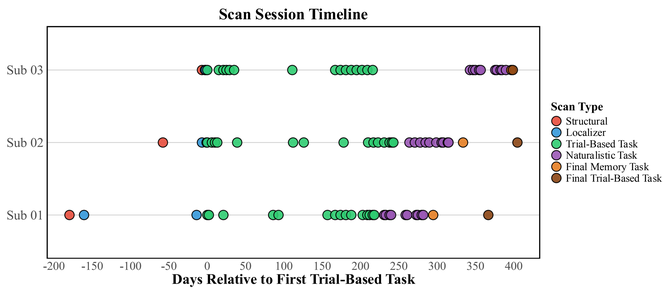
Introduction

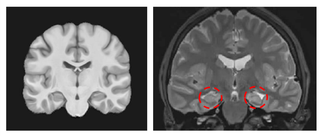
- **Goal of MMM Dataset:** create an open resource of densely sampled[5], 3T fMRI data of humans engaging in encoding, consolidation, and retrieval of trial-based and naturalistic episodic memories.
  - **Inspired by:** Naturalistic Scenes Dataset[1]
- Track visual, auditory, and verbal recall process across **multiple modalities and sessions**.

Methods

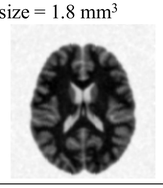
Participants: N = 3, (6 planned)
- Age (22-30), sex (2 males, 1 female)
- VVIQ score (Sub-01 = 54, Sub-02 = 72, **Sub-03 = 16**)



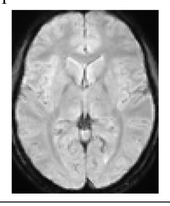
Structural
- T1w MPR, T2w oblique



DWI
- CMRR diffusion
- Voxel size = 1.8 mm^3

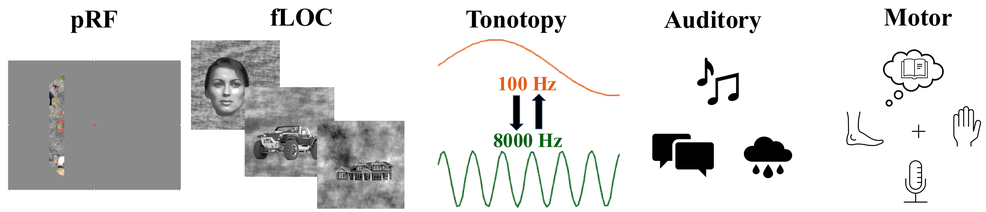


Functional
- BOLD: EPI
- 183 total functional scans
- Multiband Acceleration Factor = 3
- 69 Slices, 2 mm slices
- In-plane resolution = 1.8 mm^2

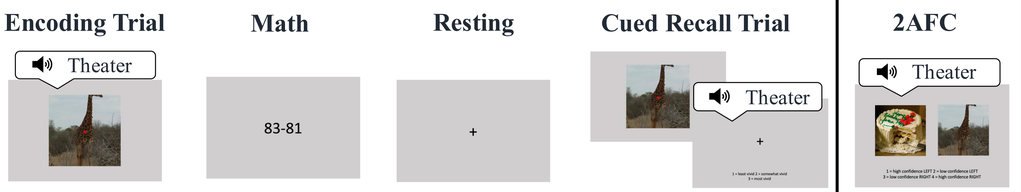


Behavioral/Physiological:
- Pre-session Questionnaire
- Heart Rate
- Respiration
- Reconstructed Eye Movement

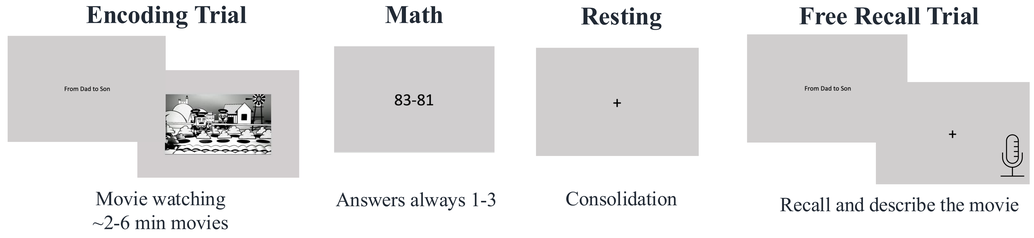
Localizer Task



Trial-Based Task

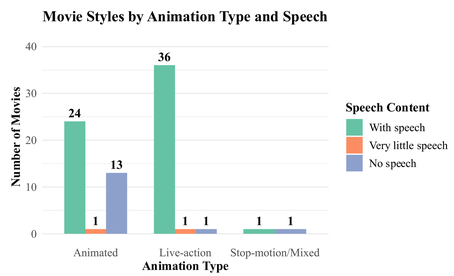


Naturalistic Task



Stimulus

- 1000 NSD shared naturalistic images[1]
- Toronto Word Pool[3] - AI vocalization
  - 4 randomly selected voices
- Movie clips

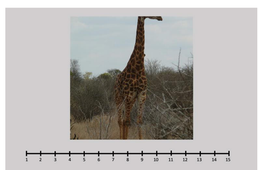


Final Tasks

Final Memory Task: Recall as many details as possible about the entire experiment.

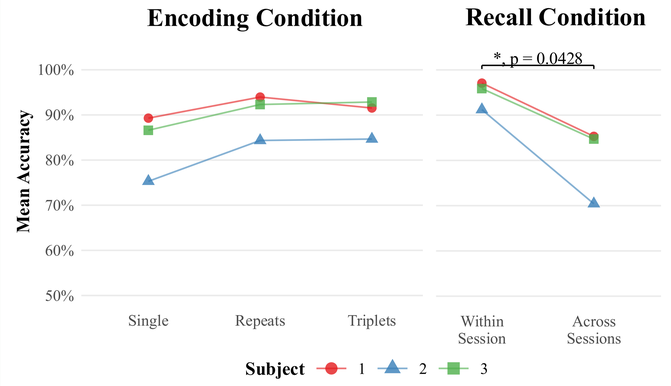
Final Trial-Based Task
- Fixation Calibration
- Cued Recall Trial
- Timeline Task
- Association Recognition Task

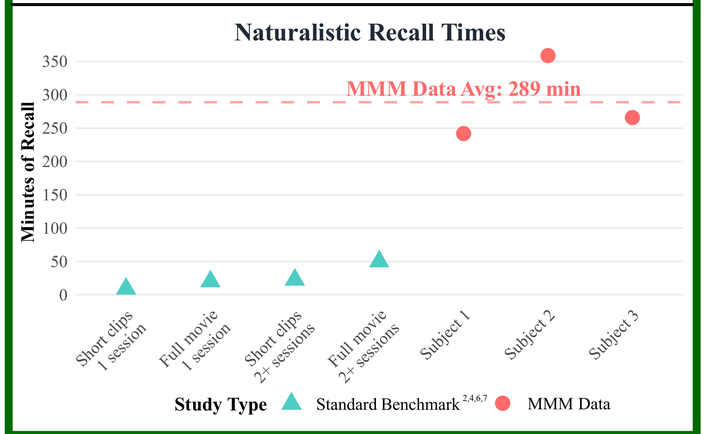
Timeline Task



Outside scanner: Temporal Memory

Results





Conclusion

- What the open-source dataset will hold:
  - Memory BOLD data: 75+ sessions
  - Free recall transcriptions
  - Recall and movie time mapping
  - Stimuli: 1000 NSD shared naturalistic images, Toronto Word Pool- AI vocalization, movie clips
- Available in 2027

References

1. Allen, E. J., St-Yves, G., Wu, Y., Breedlove, J. L., Prince, J. S., Dowdle, L. T., Nau, M., Caron, B., Pestilli, F., Charest, I., Hutchinson, J. B., Naselaris, T., & Kay, K. (2022). A massive 7T fMRI dataset to bridge cognitive neuroscience and artificial intelligence. *Nature Neuroscience*, *25*(1), 116–126. https://doi.org/10.1038/s41593-021-00962-x
2. Chen, J., Leong, Y. C., Honey, C. J., Yong, C. H., Norman, K. A., & Hasson, U. (2017). Shared memories reveal shared structure in neural activity across individuals. *Nature Neuroscience*, 20(1), 115–125. https://doi.org/10.1038/nn.4450
3. Friendly, M., Franklin, P. E., Hoffman, D., & Rubin, D. C. (1982). The Toronto Word Pool: Norms for imagery, concreteness, orthographic variables, and grammatical usage for 1,080 words. *Behavior Research Methods & Instrumentation,* 14(4), 375–399. https://doi.org/10.3758/BF03203275
4. Michelmann, S., Staresina, B. P., Bowman, H., & Hanslmayr, S. (2019). Speed of time-compressed forward replay flexibly changes in human episodic memory. *Nature Human Behaviour*, *3*(2), 143–154. https://doi.org/10.1038/s41562-018-0491-4
5. Naselaris, T., Allen, E., & Kay, K. (2021). Extensive sampling for complete models of individual brains. *Current Opinion in Behavioral Sciences*, *40*, 45–51. https://doi.org/10.1016/j.cobeha.2020.12.008
6. Raccah, O., Chen, P., Gureckis, T. M., Poeppel, D., & Vo, V. A. (2024). The "Naturalistic Free Recall" dataset: Four stories, hundreds of participants, and high-fidelity transcriptions. *Scientific Data*, *11*(1), 1317. https://doi.org/10.1038/s41597-024-04082-6
7. Zadbood, A., Chen, J., Leong, Y. C., Norman, K. A., & Hasson, U. (2017). How we transmit memories to other brains: Constructing shared neural representations via communication. *Cerebral Cortex, 27*(10), 4988–5000. https://doi.org/10.1093/cercor/bhx202