How can we effectively reinstate narrative memory?

Mareike Carolin Keller

Honors Program

May 19th, 2022

Abstract

Studies have shown that the hippocampus is primarily active during the offset of an event. The strength of the hippocampal response is an indicator of better memory performance during recall. Moreover, key events in the narrative are more likely to produce large hippocampal responses. To see if a higher hippocampal response during encoding of an event also leads to better memory of related events during recall, this study uses reminder stimuli consisting out of high or low hippocampal response during encoding to investigate which kinds of reminders are most successful at effectively reinstating the memory of a narrative. Participants watched an episode of the TV show “Merlin”. After a three-week delay, they then completed a free recall after being reminded with events corresponding to either high or low hippocampal activity during encoding. This study found no significant difference in recall accuracy between conditions. Thus, there is no evidence that reminders based on high hippocampal activity during watching/encoding lead to better memory of related events.

When experiencing different events in their lives, for example, core memories such as birthdays, episodic memory allows people to remember the details associated with said event. Over the past decades, research has been dedicated to further breaking down the well-studied concept of episodic memory.

One theory explaining how people segment episodes in episodic memory is event segmentation theory (Ezzyat & Davachi, 2010). In their study, Ezzyat & Davachi (2010) found that participants showed better long-term memory of details within an event than memories that spanned across event boundaries, the points of transition between two discrete events in an episode. These findings suggest that people organize their narrative memory using the mechanism of event segmentation.

Since narratives, such as stories, movies, or shows, largely represent the way we perceive real-life events, which we segment into episodes, they are well-suited for studying episodic or narrative memory. Similarly, when creating memories for narrative stories, such as a TV show, people dissect the narrative into meaningful events divided by event boundaries (DuBrow & Davachi, 2014). In films or shows, people often divide the narrative by different scenes or intervals in the plot that we think coherently fit together.

While Ezzyat & Davachi's (2010) fMRI data determined that the binding of within-event details is a result of integration processes during the encoding of a narrative, subsequent research identified the bilateral hippocampus, a brain structure known to be involved in the encoding of episodic memories, as one of the brain regions involved in said integration of information of episodic memory (Ben-Yakov & Dudai, 2021). The same study suggests that post-stimulus activity represents an encoding process that is correlated with subsequent memory of the encoded episode (Ben-Yakov & Dudai, 2021). Follow-up studies have also shown that the hippocampus is especially active at event boundaries and at the offset of an event (Ben-Yakov et al., 2013, 2018, Cohen, 2021). Furthermore, research shows that the amount of hippocampal activity at the end of an event is related to later memory for that event,

with higher activation at the end of an event indicating encoding and, subsequently, better memory performance (Ben-Yakov et al. 2011, Reagh et al. 2020). Similarly, there is evidence that the strength of this boundary-related hippocampal activity predicts the extent to which the neural pattern for an event will reappear during recall (Baldassano et al., 2017)

Interestingly enough, hippocampal post-event responses are also related to how semantically central an event is to a narrative, with key events that have strong causal connections for the narrative showing larger responses (Lee & Chen, 2021). We, therefore, think of these responses as a means to index the strength of memory encoding for each event during a narrative. If hippocampal responses are an indicator of the strength of memory encoding for each event during a narrative, then scenes in a narrative such as a TV show that is accompanied by strong hippocampal activation should be more likely to invoke memories of related events. If one wants to reinstate such memories, how can we most efficiently reinstate memory for a narrative using reminder clips featuring events from the narrative/TV show/movie?

In the past, there have been conflicting theories of how we perceive event boundaries and how they can be set to best reinstate memories. The role of the hippocampus in episodic memory has been of great interest, however, most studies use a short delay to study narrative memory. Also, very few studies have been working with content-based reminders to determine what kind of information is forgotten over long intervals (Tang et al., 2016). To see if there is a connection between the amount of hippocampal response during encoding and the memory of events related to key events during recall, this study has taken a novel approach to generating stimuli from hippocampal responses during encoding. This study investigates which kinds of reminders are most successful at effectively reinstating the memory of a narrative, allowing viewers to remember the whole story from only a few short reminder clips.

This study hopes to determine which parts of a movie induce the largest hippocampal activity and subsequently create reinstatement (known as previously on/recap) clips based on

this insight. Here, we compared two different types of reinstatement, based on scenes that correspond with low vs. high hippocampal activity, to see if scenes that indicated high activity in the hippocampus invoke more detailed semantic memory, especially of related events.

We hypothesize that providing reminders for strongly-encoded events (which evoke high levels of hippocampal response during viewing) will lead to the best overall recall of the narrative, since these “key” memories are the most accessible and may be the most important to the overall thread of the narrative. Consequently, if strongly-encoded events are best suited for effective recall of a narrative, viewing the strongly-encoded scene reminder will lead to the best memory accuracy (higher accuracy score) during recall. An alternative hypothesis is that providing reminders for weakly-encoded events (which evoked low levels of hippocampal response during viewing) will lead to better recall of the narrative since these memories might be otherwise forgotten and therefore must be cued with specific reminders.

The independent variable in this between-subjects design was whether and the type of recall participants were randomly assigned to, namely; whether they saw reminder clips from strongly-encoded scenes, reminder clips from weakly-encoded scenes, or neither. Therefore, our dependent variable was the score of correctly remembered events that participants mentioned during a free recall. We hypothesize that getting either kind of reminder will increase memory accuracy compared to the no-reminder control condition, but that viewing the strongly-encoded scene reminder will lead to the best memory accuracy. In addition, receiving a reminder based on high hippocampal activity should also lead to better memory of scenes semantically related to the identified key events.

Taking this new approach could offer more insight on the relationship between hippocampal activity during encoding of episodic memory and later memory accuracy of related events. Moreover, knowledge about how memory can be most effectively reinstated with just a few reminder scenes could aid people with memory disorders. Martin et al’s (2022) HippoCamera successfully helped older adults reinstate their narrative memory by re-watching

episodic recordings of core memories from their day-to-day lives. Here, the researchers found that it increased detail in participants' narrative memory and showed differentiation in their hippocampal activity. This study also can allow for future inferences on the function of this hippocampal signal appearing post-event. Knowing which reminder events lead to stronger memory can also shed light on which kind of memories are most valuable to retrieve. In the future, this research could also have real-world applications in the film industry when creating recap clips of past episodes to evoke relevant target memories in the viewer.

Method

Stimuli

To create stimuli for memory retrieval, this study first identified strongly- and weakly-encoded events based on fMRI data from a previous study conducted by Zadbood et al. (2013). Using the study's predetermined list of events, the first step was to identify if each of these scenes was strongly or weakly encoded across participants. We conducted a data analysis of 17 participants' fMRI data that was recorded while they were watching 25 minutes of the first episode of the TV show "Merlin". Zadbood et al.'s (2013) study was chosen because Merlin had several story arcs and clear events and allowed the viewer to understand the plot regardless of not having seen the rest of the movie. We also identified it as a show with a smaller likelihood of having already been seen by participants.

To ensure that we could make inferences about the hippocampal activity across participants, we conducted a pairwise inter-subject correlation of the hippocampal activity between participants. We removed the diagonal indicating the correlation of each subject with itself. In Figure 1, non-zero correlations indicate that the hippocampal responses were similar across participants. This first analysis indicated similar mean hippocampal responses across participants

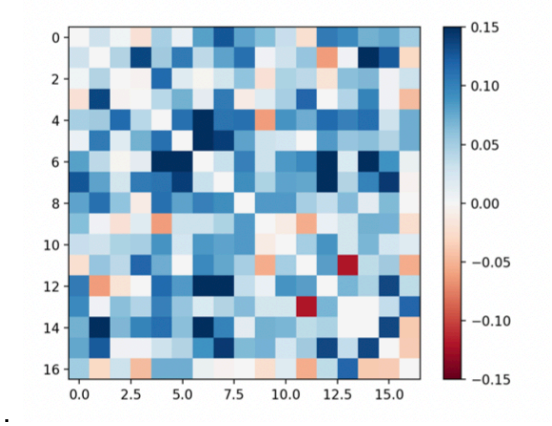

Figure 1: Pairwise inter-subject correlation of hippocampal activity between participants indicates similar hippocampal responses across participants

We then looked at the activity across time points in split halves of the dataset and centered data (Figure 2). We saw spikes in hippocampal activation around the same time points across participants. In addition, the correlation between the two group means was moderate, with a value of 0.33, which also indicates that for most of these participants, we can see similar hippocampal activity. This analysis ensured that activity was not entirely random across participants and confirmed that this initial dataset is suitable to base stimuli creation on.

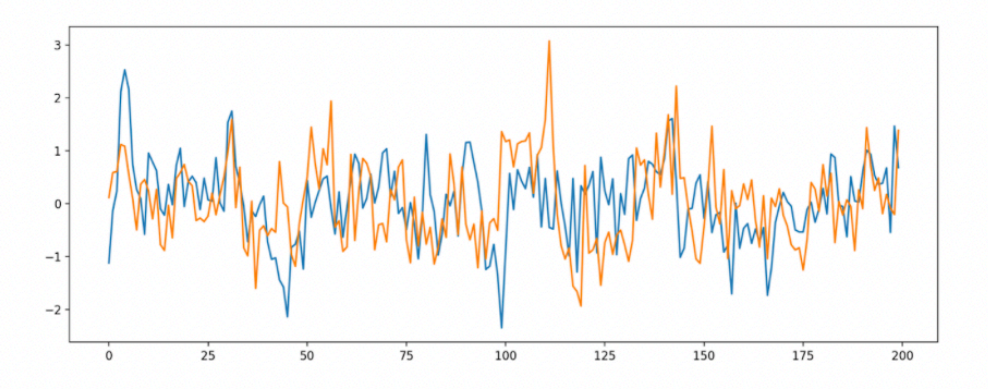

Figure 2: Hippocampal activity across the first 200 timepoints in split halves of the dataset showed similar spikes around the same time points. The correlation coefficient was 0.33.

After cleaning and denoising the raw data, we computed hippocampal activity for each participant using nibabel. We measured the hippocampal response at the end of each scene of the TV show using python.

Scene Number and Title	Hippocampal Offset
7-Merlin finds and saves Gaius	-0.33767204
16-Merlin thrown in jail	-0.09220337
4-Merlin arrives at Camelot	-0.05336477
16-Mysterious voice	-0.02741518
6-Old woman's threat	0.05843362
10-Morgana’s discontentment	0.10199977

Table 1: Scenes with lowest hippocampal responses

Scene Number and Title	Hippocampal Offset
19-Gaius frees Merlin	0.46175039
20-Target-standing in stocks	0.44823979
21-Merlin meets Gwen	0.46682367
17-Witch arrives in Camelot	0.7782421
12-Merlin morning	0.93920397
13-Merlin delivers medicine	0.980708

Table 2: Scenes with highest hippocampal responses

To ensure no abnormally big spikes are right after the boundary that might influence our event selection, we identified the best-fitting window size across all scenes as 4 TRs. This allowed us to identify the most strongly and weakly encoded events. As a next step, we identified the scenes with the five smallest (Table 1) and five largest (Table 2) hippocampal offsets across all participants. Here, we used the absolute value for hippocampal offsets to determine the overall change between the mean difference between the 10 seconds before and after each event.

In order to create relatively brief reminder clips, we used the last 10 seconds of each of these events and created two sets of reminder clips - one with clips from the five scenes with the highest hippocampal response and one with clips from the five scenes with the lowest hippocampal response. We used five scenes because we wanted a reminder clip of about 1 minute, and we chose to include the last seconds of each clip as it represents the culmination of each event.

Experiment

This two-part experiment recruited 45 participants through Columbia University's undergraduate student participant pool (SONA) between 18-31 (m=24) years old. 14 participants were male, 21 were female, and 17 were non-specific. We excluded 5 participants that dropped out after phase 1.

In the first phase of the design, participants were shown a 25-minute episode of the TV show Merlin. This was the same stimuli clip used in Zadbood et al.'s (2013) initial study that we used to make inferences about brain activity. So, likely, the participants of this behavioral experiment should show similar activity during encoding. After watching the whole clip, the participants were then asked again if they had seen the Merlin TV show before to ensure they were unfamiliar with what they had just seen. Participants were then sent home.

Three weeks later, participants were invited back to the lab to complete the second part of the study, in which we tested their memory for the episode they saw in the first part. We chose a 19-23 day gap between both parts because other studies indicated that this was enough time for the narrative to be forgotten. Upon return, each participant was randomly assigned to one of three conditions: those who would see a reminder clip based on high hippocampal activity, based on low hippocampal activity, or those who were not reminded with a clip at all.

Before we asked participants to recall the episode they had seen three weeks ago, participants were shown a 1-minute reminder clip, based on their condition, from strongly-encoded scenes (supporting hypothesis 1), reminder clips from weakly-encoded scenes (supporting hypothesis 2, alternative hypothesis), or neither (control condition). Each condition was then asked to complete a free recall, where they openly recalled everything they remember having seen in the first part of the study. Next, participants were asked to write full sentences in the order they remembered the narrative in and completed the task in 25-40 minutes. Participants were then asked to indicate if they felt they were done with the recall, as individuals took different amounts of time to type, and we wanted to ensure that they recalled everything they remembered.

After phase two was completed, we scored participants' recall to assess their accuracy in remembering all the TV show scenes, which is our dependent variable. The rubric that was adopted from Zadbood et al. (2013) initially included 24 events. However, to determine a more fine-grained idea of how many details were remembered, we chunked each event into subevents, resulting in a rubric with 169 detailed items about the 25-minute Merlin episode.

Results

To evaluate whether participants in either the high-hippocampal response or low-hippocampal response condition were able to remember events better than the control condition, this study looked at several different measures.

Overall score

The overall accuracy score of remembered events helps determine if reminding participants with the clips based on high or low activity in the hippocampus might lead to better overall performance for the recall compared to those who saw no reminder clip before recall. This includes both the events that participants were reminded with and those that they were not.

A one-way ANOVA was performed to compare the effect of being reminded with a clip based on scenes with high hippocampal activity during encoding on the overall accuracy score. The one-way ANOVA revealed that there was no statistically significant difference in the mean overall accuracy scores between the mean overall recall accuracy scores between the high hippocampal reminder clip and low hippocampal reminder clip conditions (F(2, 36) = [0.442], p = 0.64).

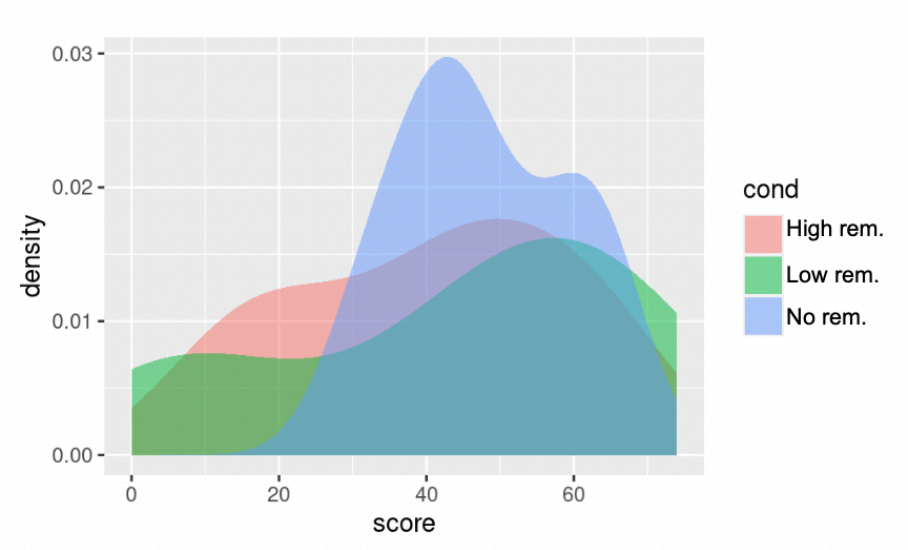

Figure 3: Density plot of the mean overall remembered events between conditions. The mean events remembered for the high reminder condition was 40.7, the low reminder condition was 43.3 and the no reminder condition was 48.0 events.

Score excluding reminder events

In our initial literature review, we found that past studies showed evidence that people should be able to recall events related to those "key events" with high hippocampal activity. Therefore, we wanted to determine if people remembered the events in neither reminder and to what extent. This is because participants might be preoccupied with the events that were in each reminder. With that, people could mainly talk about the reminder events because they saw them in the reminder, not because they remembered them three weeks ago.

A one-way ANOVA was performed to compare the effect of being reminded with a clip based on scenes with high hippocampal activity during encoding on the accuracy score for the 63 events that were in neither reminder clips. The one-way ANOVA revealed that there was no statistically significant difference in the mean overall accuracy scores for the 63 events that were in neither reminder clips between the high hippocampal reminder clip and low hippocampal reminder clip conditions ($F(2, 36) = [0.874]$, $p = 0.42$).

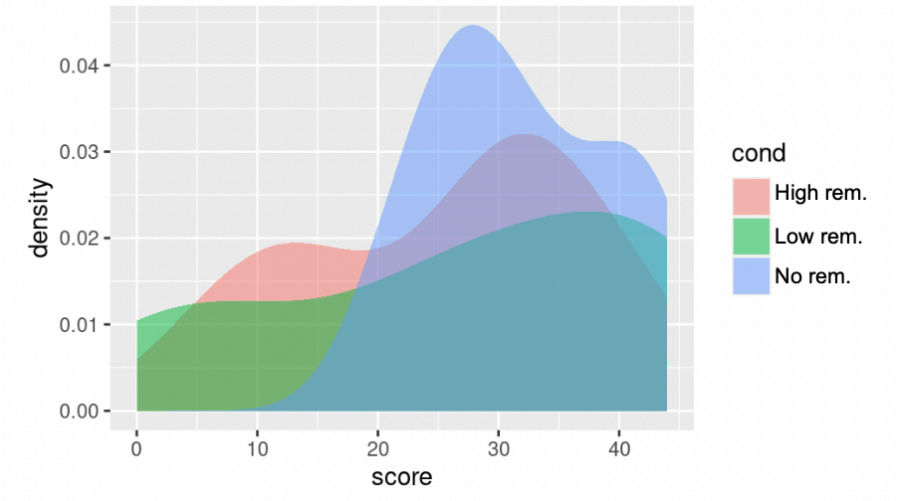

Figure 4: Density plot of the accuracy score for the 63 events that were in neither reminder clips between conditions. The mean events remembered for the high reminder condition was 25.5, the low reminder condition was 26.7 and the no reminder condition was 31.9 events.

Score for the High Hippocampal Activity Condition vs. Control Condition

To determine our hypothesis that well-encoded scenes are the best to show, since they are the easiest to reinstate and can help then bring other scenes to mind, we needed to compare the mean differences between those participants who were reminded with a clip in the high condition, and the baseline that saw no reminder. If participants remembered more events when they were reminded with the clips based on high hippocampal activity, then those clips might be the best to reinstate narrative memory.

A t-test examined the difference in recalled events between the high hippocampal reminder clip condition (M = 32.5, SD = 14.6) and the control condition who saw no reminder before recall (M = 39.5, SD = 9.1). There was no significant difference in accuracy scores between groups, $t(22.21) = -1.47$, $p = 0.15$, such that the neutral condition on average reported higher scores than those in the high reminder condition.

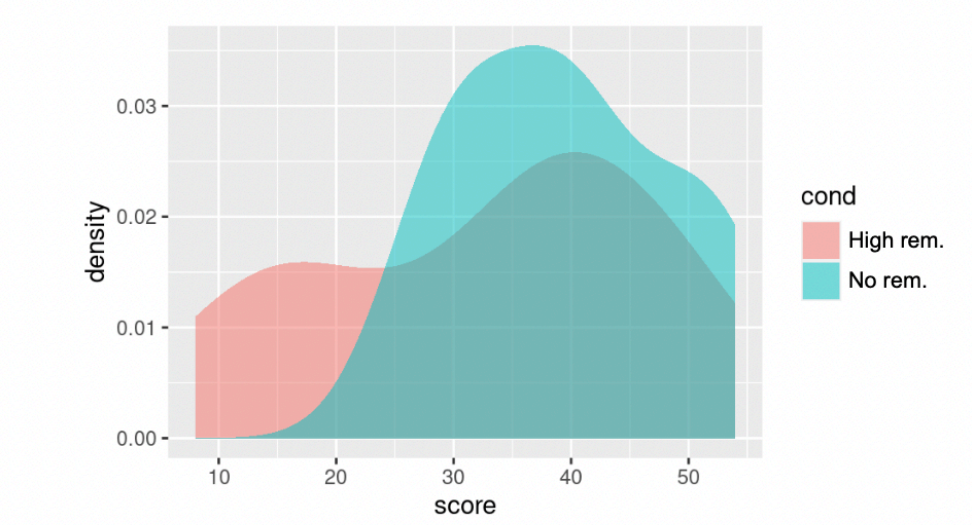

Figure 5: Density plot of the accuracy score for the high reminder condition and the control condition that received no reminder. Out of 169 events, the mean events remembered for the high reminder condition was 32.5, the no reminder condition was 39.5.

Score for the Low Hippocampal Activity Condition vs. Control Condition

To determine our alternative hypothesis that poorly-encoded scenes might be the best to show since otherwise they might be forgotten, we needed to compare the mean differences between those participants who were reminded with a clip in the low condition and the baseline group that saw no reminder. If participants remembered more events when they were reminded with the clips based on low hippocampal activity, then those clips might be the best to reinstate narrative memory.

A t-test examined the difference in recalled events between the low hippocampal reminder clip condition (M = 34.1, SD = 18.9) and the control condition who saw no reminder before recall (M = 39.5, SD = 9.1). There was no significant difference in accuracy scores between groups, $t(19.61) = -0.93$, $p = 0.36$, such that the neutral condition on average reported higher scores than those in the low reminder condition.

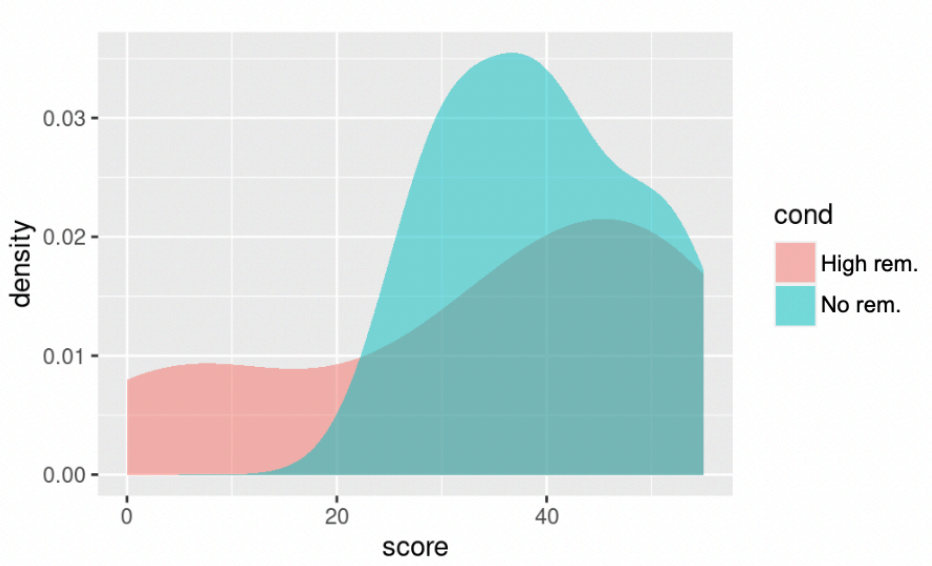

Figure 6: Density plot of the accuracy score for the low reminder condition and the control condition that received no reminder. Out of 169 events, the mean events remembered for the low reminder condition was 34.1, the no reminder condition was 39.5.

Level of Detail

Lastly, we looked specifically at the neutral condition to see if participants remembered events any differently depending on whether we flagged them as ones that corresponded with high hippocampal activity, low activity, or they remained a truly neutral event. This will determine if the events that corresponded with high hippocampal activity are generally remembered better, even if people are not cued with it.

A one-way ANOVA was performed to compare the effect of the type of event (high activity event, low activity event or neutral event) on the fraction of people remembering each event type. The one-way ANOVA revealed that there was no statistically significant difference in the mean fraction of people remembering events between the event types ($F(2, 166) = [0.596]$, $p = 0.55$).

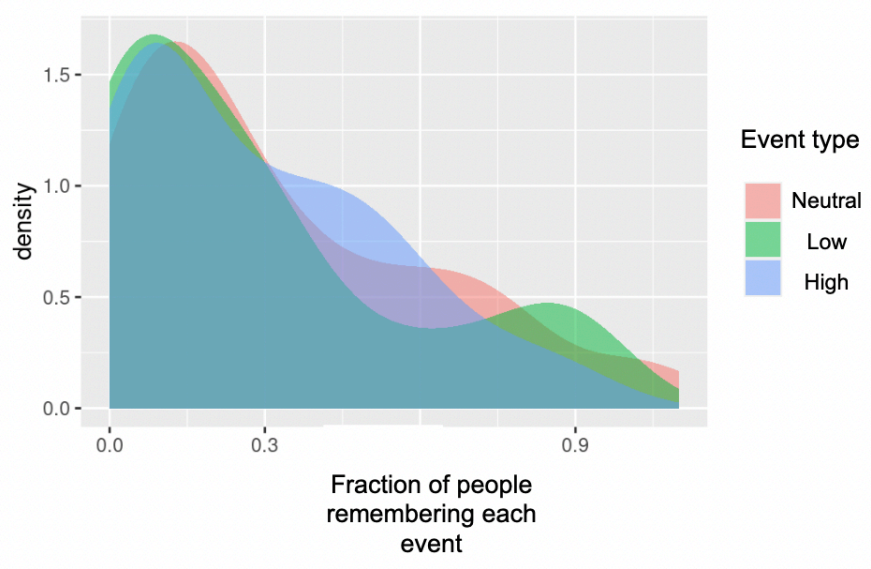

Figure 7: Density plot of the fraction of people remembering each event type. Overall, participants remembered 33% of the high hippocampal response events, 28% high hippocampal response events and 28% of the neutral events.

Discussion

Our study showed that the mean difference of events remembered is not significant in both our analyses of performance in the high reminder condition and the low reminder condition. Consequently, this study did not lead to evidence that supports our hypothesis that providing reminders for strongly-encoded events will lead to the best overall recall of the narrative. Moreover, by removing any events that were in either reminder clip, we found that events related to key events are not remembered significantly more than the baseline. Finally, while the low reminder condition performed slightly higher than the high reminder condition in overall recall and in comparison to the control condition, these results did not prove significant. This means that our alternative hypothesis that poorly-encoded scenes might be the best to invoke memory is also not supported by this study's results.

Our results show that, across different analyses, participants in the neutral condition tend to perform much better than participants in either reminder condition. While score differences are not significant across analyses, we can see that for the overall score, the group that did not see reminders on average remembered 8 more details than the high reminder condition (Figure 1). With 40.0 events remembered in the high reminder condition versus 42.3 in the low reminder condition for overall score accuracy, there is no significant difference in the number of events remembered between each reminder condition. These results do not change much when excluding events that were in either reminder condition. Figure 2 gives a better understanding of the events that participants remember that were related to the key events we identified in Zadbood et al.'s (2013) fMRI data. In line with Lee & Chen's (2021) findings that events with strong causal connections for the narrative show stronger hippocampal responses, we expected

to see that participants in the high reminder condition would remember more events that we didn't show them, however with 25.5 out of 63 (40%) non-reminder events remembered for the high reminder condition, 26.7 out of 63 (42%) for the low reminder condition and 31.9 out of 63 (50%) for those who did not see any reminder, our results cannot confirm this.

In contrast, the neutral condition remembered 48.0 out of 169 (28%) overall events, including the clips that were in the reminders, which is not statistically different from the 40.7 (24%) events remembered for the high reminder condition. This could mean that overall memory accuracy was fairly well across participants, possibly because the study was conducted on a sample consisting of mostly Columbia University first-year students who are practiced in memory and recall. Possibly their memory was high in the first place, meaning that reminder clips did not have the intended impact. Another factor is the delay of 19-23 days that participants experienced between encoding and recall. High general accuracy scores could mean that participants did not have enough time to forget sufficiently. While the delay was much longer than in comparable studies of narrative memory, participants are known to show good results when episodic memory is invoked even up to a year later (Tang et al., 2016).

Especially the analysis of memory accuracy scores for the high reminder condition (Figure 5) and low reminder condition (Figure 6) shows many differences in variance between treatment and control conditions in the density plots. For both conditions, the participants who saw a reminder showed high variability in how many events they remembered, with some individuals doing very poorly and others doing exceptionally well. In comparison, in both plots, the neutral condition steered mainly towards doing moderately well in the free recall task. However, there is no significant difference between how well the control condition remembered events that were identified as corresponding to high or low activity (Figure 7). The split of event types remembered by each participant is relatively equal. Combining this with the finding that, when excluding events that were in either reminder clip, we see a high amount of events remembered across participants of both treatment conditions. This suggests that participants in

reminder conditions tend to not talk about details that were in the reminder, possibly because they suspect not being tested on those and therefore not feeling the need to report those. Possible primacy or recency effects could also influence the reported results - a more detailed event-level analysis could give more insights into this.

Another reason for the high variability we reported for both treatment conditions could be that this experiment was conducted as a between-subjects study. A replication of this study with a within-subjects design would allow researchers to more accurately account for the differences between participants. Past studies have focussed on immediate recall (Zadbood et al., 2013), meaning that more variability could also be attributed to the longer recall time. It is also to be noted that the time of data collection overlapped with Columbia's midterm season. Many of the participants had just finished exams as they came in for their recall session, with some of them reporting fatigue. Resulting factors such as attention deficit, motivation, memory skills, or mental state either at encoding or retrieval could influence our result. The additional task of watching the reminder clip that students in the treatment conditions had to perform could have led to the additional variance. In the future, researchers should perform attention checks during encoding and recall to account for that.

This study not leading to significant results may also be warranted by the relatively small sample size of 39 students. This behavioral study is likely to be severely underpowered, and the results could change if more participants were included in the same analyses.

In the future, researchers could gain additional insights from this data collection by looking at the difference between how participants remember events that were in the reminders. Our analysis only sought out how many events participants remembered that were in neither reminder clips - possibly, there are insights to be gained on how participants utilize reminder scenes and whether our impression that participants mention them less is correct. A Recent study by Sekeres et al. (2020) took a similar behavioral approach to ours and found that reminders positively impact successful memory retrieval but found no enhancement in the

quality of the detail. The researchers also found that while many of the same brain regions were activated during retrieval, there was no difference in hippocampal activity for participants whose retrieval was preceded by a reminder. However, this study presented participants with a random selection of scenes while there were events that were linked together, which could explain the small impact of reminder clips we report.

Lastly, an important limitation of this study is that our results are entirely based on the stimuli created based on our analysis of fMRI data. If this initial analysis and the assumptions that come with it, such that hippocampal activity is similar across participants across time, are false, then the reminder clips might be ineffective. Our last analysis (Figure 7) showed that a similar fraction of people remembered events, regardless of whether they were flagged as corresponding with high or low hippocampal activity. While this insight does not account for whether the reminder clips are entirely ineffective, a future direction could include a thorough analysis of the extent to which participants display the same responses across different studies. In addition, future research could initially identify each participant's actual brain activity during encoding and subsequently create custom reminder clips for each participant. This procedure could give a clearer picture of how hippocampal activity is related to recall and has the potential to answer the question of what kind of reminder clips are most effective based on brain activity during encoding.

Acknowledgements

I thank Prof. Christopher Baldassano (Columbia University) for the close collaboration and for providing excellent mentorship and guidance throughout this senior thesis project. This thesis project was created as part of Columbia University's Honors Program led by Prof. Lila Davachi and Prof. Nim Tottenham, whom I would like to thank for their continued support and guidance during this process. I thank the entire DPML and my fellow students for providing continuous, integral feedback on this project and Franck Mugisho for their support during data

analysis and rubric grading. I want to add a special thank you to Zadbood et al. (2013) for publicly providing the fMRI dataset on which this study is based. Lastly, I would like to thank Columbia GS for providing me with a grant to complete this project and Prof. Fox-Glassman for her support as my psychology advisor.

References

Baldassano, C., Chen, J., Zadbood, A., Pillow, J. W., Hasson, U., & Norman, K. A. (2017). Discovering Event Structure in Continuous Narrative Perception and Memory. Neuron, 95(3), 709-721.e5. https://doi.org/10.1016/j.neuron.2017.06.041

Ben-Yakov, A., & Dudai, Y. (2011). Constructing Realistic Engrams: Poststimulus Activity of Hippocampus and Dorsal Striatum Predicts Subsequent Episodic Memory. Journal of Neuroscience, 31(24), 9032–9042. https://doi.org/10.1523/JNEUROSCI.0702-11.2011

Ben-Yakov, A., Eshel, N., & Dudai, Y. (2013). Hippocampal immediate poststimulus activity in the encoding of consecutive naturalistic episodes. Journal of Experimental Psychology: General, 142(4), 1255–1263. https://doi.org/10.1037/a0033558

Ben-Yakov, A., & Henson, R. N. (Eds.). (2018). The Hippocampal Film Editor: Sensitivity and Specificity to Event Boundaries in Continuous Experience. The Journal of Neuroscience, 38(47), 10057–10068. https://doi.org/10.1523/JNEUROSCI.0524-18.2018

Cohen, S. S., & Baldassano, C. (2021). Developmental changes in story-evoked responses in the neocortex and hippocampus (p. 2021.04.12.439526). https://doi.org/10.1101/2021.04.12.439526

DuBrow, S., & Davachi, L. (2014). Temporal Memory Is Shaped by Encoding Stability and Intervening Item Reactivation. Journal of Neuroscience, 34(42), 13998–14005. https://doi.org/10.1523/JNEUROSCI.2535-14.2014

Ezzyat, Y., & Davachi, L. (2011). What constitutes an episode in episodic memory?. Psychological science, 22(2), 243-252.

Lee, H., & Chen, J. (2021). Narratives as Networks: Predicting Memory from the Structure of Naturalistic Events (p. 2021.04.24.441287). https://doi.org/10.1101/2021.04.24.441287

Martin, C. B., Hong, B., Newsome, R. N., Savel, K., Meade, M., Xia, A., ... & Barense, M. (2022). A smartphone intervention that enhances real-world memory and promotes differentiation of hippocampal activity in older adults.

Reagh, Z. M., Delarazan, A. I., Garber, A., & Ranganath, C. (2020). Aging alters neural activity at event boundaries in the hippocampus and Posterior Medial network. Nature Communications, 11(1), 3980. https://doi.org/10.1038/s41467-020-17713-4

Sekeres, M. J., Moscovitch, M., Winocur, G., Pishdadian, S., Nichol, D., & Grady, C. L. (2021). Reminders activate the prefrontal-medial temporal cortex and attenuate forgetting of event memory. Hippocampus, 31(1), 28-45.

Tang, H., Singer, J., Ison, M. J., Pivazyan, G., Romaine, M., Frias, R., ... & Kreiman, G. (2016). Predicting episodic memory formation for movie events. Scientific Reports, 6(1), 1-14.

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