How the organization of autobiographical memories changes over time

Yoed N. Kenett, Alexa M. Tompary, Sharon L. Thompson-Schill

University of Pennsylvania

Introduction

Autobiographical memories (AM) are often theorized as highly structured clusters of related events, but limited empirical research has examined how memories of our daily experiences are organized.

Over consolidation, memories become less detailed, more integrated with prior knowledge stores, and more distributed across cortical regions. However, it is unclear how these changes affect the organization of these memories over time.

Here, we apply computational network science methodologies to quantify the organization of recent (within the past year) and remote (5 – 10 years ago) AM and quantitatively examine how these networks change over time.

Methods

Participants

Study 1: 30 participants were recruited from the University of Pennsylvania were qualified to participate (18 women; mean age = 22.6 y, SD = 3.9 y; mean education = 16.4 y, SD = 3 y).

Study 2 (on-going): 13 Experimental participants (11 women; mean age = 22.5 y, SD = 2.8 y; mean education = 16.5 y, SD = 1.5 y) and 13 Control participants (10 women; mean age = 22.6 y, SD = 1.7; mean education = 17 y, SD = 1.4 y) participated in the study.

Design Overview

Session 1: Participants recalled both recent and remote memories to a list of 35 general events (e.g., Thanksgiving dinner, going to a wedding, playing in the snow, etc.; **Fig. 1a**).

Session 2 & 3: Participants rated the relatedness of all possible pairs of memories, separately for recent and remote memories (**Fig. 2**).

In Study 2, Control participants completed a modified version of Session 1 **(Fig. 1b)**, but in Sessions 2 & 3 rated memories generated by an Experimental Participant from Study 2.

Fig. 1. a) Study 1: Participants generated recent and remote memories to a list of 35 events on a spreadsheet, as well as how difficult it was to retrieve them. b) Study 2: Participants similarly retrieve memories, for a list of 60 events on an online questionnaire. Out of these 60 events, 35 are randomly chosen for Sessions 2 & 3

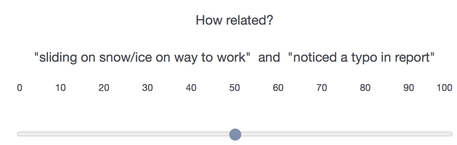

Fig. 2. In both studies, participants rated how similar all possible of pairs of recent/remote memories are to each other, Participants were instructed to make similarity judgments based on several episodic dimensions (e.g., did the two memories happen in the same place, happen with the same people, etc.).

Subjective measures of AM

For each recent/remote memory, participants provided a subjective ratings of its vividness, emotional valence, and intensity of each one, standard subjective measures used in episodic memory research (Fig. 3). These measures allow us to examine how quantitative measures of the AM networks relate to these subjective measures of AM.

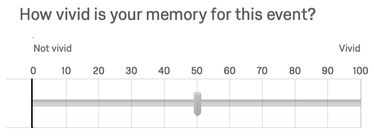

Fig. 3. An example of how participants judge the vividness of each memory.

Episodic Network Analysis

The recent and remote AM networks estimation approach assumes that participants' ratings of the relatedness between the memory descriptions serves as a proxy to the organization of these events at the recent and remote AM networks. For each participant and for each time window, a 35 x 35 adjacency matrix was extracted, where each cell denotes the relatedness ratings between node *i* and node *j* . These matrices represent the AM networks (**Fig. 4**) and allow computing and comparing standard network measures (**Fig. 5**).

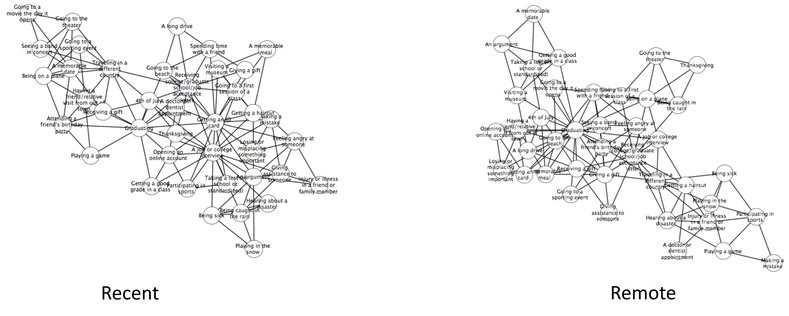

Fig. 4. An example of a participant's recent and remote AM networks. Nodes (circles) represent events, and edges represent binary relations between nodes.

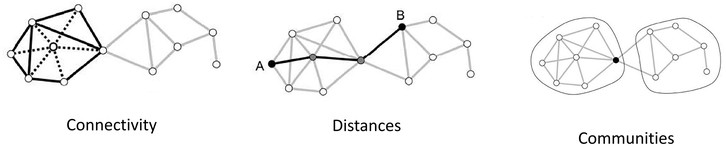

Fig. 5. Standard network measures we computed and compared for the recent and remote AM networks.

Results

We assess the main effect, within participant, of consolidation—operationalized via the recent and remote time windows—on AM network properties (**Fig. 6**). Furthermore, our design allows us to assess how subjective measures of AM relate to quantitative, local network measures of AM. (**Fig. 7**). Finally, we examine how our network findings replicate in a better controlled study, that includes an Experimental and a Control condition (**Fig. 8**). * - $p < .05$, ** - $p < .01$.

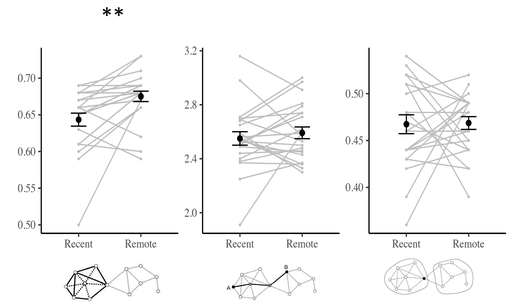

Fig. 6. Comparing network measures across networks and participants only reveals a significantly higher connectivity score for remote networks.

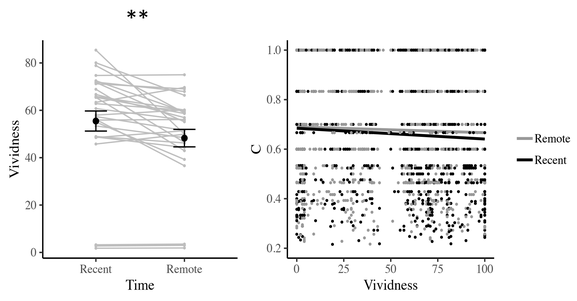

Fig. 7. Examining the subjective AM measures across time points found significantly lower vividness for remote memories. Furthermore, vividness significantly predicted the networks connectivity measure.

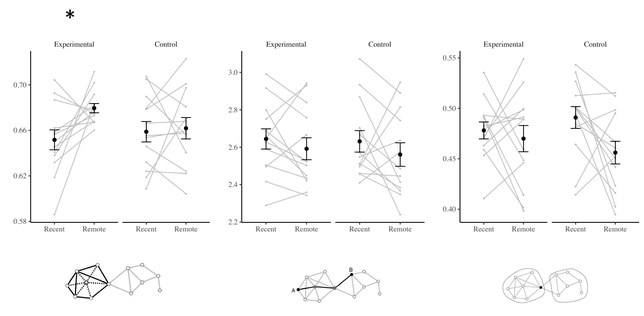

Fig. 8. Study 2's replication results of Study 1: Higher overall connectivity for remote AM network of Experimental group, but not Control group.

Conclusions

We found that remote memories exhibited higher global connectivity relative to recent memories, and that this increased connectivity is coupled with lower subjective ratings of vividness.

Our results demonstrate how such cognitive features of episodic memory can be quantitatively examined and shed novel light on the organization and reconfiguration of episodic memories over time.

This research was funded by an NIH award to Sharon Thompson-Schill (R01 DC015359-02).