The Neural Correlates of Memory Transformation in Rodents and Humans

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Introduction: Transformation of episodic memory over time

Transformation Theory of memory consolidation proposes that:
1. Memory for rich perceptual detail of an episodic memory always depends on the hippocampus (HPC).
2. Over time, a less detailed, gist-like version of the memory develops in the cortex.
3. Both versions of the memory can co-exist.

(Winocur & Moscovitch, 2010)

Memory transformation in rodents: Context memory generalizes over time, accompanied by a time-dependent increase in aCC activity. Precise context memory continues to recruit the hippocampus, even at a remote time point.

Methods

Encoding: Context Fear Conditioning: 32 male Long-Evans rats were conditioned in CXT-A with 10 tone-shock pairings (tone 1000 Hz, shock 1mA 1sec).

Retrieval: Context Fear Testing
Short-Delay (SD) group: 24hrs after conditioning, rats were tested for the context fear memory (percent of time spent freezing during 6 min test) in either CXT-A (n=8), or in novel CXT-B (n=8).

Long-Delay (LD) group: 28 days after conditioning, rats were tested for the context fear memory in either CXT-A (n=8), or in novel CXT-B (n=8).

fMRI Retrieval
Verbal retrieval was scored for the number of central story details (plot line, main characters), and peripheral details (perceptual, contextual, action, emotional elements).

Central details: could not be left out or replaced without a major change in the content of the event (adapted from Barnstain, Memory & Cognition, 2003).

Results

Result 1: Memory for rich perceptual details are forgotten at a higher rate than central story content. Reminders can reinstate memory for details.

Result 2: Hippocampal activity decreases, prefrontal cortical activity increases as a memory ages and loses peripheral detail; Hippocampus does not show a time-dependent decrease for vividly retrieved memories.

Conclusion

In both rodents and humans, the time-dependent transformation of an episodic memory from precisely detailed to a less-detailed, generalized version is accompanied by a decrease in hippocampal activity, and an increase in activity in the prefrontal cortex. Briefly reactivating the generalized memory prior to retrieval reinstates memory for vivid detail. We are currently determining if reactivating the remote, generalized memory will reinstate high hippocampal activity. This will provide support for the idea that both a detailed, hippocampal-dependent version, and a generalized, cortically-dependent version of remote memory can co-exist, with the demands at the time of memory retrieval mediating which version of the memory will be expressed.