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TEMPORAL MEMORY FOR COMPLEX EVENTS IS SUPPORTED BY GAMMA OSCILLATORY ACTIVITY

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Background: The ability to organize events in time is a hallmark of episodic memory. Prominent fMRI studies have shown that the entorhinal-hippocampal network is involved in judging precisely the time of occurrence of episodic memories and in representing the temporal structure of the event. However, little is known about the relationship between these two processes and their temporal characteristics.

Aims: The present EEG study investigated whether the neural correlates of temporal memory precision and event structure are related, whether they occur during stimulus encoding, memory decision or response execution, and whether they are distributed also outside the entorhinal-hippocampal network.

Method: Twenty volunteers reported the time of occurrence of short video clips extracted from a previously encoded movie on a horizontal timeline representing the movie duration. This procedure provided measures of temporal memory precision and perceived temporal distance between stimuli extracted from distinct movie parts. A multivariate pattern analysis (MVPA) of the time-frequency data was used to classify trials associated with low, medium and high precision. A representational similarity analysis (RSA) was used to investigate the similarity between behavioral and neural distance associated with pairs of movie parts.

Results: Using MVPA, we found an electrophysiological signature of temporal precision in the high beta/low gamma band (28-40 Hz) during presentation of the timeline, extending outside the entorhinal-hippocampal network. An independent RSA of spatially distributed activity revealed a strong coupling between behavioral and neural distance related to pairs of movie parts at the same time and frequency band compared to the precision effect. Crucially, we found that subjects showing higher temporal precision were those who also exhibited a stronger correlation between behavioral and neural distance.

Conclusions: We found that oscillatory activity in the high beta/low gamma frequency codes for both temporal memory precision and the representation of event structure. These effects occur simultaneously after stimulus presentation but before the manual response and extend beyond the MTL, suggesting that temporal memory is supported by a distributed cortical network. These results help to link different phenomena reported in the literature on temporal memory and shed new light on how complex events in our life become "infused with time".

Keywords: Episodic memory, Memory for time, Temporal representation, Temporal memory precision, Beta/gamma band

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