There is conflicting evidence on the role of theta oscillations in episodic memories. While most studies employing surface EEG report increases in theta power, most iEEG studies report a memory induced theta power decrease. Herweg and colleagues (tics, 2020 xx) review this evidence and suggest that studies contrasting later remembered with later forgotten conflating domain-general cognitive processes such as attention and perception with memory specific processes. Because the former is assumed to lead to a spectral tilt (less low frequency power and more high frequency power) a narrow band theta power increase induced by memory might be overshadowed. [simons synch/desync].

To ameliorate this shortcoming researcher should not contrast successful memory with unsuccessful memory but instead should compare strength of memory (e.g., retrieval confidence, amount of detail in contextual retrieval, retrieved spatial distance to encoded location in a navigational task). The authors implicitly assume that task engagement, effort and perception/attention are binary processes, whereas memory strength is continuous. Although a valid concern, this assumption is not necessarily met. One way to test this hypothesis is to invert the focus from remembered episodes to forgotten episodes. If successful memory hinges on domain-general cognitive processes manifested in a spectral tilt and memory-specific narrowband theta increases, then later forgotten episodes should sometimes exhibit a spectral tilt without a narrowband theta peak if the point of failure was memory related and sometimes there should be neither spectral tilt, nor theta peak if unsuccessful memory was due to failure in attention et al. Importantly, a theta peak without a spectral tilt would falsify the theory.

Another reason how surface EEG might show a theta power increase although the LFP shows a decrease is if theta over larger areas synchronizes but decreases in amplitude. The decrease is truthfully reflected in the LFP, but activity on the scalp is integrated over larger areas and thus more synchronous theta could lead to higher scalp theta power. Taken together these considerations imply theta activity as an integral part of memory processing and suggest that conflicting evidence arises due to different recording methods (EEEG/iEEG), memory contrasts (success vs success or vs failure9 and frequency ranges (broadband vs narrowband).

An open question remains if all theta is created equal. Compared to rodents human theta activity is slower (xx) (hippocampal?) and in the hippocampus split into slow (2-5 Hz) and fast theta (5-9 Hz) (xx). Contrary to what has been believed for a long time there are separate theta generators in the hippocampus (septum, xx) and the cortex (xx).

* Buzsaki STDP idea and more into phase precession in place cells

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Include a figure showing the LFP with AP

Episodic memories:

Tulving & markowitch 1998)

Nadel & Moscovitch 1997: even highly overlapping episodes are all unique.

We use the hilbert transform which assumes sinusoidality of the signal.

Other methods (e.g., linear interpolation methods: doi.org/10.1152/jn.00273.2019; empirical mode decomposition) do not have that assumption and might be more adequate.

During a spatial navigation task neural spiking locked to oscillations in the LFP of the microwire at which they were recorded, particularly at theta and gamma (josh 2007 paper). Locked to various phases in the theta range

The patient was implanted with six depth electrodes of the Behnke Fried type (see Figure 4) from Ad-Tech Medical Instrument Corporation. These single-use electrodes are made from platinum, have a diameter of 1.3mm and allow for simultaneous macro and micro contact recordings. Platinum has a high impedance for lower frequency and a low impedance for higher frequency bands. As such it is suitable to pick up local action potentials. The micro contacts extend radially past the end point of the macro depth electrode. Each Behnke-Fried electrode contains eight high-impedance microwires and one low-impedance microwire.