The consolidation of episodic memories is thought to require precisely timed interactions between cells in the hippocampus and neocortex during sleep, but the specific mechanisms by which this dialogue unfolds are poorly understood. During sleep, activity in the hippocampus and neocortex is temporally structured by a slow oscillation (1-4Hz) that frames the occurrence of faster oscillations: spindles (7-14Hz) in neocortex, and ripples (150-200Hz) in hippocampus. The observation of spindles suggests the participation of the thalamus, but its contribution has remained an open question. I will present results from simultaneous extracellular recordings of single units and local field potentials in the midline thalamus, mPFC *and* CA1 in freely behaving rats.

We find that both CA1 ripples and unit firing in the midline thalamus are coordinated with the neocortical slow oscillation. Interestingly, while hippocampal ripples are more likely to occur in 250ms windows before and after neocortical K-complexes (KCs, which mark the downstate of the slow oscillation), spiking probability in a subset of thalamic units is asymmetric and increases following neocortical KCs. Of the units recorded in midline thalamus simultaneously with CA1 and mPFC (n=29), 20.7% showed a significant increase in firing rate (>2 standard deviations from baseline) following mPFC KCs. This finding suggests that the time following KCs (the start of the slow oscillation) is functionally different from the end of the oscillation (before KCs), and includes an increased contribution from cells in the midline thalamus, which could influence neocortical populations in preparation for the reactivation of hippocampal memory traces. Furthermore, the correlation between KCs and thalamic units can be modulated by CA1 ripples, suggesting that combined ‘neocortical KC+CA1 ripple’ events can reveal subtle interactions between the three regions. Lastly, units in the reuniens and the ventromedial nuclei show a broad decrease in spiking probability around the time of hippocampal ripples. 57.6% of units in these nuclei present a significant drop in firing rate compared to 20.8% in cells recorded in other midline nuclei (p< 0.05; n=57 units). This suggests that certain thalamic nuclei may be key for gating the transfer of memory information from the hippocampus to neocortex, by opening a time window in which ripples may be more likely to occur.

These results provide the first evidence of the involvement of midline thalamic cells in neocortico-hippocampal interactions during sleep, and point to specific mechanisms by which multi-region brain interactions may contribute to the systems consolidation of memories.