Understanding the roles of slow and fast gamma rhythms in memory processing

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Principal Investigators

COLGIN, LAURA LEE

Institution

UNIVERSITY OF TEXAS, AUSTIN

Contact information of lead PI
Country

USA

Title of project or programme

Understanding the roles of slow and fast gamma rhythms in memory processing

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NIH (NIA)

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25/09/2014

Total duration of award in years

2

The project/programme is most relevant to:

Alzheimer's disease & other dementias

Keywords

memory retrieval, memory process, memory encoding, entorhinal cortex, Hippocampus

Research Abstract

DESCRIPTION (provided by applicant): Aberrant gamma rhythms are seen in Alzheimer’s disease and schizophrenia and may relate to memory impairments in these disorders. It is thus

imperative to understand gamma rhythms role in memory. Separate fast (~65-100 Hz) and slow (~25-55 Hz) gamma subtypes differentially route inputs to hippocampus, a brain region critical for memory. Fast gamma links the hippocampus to current sensory inputs from the medial entorhinal cortex (MEC). Slow gamma couples hippocampal subfield CA1 with CA3, a subfield essential for memory retrieval. Still, the functional relevance of slow and fast gamma with regard to memory processing remains largely unknown. The proposed work will test the hypothesis that slow and fast gamma perform distinct functions in the hippocampal network, with fast gamma promoting memory encoding and slow gamma mediating memory retrieval. The studies will employ multisite electrophysiological recordings of local field potentials and single unit activityin freely behaving rodents. Specific Aim 1 will test whether hippocampal ‘place cells’ and MEC ‘grid cells’ code locations differently during slow and fast gamma, as expected if slow and fast gamma are functionally distinct. Ensembles of place cells and grid cells will be recorded in rats running on a linear track. The track’s one-dimensional nature will allow identical trajectories to be compared for slow and fast gamma periods. Bayesian decoding techniques will be applied to decipher neuronal ensemble activity for slow and fast gamma-associated trajectories. If fast gamma is involved in memory encoding, then place and grid cells should encode recent locations during fast gamma. If slow gamma is involved in memory retrieval, then place and grid cell codes should predict upcoming locations during slow gamma. Specific Aim 2 will test whether fast gamma promotes memory encoding using spatial memory tasks. The proposed studies will determine whether fast gamma correlates with memory encoding and also whether significant decreases in fast gamma during memory encoding are associated with error trials. Furthermore, Aim 2 will test whether fast gamma stimulation of the perforant path during encoding will improve memory in a mouse model of Alzheimer’s disease (AD). Effects will be compared to slow gamma stimulation to determine whether fast gamma timing in particular facilitates memory encoding. Specific Aim 3 will test whether slow gamma promotes memory retrieval in the same spatial memory tasks. The studies will determine whether slow gamma correlates with memory retrieval and whether slow gamma is selectively enhanced during memory retrieval in correct, but not error, trials. This Aim will also test whether slow gamma stimulation of the Schaffer collaterals during memory retrieval improves memory in AD mice. Effects will be compared to fast gamma stimulation to determine if slow gamma timing is particularly well suited for memory retrieval. Discovering functional differences between slow and fast gamma is expected to change the field’s concept of gamma rhythms and thereby lay the foundation for exciting future discoveries.

Lay Summary
PUBLIC HEALTH RELEVANCE: Gamma rhythms coordinate activity across ensembles of neurons and play an important but poorly understood role in memory. Aberrant gamma rhythms are observed in several disorders including Alzheimer’s disease and schizophrenia and may relate to memory impairments in these diseases. Here, we propose to test the hypothesis that distinct gamma rhythm subtypes, slow and fast gamma, perform unique mnemonic functions, and in this way we expect to develop new theories of how gamma deficits relate to disease-related memory dysfunction.

Further information available at:

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Investments > €500k

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United States of America

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Alzheimer's disease & other dementias

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