

# Discrete synaptic transmission impacts the onset of rhythmic network dynamics

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In focal epilepsy, seizures originate in specific brain regions. Electroencephalogram recordings from these regions, where seizure activity begins, are referred to as focal signals, while recordings from uninvolved areas are called non-focal signals. Comparing focal and non-focal signals is essential for understanding the neural dynamics involved in seizure generation and propagation. To this end, we introduce a novel approach based on chimera states<sup>1,2</sup>, which are intriguing phenomena characterized by the coexistence of synchronous and asynchronous dynamics in networks of coupled identical oscillators. Chimeras' partial synchronization makes them good models for studying real-world complex systems<sup>3,4</sup>, such as the brain<sup>5,6</sup>. While single chimera states can model the dynamics of neuronal populations, multi-layer chimera networks provide a framework to study interactions between brain regions. For this reason, the illustrative model of a two-layer chimera state network has been investigated<sup>7</sup>, demonstrating that the driven layer can synchronize with the driving layer without disrupting its partially synchronized state. In this study, we replace the driving layer with real-world focal and non-focal signals from epilepsy patients and assess their entrainment power on the driven layer. Entrainment power measures the ability of a driving signal to influence the phase dynamics of the driven layer, quantified by the phase coherence between the two. Our results demonstrate that focal signals exhibit higher entrainment power than non-focal signals when the frequency detuning between the driving signal and the driven chimera states is about zero. This could suggest that, even before a seizure begins, the focal zone increases the susceptibility of connected brain regions to incoming activity, potentially facilitating the spread of seizure dynamics. Such findings highlight differences in the dynamical properties of focal and non-focal signals, contributing to our understanding of focal epilepsy.

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