Optimal energy pumping in an entrained neural system via frequency shuffling

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Neural entrainment, the phenomenon of adjusting the dynamics of a neural system to that of an external stimulus, underlies various cognitive phenomena. Traditionally, most entrainment studies focus on an external periodic drive. However, most naturalistic stimuli are rarely periodic and often have a spread in frequency domain rendering an intrinsic aperiodic component. One intuitive way to account for this variability is by introducing a spread around the forcing frequency to mimic the temporal structure of more naturalistic inputs. In this work, we investigate how such variability affects the dynamics of a canonical neural mass model namely the Jansen and Rit Neural Mass Model. The stimulant frequency is shuffled and drawn from a Gaussian distribution with mean = system frequency. It is seen that a stimulated Jansen and Rit model shows an optimal amount of energy pumping for an intermediate amount of shuffling (standard deviation of frequencies). Furthermore, this optimality is lost if the shuffling rate is higher than the system frequency.