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Hippocampal-prefrontal neural dynamics underlying impulsive-like behavior in food addiction

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Food addiction is characterized by impulsive decision-making, compulsive food intake, and a loss of behavioral control toward highly palatable foods. The ventral hippocampus (vHPC) to prelimbic medial prefrontal cortex (PL mPFC) pathway has been associated with impulsive operant responses towards highly palatable foods. Electrophysiological studies showed that a significant portion of neurons in the mPFC were phase-locked to the hippocampal theta rhythm. We hypothesize that impaired vHPC-mPFC neuronal communication, potentially driven by altered theta synchrony, could contribute to food addiction development by affecting impulsive-like behavior.

Male mice were trained in operant boxes to develop a food-addictive-like behavior phenotype. Stereotrodes were implanted in the PL mPFC and the CA1 layer of the vHPC. In vivo electrophysiological recordings were performed during operant sessions. Impulsivity was measured by the mice's non-reinforced active lever presses during the time-out periods (15 s) after each pellet delivery.

Animals' behavior was variable across sessions and trials, showing different levels of impulsivity as revealed by a broad distribution of lever presses during the time-out period. The timing of these responses showed two peaks occurring shortly after reward delivery and towards the end of the time-out period, suggesting potential difficulties in stopping motor responses and withholding premature responses, respectively. We then assessed the relationship between the local field potentials (LFP) in the vHPC and the prelimbic mPFC (i.e., coherence) and power spectral density within each area. Preliminary analysis showed that mPFC-vHCP coherence in the theta band increased when mice pressed the lever. However, we did not find an interaction between lever presses inside and outside the time-out, suggesting that the modulation of coherence can not distinguish between impulsive and non-impulsive responses.

Our findings may help to elucidate the neural correlates of impulsive-like behavior deriving from circuit alterations, providing valuable insights into the underlying mechanisms of food addiction.