

## Publication

# Abnormal Functional Integration of Thalamic Low Frequency Oscillation in the BOLD Signal After Acute Heroin Treatment

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Heroin addiction is a severe relapsing brain disorder associated with impaired cognitive control, including deficits in attention allocation. The thalamus has a high density of opiate receptors and is critically involved in orchestrating cortical activity during cognitive control. However, there have been no studies on how acute heroin treatment modulates thalamic activity. In a cross-over, double-blind, vehicle-controlled study, 29 heroin-maintained outpatients were studied after heroin and placebo administration, while 20 healthy controls were included for the placebo condition only. Resting-state functional magnetic resonance imaging was used to analyze functional integration of the thalamus by three different resting state analysis techniques. Thalamocortical functional connectivity (FC) was analyzed by seed-based correlation, while intrinsic thalamic oscillation was assessed by analysis of regional homogeneity (ReHo) and the fractional amplitude of low frequency fluctuations (fALFF). Relative to the placebo treatment and healthy controls, acute heroin administration reduced thalamocortical FC to cortical regions, including the frontal cortex, while the reductions in FC to the mediofrontal cortex, orbitofrontal cortex, and frontal pole were positively correlated with the plasma level of morphine, the main psychoactive metabolite of heroin. Furthermore, heroin treatment was associated with increased thalamic ReHo and fALFF values, whereas fALFF following heroin exposure correlated negatively with scores of attentional control. The heroin-associated increase in fALFF was mainly dominated by slow-4 (0.027-0.073 Hz) oscillations. Our findings show that there are acute effects of heroin within the thalamocortical system and may shed new light on the role of the thalamus in cognitive control in heroin addiction. Future research is needed to determine the underlying physiological mechanisms and their role in heroin addiction.

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