

# Study shows differences in how patients with heroin use disorder process drug and reward cues

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An Icahn School of Medicine at Mount Sinai study sheds new light on some of the underlying neurobiological mechanisms of opioid addiction,

which accounted for three-quarters of the more than 100,000 fatal drug overdoses in the United States in 2021.

The Mount Sinai researchers found that inpatients with heroin use disorder exhibited a bias in favor of processing [drug](#) cues over cues related to natural, non-drug rewards, as observed during passive viewing of the cues and when the patients were asked to try two emotional regulation strategies. Results of the study were published in the July 12 issue of the *American Journal of Psychiatry*.

For this study, researchers used functional magnetic resonance imaging (fMRI), an imaging scan that shows activity in a specific area of the brain, to track [blood oxygenation](#) in real time while individuals looked at drug-related, neutral, and food images. Since [brain cells](#) use more oxygen when active, the fMRI signals areas of the brain that "light up" when most active.

The research team found that in individuals with heroin use disorder, responses to drug cues (images of individuals using or simulating use of drugs or of drug paraphernalia) were enhanced in [brain regions](#) associated with reward and inhibitory control, while these individuals' brain regions were less reactive to food or neutral images (e.g., stapler) when compared to healthy control subjects.

Although there were no group differences during the two emotional regulation strategies (aimed at decreasing drug-related reactions and enhancing natural reward-related reactions) when inspected separately, significant differences between the groups emerged when the two strategies were considered together. One of the emotional regulation strategies—cognitive reappraisal—involved re-evaluating the significance of the drug cues (e.g., imagining that the drugs in the pictures are not real, or that the people in the images are actors). The other emotional regulation strategy—savoring—involved enhancing the

significance of the food cues (e.g., imagining holding, eating, and enjoying the food pictured).

Compared to healthy controls, participants with heroin use disorder showed enhanced cortico-striatal reactivity when reappraising drug cues compared to when savoring food cues, with healthy controls showing the opposite pattern.

"In [heroin addiction](#), the effort to downregulate response to drug cues via reappraisal may come at the expense of the ability to upregulate healthy hedonic responses, depleting the cognitive-affective resources needed to enjoy natural, non-drug rewards," said Yuefeng Huang, Ph.D., a postdoctoral fellow in psychiatry at the Icahn School of Medicine at Mount Sinai and first author of the study.

These findings suggest that inpatients who are in the early stage of treatment for heroin use disorder possess the neural resources to modulate their emotional responses to drug and food cues. However, in these individuals the neural resources needed to suppress responses to drug cues appear to come at the cost of the ability to amplify responses to healthy reward stimuli, which may diminish the resources necessary to derive enjoyment from natural, non-drug rewards. Conversely, healthy controls who do not have addiction demonstrated the opposite pattern, pinpointing an important target for intervention to normalize function.

"This study paves the way for testing interventions to normalize these deficits, reduce craving, and enhance recovery in drug addiction, including via cognitive reappraisal and savoring in mindfulness-oriented recovery enhancement, non-invasive brain stimulation, and/or pharmacologically," adds Rita Z. Goldstein, Ph.D., senior author of the study and Professor in Neuroimaging of Addiction at the Icahn School of Medicine at Mount Sinai.

The study team is currently collecting longitudinal data from the participants of the study who were scanned again after 15 weeks of treatment to investigate potential recovery effects. They are also planning to increase the recruitment of women to investigate sex differences in the patterns identified in the study, since the current sample size was small and predominantly men.

**More information:** Yuefeng Huang et al, Association of Cortico-Striatal Engagement During Cue Reactivity, Reappraisal, and Savoring of Drug and Non-Drug Stimuli With Craving in Heroin Addiction, *American Journal of Psychiatry* (2023). [DOI: 10.1176/appi.ajp.20220759](https://doi.org/10.1176/appi.ajp.20220759)

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