Medical Xpress

Study shows that human beliefs about drugs could have dose-dependent effects on the brain

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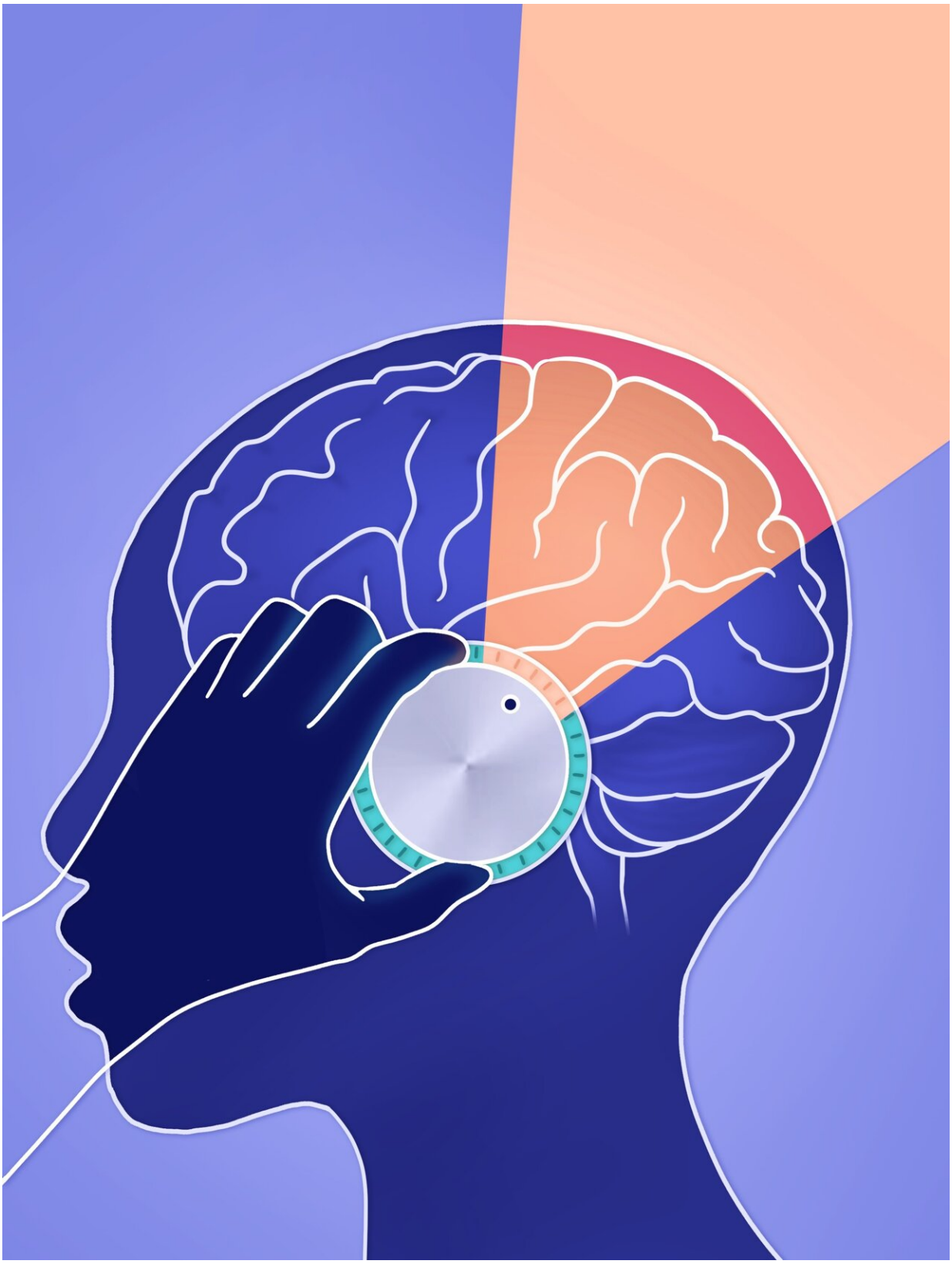

Graphic for study. Credit: Lily Armstrong-Davies, Medical Illustrator

Mount Sinai researchers have shown for the first time that a person's beliefs related to drugs can influence their own brain activity and behavioral responses in a way comparable to the dose-dependent effects of pharmacology.

The implications of the study, which directly focused on beliefs about nicotine, are profound. They range from elucidating how the neural mechanisms underlying beliefs may play a key role in addiction to optimizing pharmacological and nonpharmacological treatments by leveraging the power of human beliefs. The study is published today in the journal *Nature Mental Health*.

"Beliefs can have a powerful influence on our behavior, yet their effects are considered imprecise and rarely examined by quantitative neuroscience methods," says Xiaosi Gu, Ph.D., Associate Professor of Psychiatry and Neuroscience at the Icahn School of Medicine at Mount Sinai, and senior author of the study.

"We set out to investigate if human beliefs can modulate brain activities in a dose-dependent manner similar to what drugs do, and found a high level of precision in how beliefs can influence the human brain. This finding could be crucial for advancing our knowledge about the role of beliefs in addiction as well as a broad range of disorders and their treatments."

To explore this dynamic, the Mount Sinai team, led by Ofer Perl, Ph.D., a postdoctoral fellow in Dr. Gu's lab when the study was conducted, instructed nicotine-dependent study participants to believe that an electronic cigarette they were about to vape contained either low,

medium, or high strengths of nicotine, when in fact the level remained constant.

Participants then underwent functional neuroimaging (fMRI) while performing a decision-making task known to engage neural circuits activated by nicotine.

The scientists found that the thalamus, an important binding site for nicotine in the brain, showed a dose-dependent response to the subject's beliefs about nicotine strength, providing compelling evidence to support the relationship between subjective beliefs and biological substrates in the human brain.

This effect was previously thought to apply only to pharmacologic agents. A similar dose-dependent effect of beliefs was also found in the functional connectivity between the thalamus and the ventromedial prefrontal cortex, a brain region that is considered important for decision-making and belief states.

"Our findings provide a mechanistic explanation for the well-known variations in individual responses to drugs," notes Dr. Gu, "and suggest that subjective beliefs could be a direct target for the treatment of substance use disorders. They could also advance our understanding of how cognitive interventions, such as psychotherapy, work at the neurobiological level in general for a wide range of psychiatric conditions beyond addiction."

Dr. Gu, who is one of the world's foremost researchers in the emerging field of computational psychiatry, cites another way in which her team's research could inform clinical care. "The finding that human beliefs about drugs play such a pivotal role suggests that we could potentially enhance patients' responses to pharmacological treatments by leveraging these beliefs," she explains.

Significantly, the work of the Mount Sinai team can also be viewed in a much broader context: harnessing beliefs in a systematic manner better to serve mental health treatment and research in general.

"We're interested in testing the effects of beliefs on drugs beyond nicotine to include addictive substances like cannabis and alcohol and therapeutic agents like antidepressants and psychedelics," says Dr. Gu.

"It would be fascinating to examine, for example, how the potency of a drug might impact the effect of drug-related beliefs on the brain and behavior and how long-lasting the impact of those beliefs might be. Our findings could potentially revolutionize how we view drugs and therapy in a much broader context of health."

More information: Ofer Perl et al, Nicotine-related beliefs induce dose-dependent responses in the human brain, *Nature Mental Health* (2024). DOI: 10.1038/s44220-023-00188-9

Provided by The Mount Sinai Hospital

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