

Social Context and Drug Cues Modulate Inhibitory Control in Cocaine Addiction: involvement of the STN evidenced through fMRI

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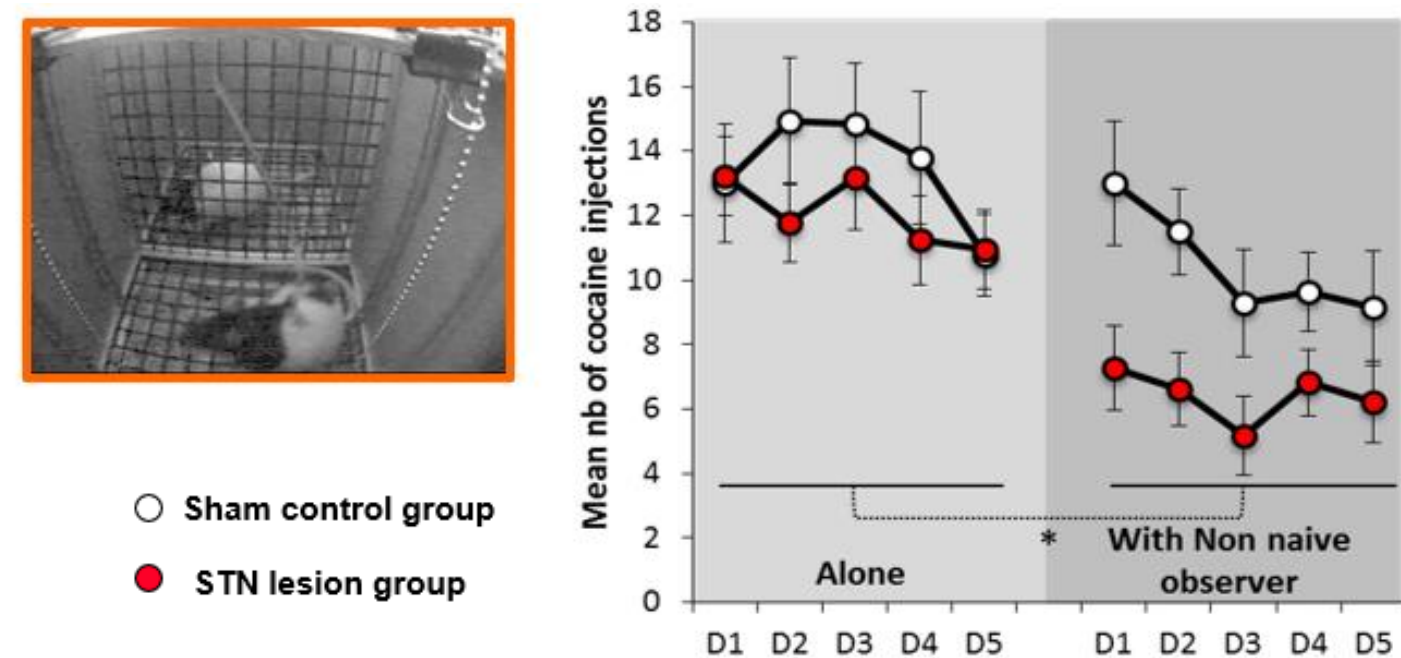
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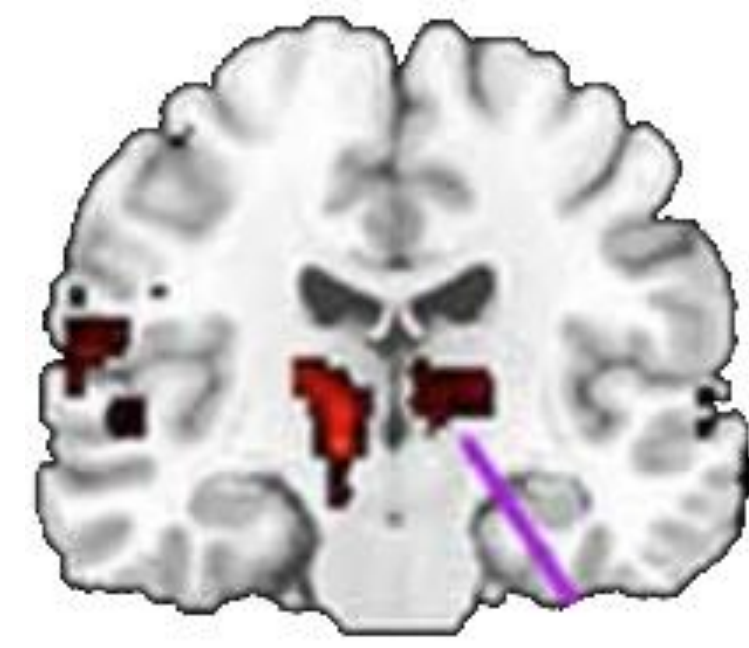
Influence of a peer on drug addiction & Response inhibition network

Influence of the presence of a peer on cocaine self-administration: STN lesion effect



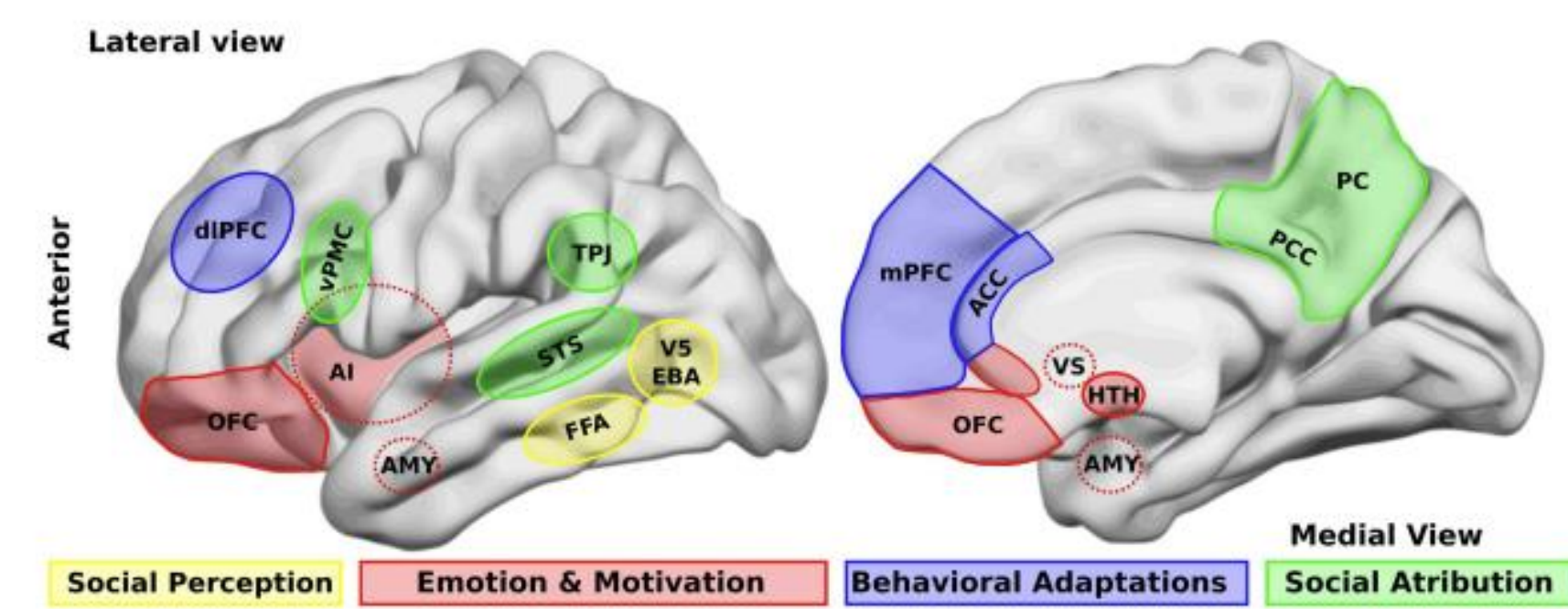
- A recent study on rats showed that drug consumption decreased with the presence of a peer [1].
- This effect was potentiated by a lesion of the subthalamic nucleus (STN).

The role of the STN in stop signal response inhibition



- The STN is activated by scenarios involving suppressing an ongoing motor response, possibly via a “hyperdirect pathway” that connects the IFG/OFC and the STN [2].
- Hence, manipulating the presence of an observing person may impact inhibitory control processes in drug addiction, which is characterized by impulsive behavior

The «social brain»



- Multiple brain areas, including temporal and frontal regions, encode the presence of an observing person.
- These brain areas, along with the STN, may contribute to the impact of the presence of an observer on inhibitory control in addiction

Materials and Methods: The ‘Social’ Stop-Signal Task (SSST)

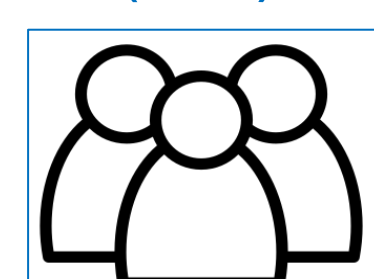
This study has two main aims: 1) to test whether **the control of inhibition** in individuals with cocaine use disorder (CUD) **can be affected by either cocaine-related cues and/or social context** 2) and which are the **neurobiological correlates** of this possible modulation

Three factors:

- **Group** (cocaine users, controls)
- **Social context** (observer, non observer)
- **Cues** (cocaine, neutral)

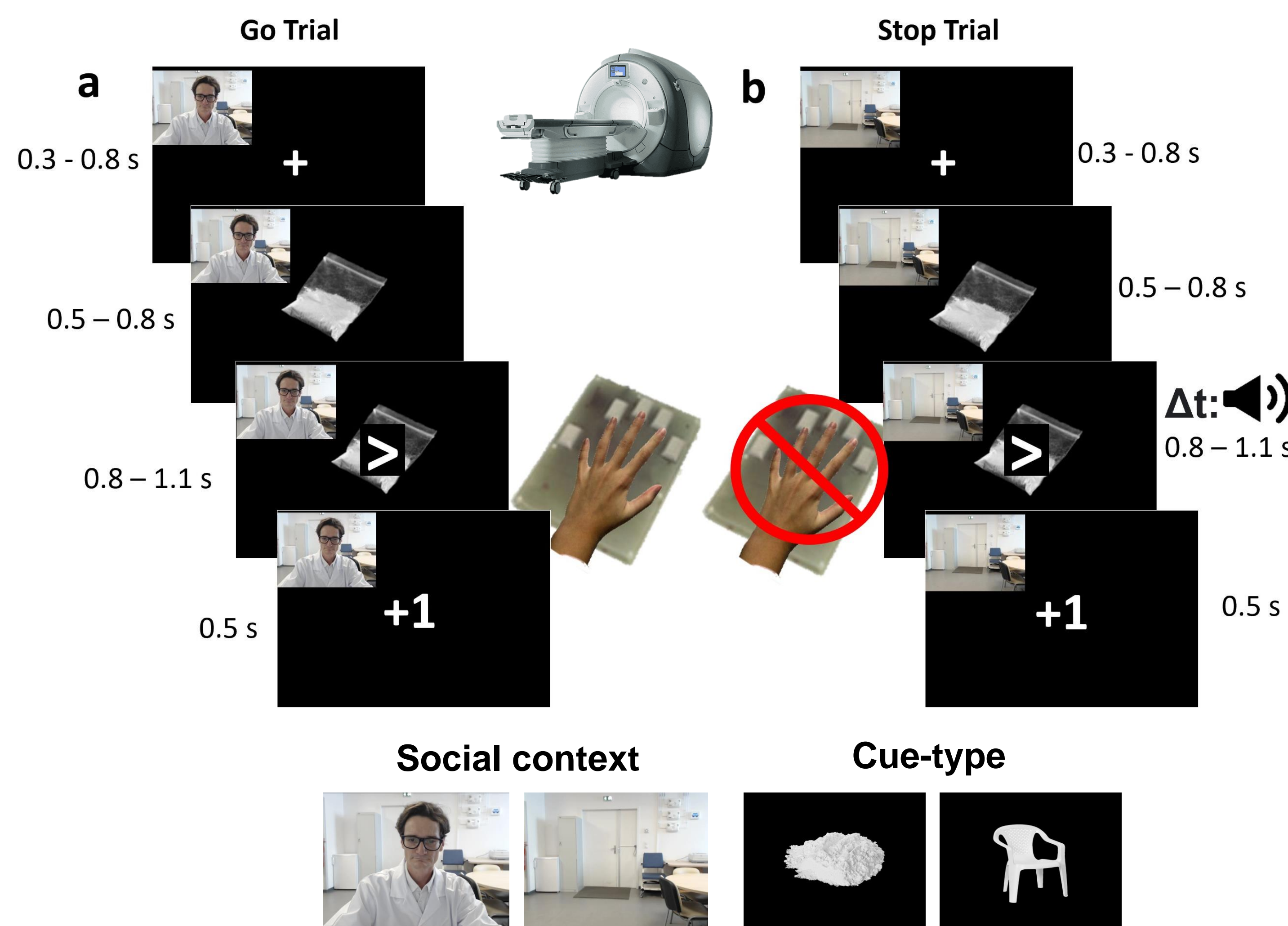
- 480 trials in total (108 stop trials; 22.5%)
- 4 sessions (5 min each)

17 Cocaine Users (CUD) 17 Healthy Controls (HC)



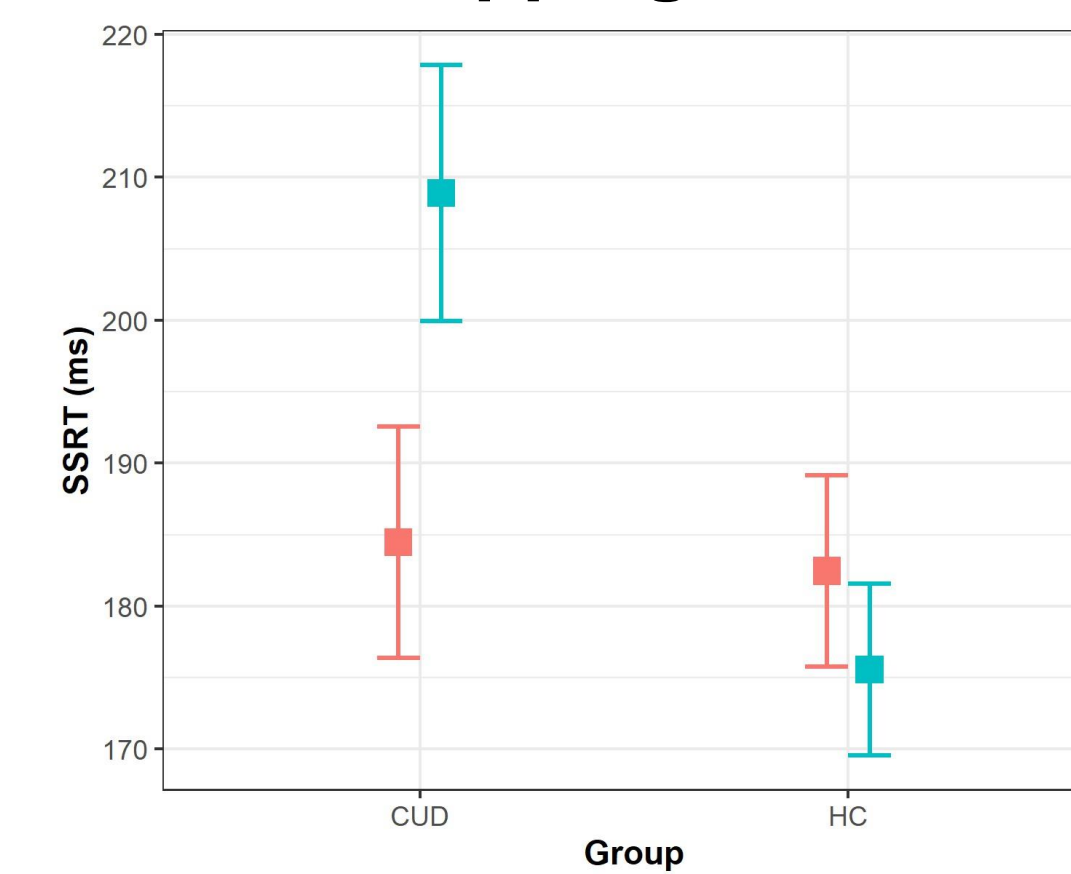
- 4 female
- mean age 36.5 (SD 9.23)

- 9 female
- mean age 31.8 (SD 13.0)



Results

Stopping abilities

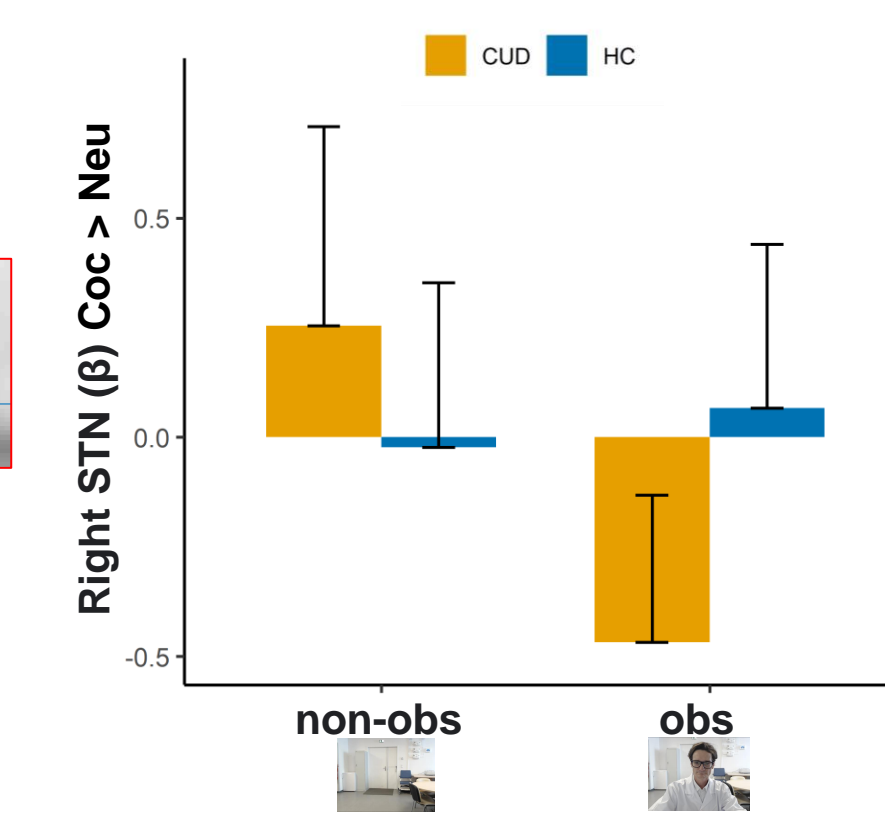


CUD participants, while slower at stopping with neutral cues, recovered control level stopping abilities with cocaine cues, while HC did not show any difference.

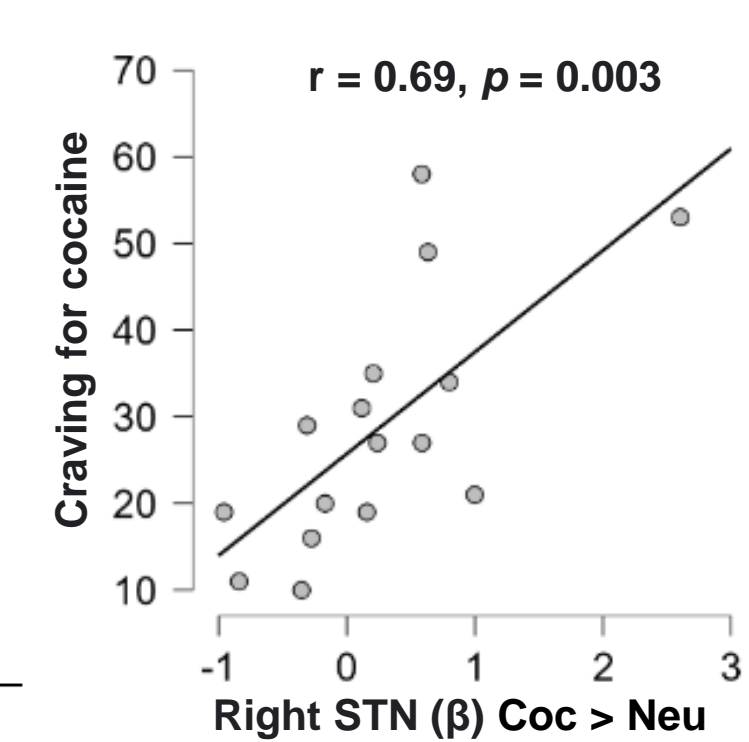
STN mask (Pauli et al. 2018 [4])



A)

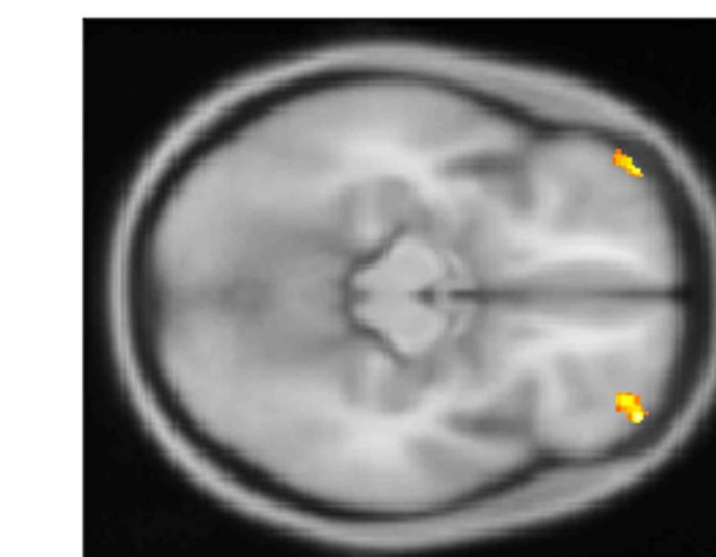


B)

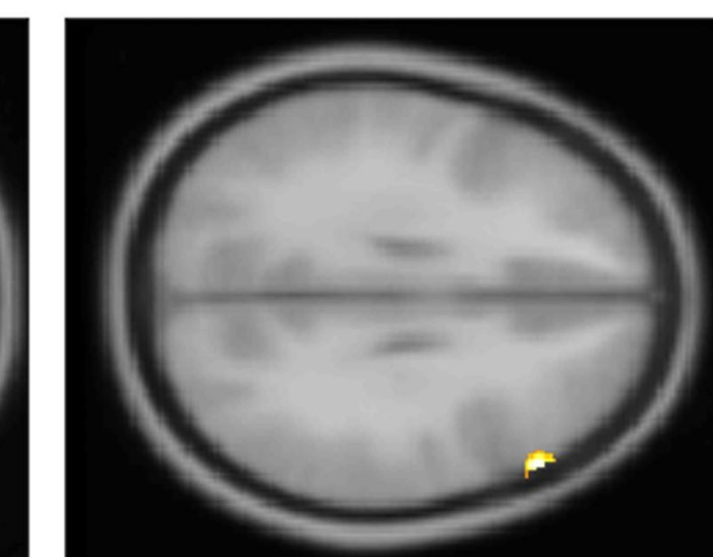


In line with [2], the STN is involved in inhibitory control. Importantly, when observed by another person, CUD participants displayed reduced activity in the STN (A). Also, craving for cocaine in CUD is positively associated with STN activity during cocaine-related inhibitory control (B).

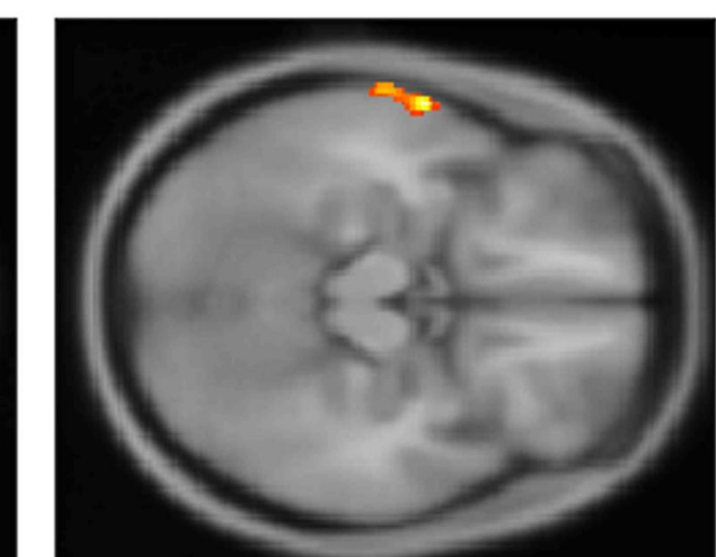
A)



B)

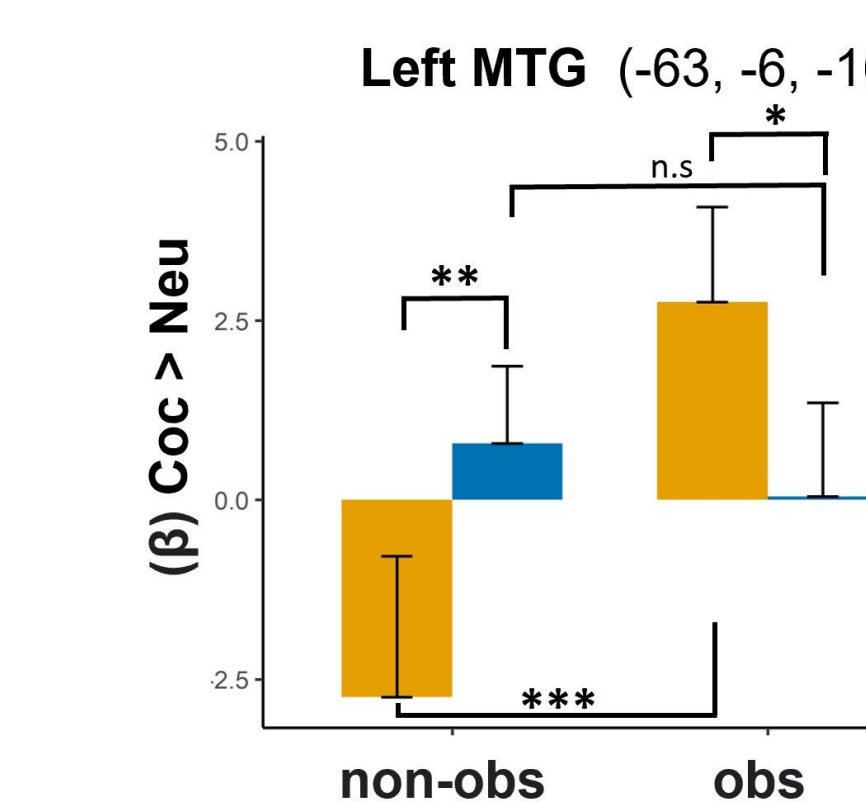
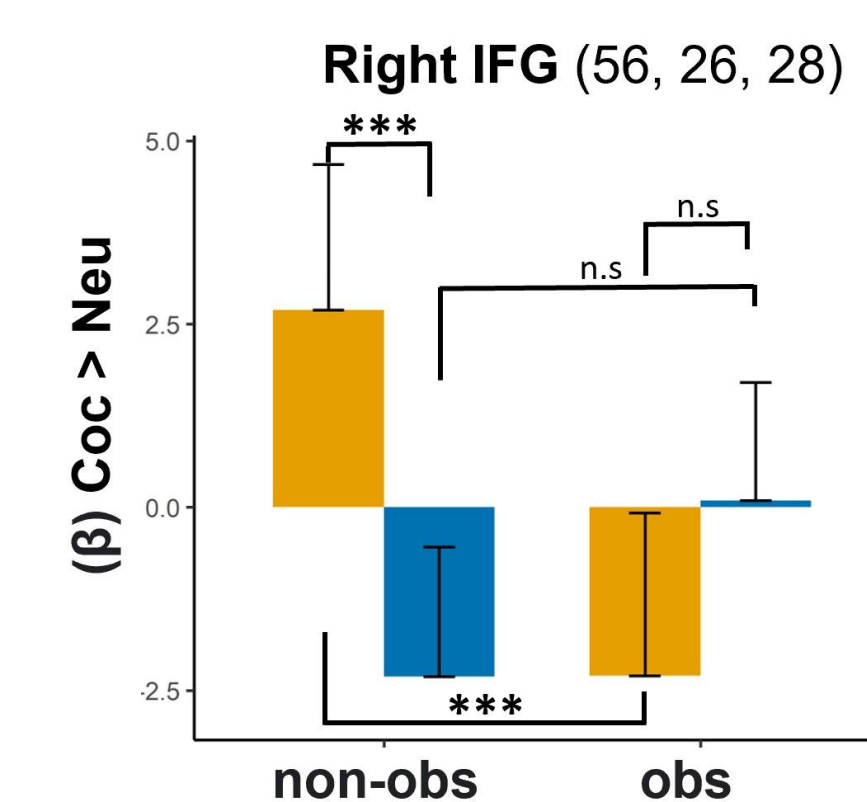
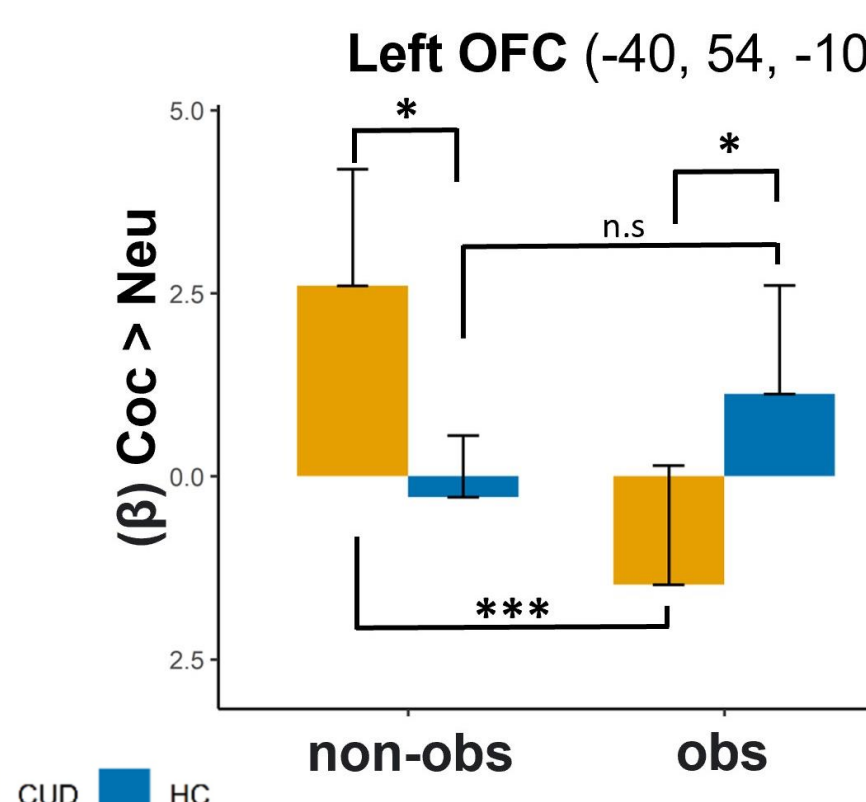
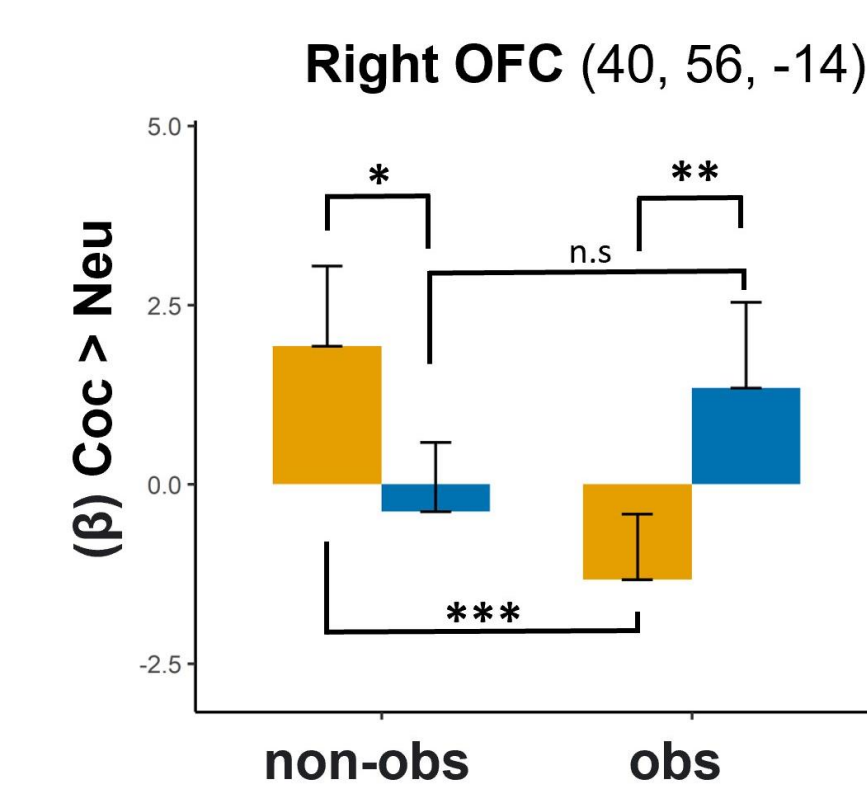


C)



0 10 20 30 40
F value

Contrast Stop Correct > Stop Incorrect (Cocaine > Neutral)
($p < 0.001$; $P_{FWE} < 0.05$)



- CUD participants exhibited increased activity in the bilateral OFC (A) and in the right IFG (B) during inhibition in trials involving cocaine-cues compared to those with neutral cues.
- Notably, in the presence of an observer, CUD participants showed reduced activity in these regions. This decrease in activity could be attributed to the observer acting as an alternative reinforcer, dampening the salience and motivation associated with drug-related cues during the SSST.
- In contrast, the HC group did not show significant differences between observer and non-observer conditions.
- Interestingly, the left MTG (C), involved in multisensory integration and social cognition, demonstrated increased activity in CUD participants in the observer condition.

Discussion

Our results indicate that **the control of impulsivity in individuals with CUD is influenced by both cocaine-cues and social context**. This influence is mediated by the right STN, right IFG, and bilateral OFC. Our results emphasize the importance of considering the social context in addiction research. They also comfort the STN as a potential addiction treatment target.

1) Gloria, E., Nordmann, S., Vielle, C., Pelloux, Y., Roux, P., Protocolescu, C., Manrique, C., Davranche, K., Montanari, C., Giorgi, L., Viotto, A., Huguet, P., Carrieri, P., & Baunez, C. (2022). Peer presence and familiarity as key factors to reduce cocaine intake in both rats and humans: an effect mediated by the subthalamic nucleus. *Psychopharmacology*, 239(4). <https://doi.org/10.1007/s00213-021-06033-0>

2) Aron, A. R., & Poldrack, R. A. (2006). Cortical and subcortical contributions to stop signal response inhibition: Role of the subthalamic nucleus. *Journal of Neuroscience*, 26(9). <https://doi.org/10.1523/JNEUROSCI.4682-05.2006>

3) Billeke, P., & Abolitz, F. (2013). Social cognition in schizophrenia: From social stimuli processing to social engagement. In *Frontiers in Psychiatry* (Vol. 4, Issue FEB). <https://doi.org/10.3389/fpsy.2013.00004>

4) Pauli, W. M., Nili, A. N., & Michael Tyszka, J. (2018). Data Descriptor: A high-resolution probabilistic in vivo atlas of human subcortical brain nuclei. *Scientific Data*, 5. <https://doi.org/10.1038/sdata.2018.63>