

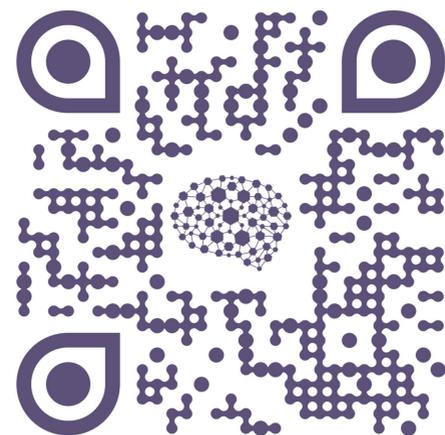
# Closed-Loop Emotion Augmentation for Depression: Combining Brain, Body, and Audiovisual Stimulation

Schoeller, F.<sup>1</sup> Jain, A.<sup>2</sup>, Reggente, N.<sup>1</sup>

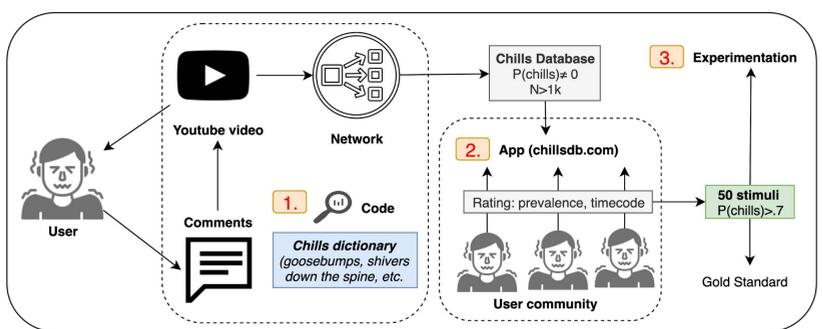
<sup>1</sup>Institute For Advanced Consciousness Studies, Santa Monica, CA, USA | <sup>2</sup>MIT Media Lab, Cambridge, MA, USA

## Summary

We tested the effect of aesthetic chills on MDD, showing improvements in reward learning (PRT), PHQ-9, BDI, and maladaptive schemas, with chills enhancing reward sensitivity in anhedonia and reducing negative cognitive patterns. To systematically control and augment these effects, we designed neurotechnologies to manipulate chills in real time. We built ChillsDB, the first validated database of chills stimuli (n=3,000+), Frisson, a wearable augmentation device stimulating the chills somatic markers in real time, and machine learning models predicting who experiences chills from what content. We used neural networks to forecast chills from neurophysiology before subjective awareness. Next, we plan to test tFUS to the nucleus accumbens and integrate generative AI for personalized chills stimuli in a closed-loop therapeutic system.



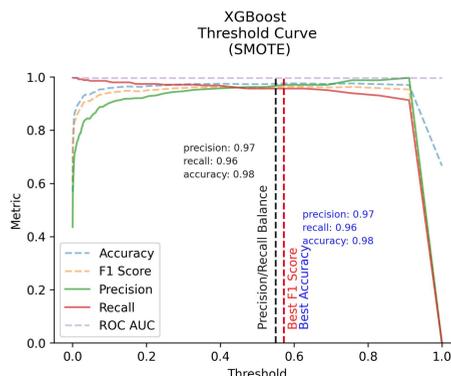
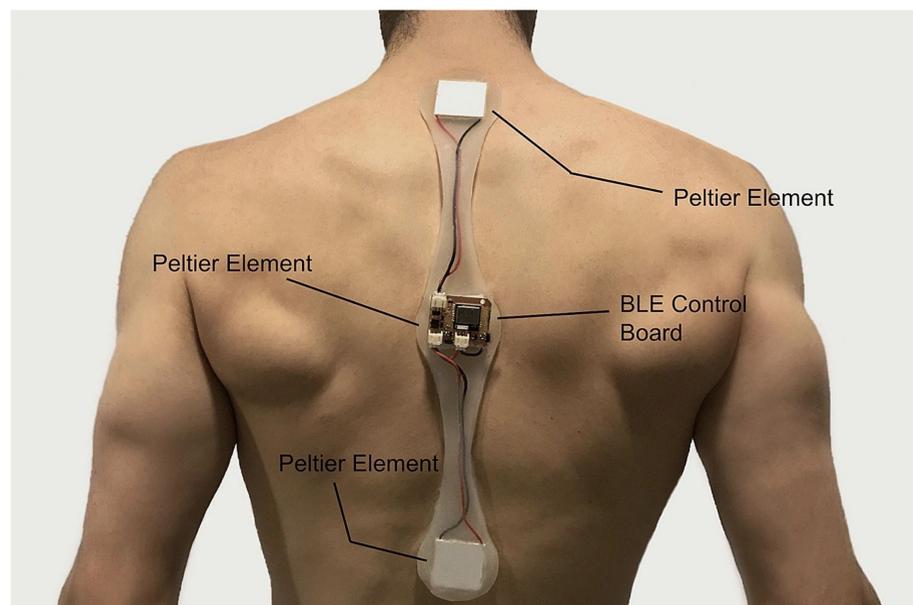
### Detecting chills stimuli [1]



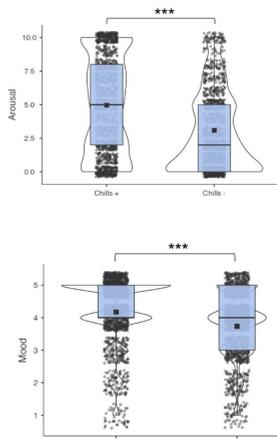
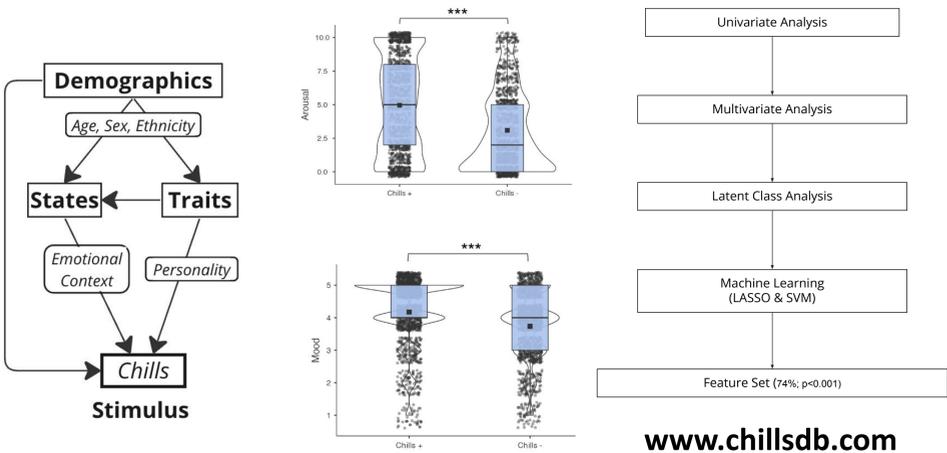
**ChillsDB**  
350 Stimuli identified  
50 validated on 600+ participants  
Top 10: 80% Chills

**ChillsDB 2.0**  
40 Stimuli on 3000+ participants  
Top 10: 50% Chills  
Top 1: 75%

### Closed Loop Neuromodulation



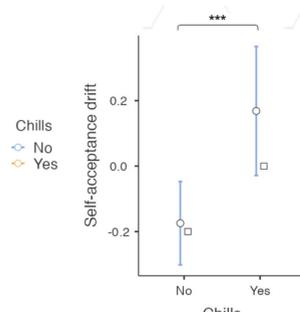
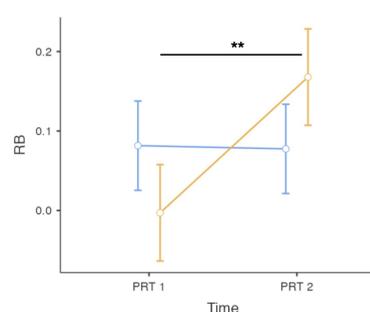
### Predicting individual differences [2]



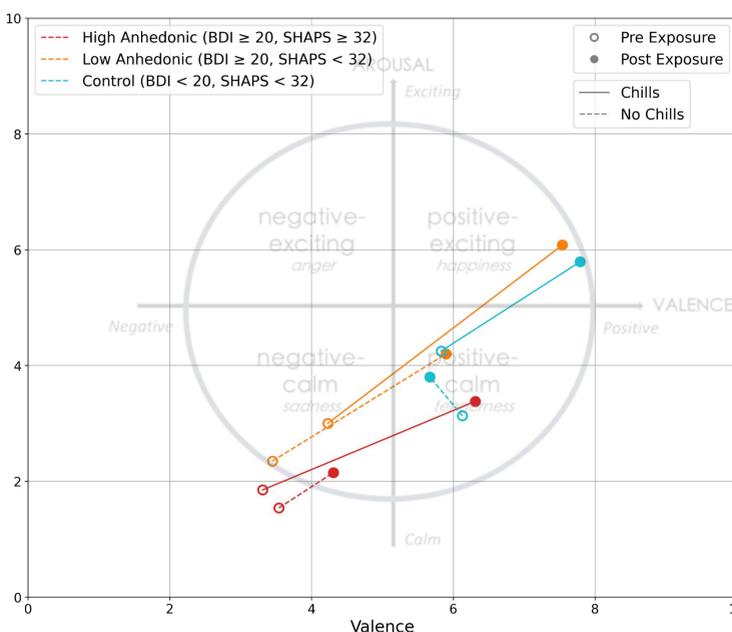
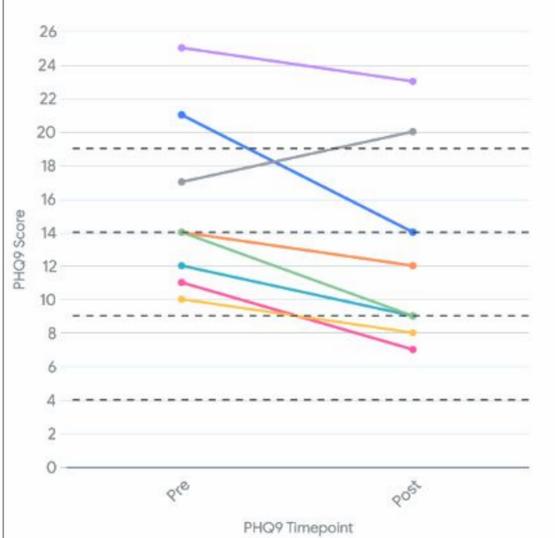
www.chillsdb.com

### Chills and depression [3-5]

- Physiological chills consistently alter emotional valence and arousal (Jain et al., 2023).
- Chills enhances reward sensitivity in individuals with anhedonic depression (Jain et al., 2024).
- Chill-evoking stimuli reliably deactivate maladaptive cognitions (e.g., shame, negativity; Schoeller et al., 2024).



### PHQ-9 Score Evolution by Patient



[1] Schoeller F et al., ChillsDB 2.0: Individual Differences in Aesthetic Chills Among 2,900+ Southern California Participants. *Nature Sci Data*. 2023  
 [2] Schoeller F., Christov-Moore, L., Lynch, C., Diot, T., Reggente, N. (2024). Latent Variables Determine Peak Emotional Responses. *PNAS Nexus*.  
 [3] Jain, A., Schoeller F., Reggente, N. Pizzagalli, D. (2024) Aesthetic Chills Modulate Reward Learning in Anhedonic Depression. *Journal of Aff. Disorder*  
 [4] Schoeller, F., Jain, A., Adrien, V., Maes, P., Reggente, N. (2024) Aesthetic Chills Mitigate Maladaptive Cognition In Depression. *BMC Psychiatry*  
 [5] Jain A, Schoeller F, et al., (2023) Aesthetic chills cause an emotional drift in valence and arousal. *Front. Neurosci*.

