

## **Spiritual states induced by ayahuasca, and the involvement of the reward system**

### **ABSTRACT:**

#### **Background**

DMT is an indole alkaloid best known by its presence in ayahuasca. It is a psychedelic tryptamine associated with intense visual phenomena, perception changes and profound spiritual experiences.

#### **Aims**

In this study we explored the neural correlates of these altered brain states during the experience produced by DMT using resting state fMRI and periodic visual stimuli.

#### **Method**

A within-subject design study with control and active treatment conditions was conducted, in 2 separate sessions: Control (no treatment) or Active treatment (inhaled DMT). In both sessions, pre and post measures of subjective experience were collected with the Spiritual Well Being Questionnaire, the Vividness of Visual Imagery Questionnaire, the Mystical Experience Questionnaire (MEQ-30) and the Hallucinogen Rating Scale (HRS). fMRI included resting state, block design with a visual hallucination inducer paradigm, and visual population receptive field (pRF) mapping.

#### **Results**

Significant behavioural and psychological effects were observed for hallucinogen and mystical subjective experiences. A surprising intrinsic hyperconnectivity pattern was found within functionally segregated regions of the DMN and Salience networks.

Mean pRF size in V1 was statistically significantly higher in the DMT condition. Visual stimulation yielded increased BOLD activity in visual areas BA18, 19 and Precuneus for the active condition. This may explain perceptual distortions induced by psychedelics such as field blurring and the enlargement of nearby visual space, particularly at the visual periphery.

#### **Conclusions**

These results suggest a neural basis for the hallucinations evoked by Ayahuasca which occur concomitantly with significant behavioural and psychological effects.

#### **Keywords**

Cognition, functional magnetic resonance imaging (fMRI), Psychedelic agents, Serotonin, Spiritual states, Hallucinations

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### **Published Work:**

Castelhano, J., Lima, G., Teixeira, M., Soares, C., Pais, M., & Castelo-Branco, M. (2021). The Effects of Tryptamine Psychedelics in the Brain: A meta-Analysis of Functional and Review of Molecular Imaging Studies. *Frontiers in Pharmacology*, *12*: 739053. doi: 10.3389/fphar.2021.739053

Duarte, I. C., Coelho, G., Brito-Costa, S., Cayolla, R., Afonso, S., Castelo-Branco, M. (2020). Ventral caudate and anterior insula recruitment during value estimation of passionate rewarding cues. *Frontiers in Neuroscience*, *14*: 678. doi: 10.3389/fnins.2020.00678

Rebelo, D., Oliveira, F., Abrunhosa, A., Januário, C., Lemos, J., & Castelo-Branco, M. (2021). A link between synaptic plasticity and reorganization of brain activity in Parkinson's disease. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(3): e2013962118. doi: 10.1073/pnas.2013962118

Sayal, A., Sousa, T., Duarte, J. V., Costa, G. N., Martins, R., & Castelo-Branco, M. (2020). Identification of competing neural mechanisms underlying positive and negative perceptual hysteresis in the human visual system. *Neuroimage*, *221*: 117153. doi: 10.1016/j.neuroimage.2020.117153

### **Researcher's Contacts:**

Miguel Castelo-Branco  
ICNAS, Polo 3  
3000-548, Coimbra  
Portugal

Phone: + 351 488514

Email: [mcbranco@fmed.uc.pt](mailto:mcbranco@fmed.uc.pt)