



# LSD MODULATES MUSIC-INDUCED IMAGERY VIA CHANGES IN PARAHIPPOCAMPAL CONNECTIVITY

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## BECKLEY / IMPERIAL RESEARCH PROGRAMME

### What is this study about?

This is the first study to examine how LSD and music work together to change consciousness and the human brain. It is part of a larger study using state-of-the-art brain imaging to give us the first insights into what happens in the brain to produce LSD's psychedelic (and potentially therapeutic) effects.

### Why did we do this study?

- Music is an effective tool for evoking and studying emotions.
- Psychedelics were used in psychotherapy in the 1950s and 60s. It was believed (but not scientifically evaluated) that music was an important component of this therapy.
- Our previous findings showed that **LSD enhances the emotional response to music**, creating a deeper and stronger emotional experience.
- **In this study, we wanted to know: What underlies this difference? How does music influence the effect that LSD has on the brain?**

### What did we do?

- We gave 12 people either **LSD** (75µg intravenous) or **placebo** (saline) on 2 separate days.
- On each day, they then completed **brain imaging** and **questionnaires**. Brain imaging (**fMRI**) measured activity during **rest** and while listening to **music**.
- Analyses focused on a specific region of the brain: **parahippocampal cortex (PHC)**, which is involved in emotion, memory, and ego/self functions, and has been linked to the response to psychedelics.
- We used 2 analysis types:
  - **Seed-based analysis** = a method of measuring all the functional connections a particular brain region has (in our case parahippocampal cortex).
  - **Dynamic Causal Modelling** = a method to determine the *direction* of information flow between connected regions.

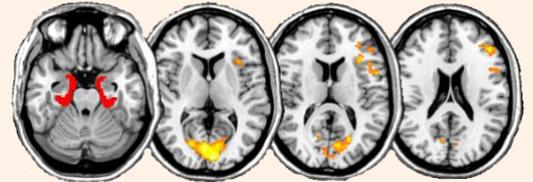
### About the research team

Amanda Feilding is the founder and director of the Beckley Foundation. She and David Nutt are Co-Directors of the Beckley/Imperial Research Programme. Robin Carhart-Harris is the Programme's lead investigator. Mendel Kaelen is a PhD student who led this study.

### What did we find?

#### 1. INCREASED FUNCTIONAL CONNECTIVITY of parahippocampal cortex (PHC).

Music on LSD (vs. music on placebo) increased connectivity of the PHC (**red**) with several other regions (**yellow/orange**), especially the visual cortex.



#### 2. INCREASED INFORMATION FLOW from PHC to visual cortex.

- The *direction* of increased connectivity was found to be *from PHC to visual cortex*.
- This effect correlated with self-report of 'eyes-closed visions,' including complex images (scenes, etc.) and visions of one's past.
- Together, the findings suggest **that music and LSD interact to increase mental imagery of autobiographical nature**.

### What do we make of this?

- PHC is highly connected with the **Default Mode Network (DMN)**, which exerts top-down control over the PHC. Psychedelics decrease this DMN control, resulting in altered consciousness.
- LSD and music lift the usual top-down control that the DMN holds over the PHC, allowing the PHC to interact more freely with the visual system.
- The input of memories to the visual system – a 'flip' in the normal direction of information flow – may underlie the reported visions.

### Why is it important?

The findings emphasise the **scientific value of psychedelics** in terms of:

- Progressing our **understanding of brain function** by clarifying the neural circuits involved in visions; and
- Developing a **rationale for LSD-assisted psychotherapy** by explaining how music – which acts to liberate emotional memories – interacts with LSD to help evoke personal memories and enhance mental imagery.