LSD MODULATES MUSIC-INDUCED IMAGERY VIA CHANGES IN PARAHIPPOCAMPAL CONNECTIVITY

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What is this study about?

The first study to examine how LSD and music work together to alter human consciousness and brain activity.

It is one component of a larger study using state-of-the-art brain imaging to give first insight 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 underwent **brain imaging** and completed **questionnaires.** Brain imaging (**fMRI**) measured activity during **rest** and while listening to **music.**
- We focused the analyses on a specific region of the brain: the **parahippocampal cortex (PHC),** which is involved in emotion, memory, and ego/self functions, and has been linked to the response to psychedelics.
- We analysed the data in two ways:
  - **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.

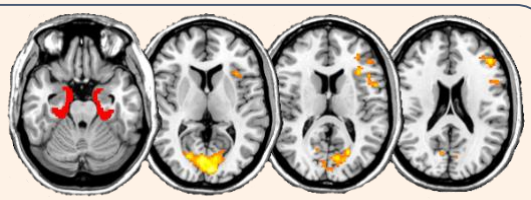
About the research team

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 connectivity between the PHC and the rest of the brain.

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* the PHC *to* visual cortex.

- The *direction* of increased connectivity was found to be *from* PHC *to* the visual cortex.
- This effect correlated with self-reports 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 vivid mental imagery of a 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 interact to 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 visions reported by participants.

Why is it important?

- Progresses our **understanding of brain function** by clarifying the neural circuits involved in visions; and
- Develops **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.