



What is this study about?

Here we find a relationship between our brain imaging results (LSD-induced 'entropy' or 'chaos' in the brain) and changed personality traits 2 weeks later. It is part of a larger study using brain imaging to give us the first insights into what happens to the brain to produce LSD's psychedelic (and possible therapeutic) effects.

Why did we do this study?

- Our research has shown that both psilocybin and LSD increase openness and optimism weeks after the psychedelic experience. This has important clinical implications, supporting psychedelic-assisted psychotherapy.
- Our research has also shown that psychedelics increase 'entropy' (chaos, or disorder) in the brain, 'loosening up' rigid patterns of activity to produce a more flexible cognitive state.
- **Here we wanted to know: How do psychedelics produce personality changes? Is it related to our finding of increased entropy?**

What did we do?

- We gave 19 people either **LSD** (75µg intravenous) or **placebo** (saline) on 2 separate days.
- On each day, they then completed brain imaging (**fMRI**) to measure activity during eyes-closed **rest** and while listening to **music**.
 - fMRI data were analysed using a new technique that calculates '**sample entropy**' - a different way of expressing the degree of chaos in the brain induced by LSD.
- We also measured **personality traits** on 3 occasions: Once at the very beginning of the study (before either LSD or saline), and again 2 weeks after each test session.

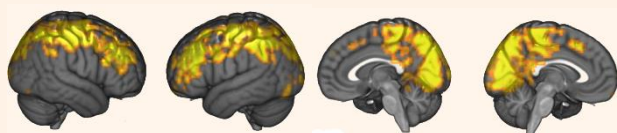
About the research team

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. Alexander Lebedev is a psychiatrist and researcher at the Karolinska Institutet (Sweden) who collaborates with our Research Programme.

What did we find?

1. INCREASED ENTROPY ACROSS THE BRAIN.

Our measure of 'entropy' (chaotic/erratic brain activity) increased throughout most of the brain.



Regions showing LSD-induced increases (yellow/orange) in sample entropy

2. INCREASED OPENNESS.

- Ratings of the personality trait 'openness' (linked to imagination, aesthetic appreciation, non-conformity, creativity) were higher 2 weeks after LSD, but not after placebo.
- This is consistent with the idea that psychedelics may serve as a kind of 'existential shock' therapy, where the profound psychological experience can lead to a change in behaviour and outlook.

3. A RELATIONSHIP BETWEEN BRAIN ENTROPY AND OPENNESS

- Those subjects showing the greatest brain entropy on LSD had the greatest increase in openness 2 weeks later.
- This relationship was made even stronger by **music** – that is, it was stronger during the music and post-music scans than pre-music.
- The finding supports the 'Entropic Brain hypothesis' – a theory to explain how and why psychedelics have their effects on the brain and on consciousness.

4. AN ADDITIONAL EFFECT OF EGO-DISSOLUTION

- Those subjects who reported the greatest amount of 'ego-dissolution' by music (on a post-scan questionnaire) AND showed the greatest increase in entropy (in certain brain networks) were also those who demonstrated the most marked increases in openness.
- This suggests that both music and an 'ego-dissolution' experience may be desirable in a therapeutic context.

Why is this important?

- This is the first time the long-known therapeutic potential of LSD has been directly linked to a biological marker in the brain.
- This helps build the rationale for developing psychedelic therapies, and indicating the beneficial potential of psychedelics and the ways to harness it.