



INCREASED GLOBAL CROSS-TALK IN THE BRAIN CORRELATES WITH REPORTS OF EGO-DISSOLUTION UNDER LSD

TAGLIAZUCCHI E, ROSEMAN L, FEILDING A, NUTT DJ, CARHART-HARRIS RL. *ET AL.*

IN PRESS, *CURRENT BIOLOGY* STRICT EMBARGO UNTIL 13.4.16

Imperial College
London

BECKLEY / IMPERIAL RESEARCH PROGRAMME

What is this study about?

This study finds that the LSD-induced experience of 'ego-dissolution' results from increased communication and integration across brain systems (networks). It is part of a larger study using brain imaging to give us the first insights into how LSD produces its psychedelic and therapeutic effects.

Why did we do this study?

- It is well-known that LSD deeply transforms human consciousness – but we don't yet know how these altered states are generated in the brain.
- Our research has shown that psychedelics increase 'cross-talk', and decrease 'separateness', between the different brain networks.
- **We wanted to know: What underlies the experience of 'ego-dissolution' – a loss of the sense of 'self' – under LSD? Is it related to the increased communication across the different brain networks?**

What did we do?

- We gave 15 people either **LSD** (75µg intravenous) or **placebo** (saline) on 2 separate days.
- On each day, they then completed **brain imaging** (resting-state fMRI) and **self-report questionnaires**.
- **Resting-state fMRI** means the subject lies still, with eyes closed, without engaging in a specific task. This is a method to assess functional connections *within* and *between* brain networks.
- fMRI data were analysed using 2 techniques: One to calculate **functional connectivity density** (which measures network connections across different regions of the brain), and another - **graph theory analysis** (which measures global network integration).

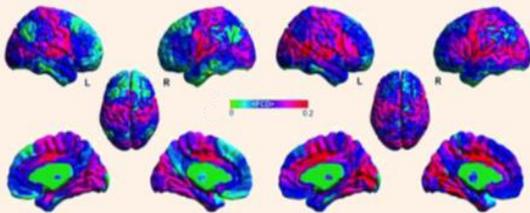
About the research team

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. Enzo Tagliazucchi is a physicist and researcher at the University of Kiel, Germany. Leor Roseman is a PhD student at Imperial College London. ET and LR led this study.

What did we find?

1. LSD increases functional connectivity across the brain

- **LSD increased functional connectivity globally**, but the strongest effects were seen in the higher-level integrative cortical and sub-cortical structures.



Green = no connectivity, red = highest connectivity

- The areas of the highest increase overlapped with three important networks: default mode network (introspection, sense of self), salience network (switching between tasks) and fronto-parietal network (conscious information access, attention).
- We also found strong overlap between the distribution of the serotonin 2A receptors (key site of action of psychedelic drugs) and the increases in functional connectivity.

2. Increases in functional connectivity in the regions associated with self-awareness correlate with 'ego-dissolution' scores.

I.e. the more connected these separate regions were with other areas, the stronger was the loss of the sense of self.

3. LSD increases between-system functional connectivity.

- LSD not only modifies the intensity of certain functional connections, but also produces qualitatively different connectivity patterns.
- Ego-dissolution scores correlate positively with the increased global integration (or desegregation of neural networks), suggesting that this phenomenon is very important, as the whole brain is affected, not only individual modules.

Why is it important?

- These results provide the evidence that **LSD selectively enhances communication between different brain areas and networks maintaining consciousness**, diminishing the functional identity of these systems, resulting in the blurring of the borders between the self and environment.
- These results confirm the mechanisms of action of psychedelics formulated from the psilocybin research, namely **disintegration** (within networks) and **desegregation** (between networks).
- Our results contrast with the states of 'diminished consciousness' such as deep sleep or anaesthesia, giving further support to the hypothesis that psychedelic state occupies the opposite end of a spectrum of conscious states, defined by their level of entropy or chaos.