What is this study about?

This is the first-ever study to examine the effects of LSD on the human brain. Using multiple brain imaging techniques, it gives us the first glimpses into what happens to the brain to produce LSD’s psychedelic (and possibly therapeutic) effects.

Why did we do this study?

- Hundreds of scientific studies examined the effects of LSD in the 1950s and ‘60s (when it was still legal), but no study has ever before examined what it does to the brain.
- We wanted to know: How does LSD so profoundly change consciousness? What changes underlie these effects? How psychedelics could be therapeutically beneficial?

What did we do?

- We gave 20 people either LSD (75µg intravenous) or placebo (saline) on 2 separate days.
- On each day, they completed brain imaging and self-report questionnaires.
- Brain imaging consisted of:
  - ASL = arterial spin labelling = an MRI method to measure blood flow within the brain.
  - Resting-state MRI = MRI while the subject lies still with eyes closed = a method to assess functional connections within and between brain networks.
  - MEG = magnetoencephalography = a method to detect ‘brain waves.

What did we find?

1. ALTERED CONSCIOUSNESS
   All participants reported visual hallucinations and profound changes in consciousness on LSD (vs. placebo).

2. ‘SEEING WITH EYES SHUT’ = Brain activity normally associated with visual input.
   - Connectivity of brain regions involved in vision (‘visual cortex’) increased on LSD, so that visual cortex ‘talked to’ much more of the rest of the brain than after placebo.
   - This increase correlated with self-reported hallucinations.
   - Changes in brain waves in visual regions also correlated with hallucinations, suggesting these findings are related.
   - Blood flow to visual regions also increased.
   - Note: These are all properties normally associated with visual stimulation, but participants had their eyes closed!

   - Brain regions that together make up brain networks lost connectivity with one another, so that ‘integrity’ within those networks decreased.
   - Decreased integrity within a specific network – the Default Mode Network (DMN) – correlated with self-reported ‘ego-dissolution’ and ‘altered meaning.’ This suggests that the DMN underlies a stable sense of self and other aspects of normal consciousness.
   - Brain wave synchronisation decreased – that is, neurons that normally fire together to produce brain waves lost their synchronisation.
   - This decrease correlated with both DMN disintegration and ego-dissolution, suggesting the findings are inter-related.

4. ‘DESEGREGATION’ = Increased connectivity between brain networks.
   - Distinct brain networks became more connected to one another – that is, they lost their ‘separateness,’ allowing for wider and more integrated communication between networks.
   - An example of this is the vision finding above, but it occurs across all the brain networks.

Why is this important?

Understanding how LSD works in the brain can:
- Help unlock its therapeutic potential.
- Provide valuable information on the mechanisms underlying consciousness and its changing states.
- The ‘brain wave’ findings also give clues as to the neuron-level mechanics underlying the network-level changes. Also we found new information about changes in blood supply within the brain.

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.