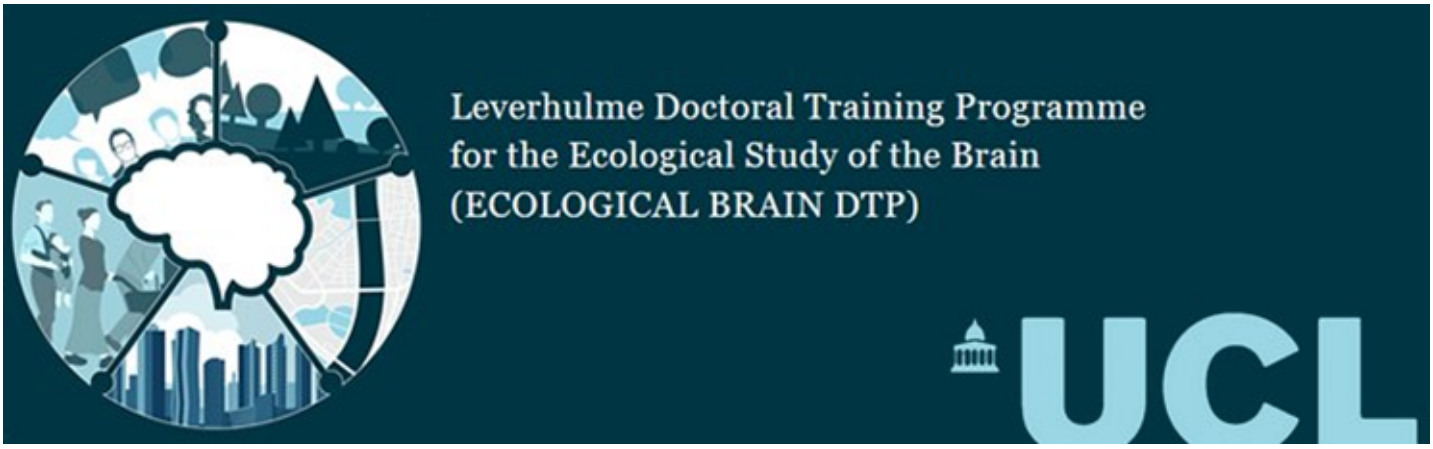


## Leverhulme Doctoral Training Programme for the Ecological Study of the Brain

# POSSIBLE PHD PROJECTS

**Please find below possible PhD projects for the Leverhulme Doctoral Training Programme for the Ecological Study of the Brain. Alternatively, you can submit your own research proposal.**

1. **How do moods influence our expectations and perception of real-life experiences? Blending smartphone-based assessment of mood, physiology and reward prediction errors with computational modelling.**

*Dr Liam Mason, MRC Clinician Scientist Fellow (Max Planck Centre for Computational Psychiatry) and Lecturer in Clinical Psychology*

Mood influences practically every decision we make in our lives, yet the neuro-computational mechanisms by which mood shapes how we perceive the world, and our behaviour, have only very recently begun to be understood. Positive moods can bias us our perception of experiences as being even more rewarding than they actually are (and vice-verse for negative moods) by modulating activation in the ventral striatum (see Mason, Eldar, Dolan & Rutledge 2017, *JAMA Psychiatry*).

Our next step is to translate this model from the laboratory to real-world environments, by leveraging our ***newly launched smartphone platform*** and integrating with ***mobile neural and physiological measurements***. This allows us to measure changes in people's momentary mood in e.g. busy urban environments, or when pursuing value-based goals.

- Drawing on a large dataset (N>15,000) with longitudinal measurements of mood and reward-based decision-making in app-based 'games', we use **computational modelling** to examine how task parameters interact with day-to-day mood and behaviour. Some questions we are interested in are:
  1) Are younger people more prone to their moods biasing reward valuation?
  2) Do men and women have different propensities for mood bias?
  3) Are we more moody at different times of the day, because of circadian rhythms?

- A second aspect involves tracking daily life experiences by integrating our smartphone platform with neural-physiological measurements (**mobile EEG** and **ECG**).

By frequently sampling their expectations about how rewarding (and how effortful) daily events will be, we can derive ***real-life reward prediction errors*** and integrate these with the ***simultaneously acquired physiological signals***.

We use linear mixed effects regression models that include derivatives that capture not only point estimates of mood and RPEs, but also their velocity and acceleration, to quantify how much people's moods are tracking the momentum of recent rewarding experiences.

REFERENCES

Mason L, Eldar E, Rutledge R (2017). Mood instability and reward dysregulation: a neuro-computational model of bipolar disorder. *JAMA Psychiatry*

Eldar, E., Roth, C., Dayan, P., & Dolan, R. J. (2018). Decodability of reward learning signals predicts mood fluctuations. *Current Biology*, *28*(9), 1433-1439.

Villano, W. J., Otto, A. R., Ezie, C. E., Gillis, R., & Heller, A. S. (2020). Temporal dynamics of real-world emotion are more strongly linked to prediction error than outcome. *Journal of Experimental Psychology: General*, *149*(9), 1755.

**2. How do psychedelic drugs change long-term conscious experience and promote wellbeing?**

*Dr. Jeremy Skipper, Senior Lecturer, Experimental Psychology*

Our 'Understanding Neuroplasticity Induced by Tryptamines' (UNITy) project attempts to address this question using the hallucinogens DMT and 5-MeO-DMT, naturalistic neuroimaging (i.e., movie fMRI), and follow-ups using naturalistic experience sampling procedures in healthy volunteers.

For more detailed information on the theoretical framework supporting this work, interested candidates are encouraged to read:

Skipper, J. I. (2021). *A voice without a mouth no more: The neurobiology of language, consciousness, and mental health*. https://doi.org/10.31234/osf.io/jfuws

and

Aliko, S., Huang, J., Gheorghiu, F., Meliss, S., & Skipper, J. I. (2020). A naturalistic neuroimaging database for understanding the brain using ecological stimuli. *Scientific Data*, *7*(1), 347.

**3. The universality or distinctiveness of musical processing across the senses**

*Dr. Velia Cardin, Head of Deafness and Neural Plasticity Lab*

The aim of these projects is to understand the universality or distinctiveness of musical processing across the senses.

Students could work on:

1) Developing multisensory technologies that allow a visual and somatosensory experience of different aspects of music, such as low-level features like notes, through to mid-level expressive gestures like phrasing and performance motive, and larger-scale formic and stylistic aspects.

2) Understanding which properties of music can be perceived by different sensory modalities in deaf and hearing individuals
3) Determine whether musical processing is modality specific or independent using fMRI or EEG in deaf and hearing individuals
4) Understanding what aspects of music and sound elicit different types of body responses, and how to measure them in real-world and lab settings.
5) Exploring how to build wearable devices that transform sound into vibrotactile feedback to share musical experience across deaf and hearing individuals.

**4. Mechanisms of Information Seeking and Their Relationship to Well-Being**

*Professor Tali Sharot, Cognitive Neuroscientist at the Department of Experimental Psychology, Director of the Affective Brain Lab, Wellcome Trust Senior Research Fellow*

People spend a substantial amount of time seeking out information (e.g., reading, asking questions, internet browsing). It is theorized that common psychiatric conditions are characterized by abnormal information-seeking patterns. These patterns could be detected in "real-world" online searches to facilitate diagnosis and treatment selection. However, the precise links between information-seeking and psychopathology are unknown. In fact, we know little about how to quantify information-seeking or the mechanisms that control it. The aim of the research is to understand (i) how people decide what information to seek out and (ii) how those decisions are related to mental health. The student will develop tasks to quantify key drivers of information-seeking. They will test participants online to assess whether psychopathology symptoms are linked to abnormal influence of these drivers on information-seeking. In the lab, they will combine pharmacological manipulation with neuroimaging to examine whether the influence of these drivers is dependent on dopamine – a neuromodulator that malfunctions in several conditions in which information-seeking is theorized to be altered- and identify the neural computations involved. They will assess whether these drivers are over/under expressed in individuals diagnosed with affective disorders, and conduct experiments to determine how these alterations impact well-being.

**5. Do books play a special role in vocabulary development across the lifespan? If so why?**

*Prof. Jennifer Rodd, Experimental Psychology*

This project will explore the idea that there is no intrinsic, inevitable advantage for reading compared with other formats (e.g., audiobooks, TV, films, youtube) in terms of their potential to drive vocabulary learning. The project will explore whether differential contribution of these different formats might arise because:
(i) Books tend to include particularly diverse, varied vocabulary content.
(ii) Shared book reading with an adult provides young children with learning 'scaffolds' that are often not present for audio/video formats in which the child is often expected to learn independently.
(iii) Different formats can vary in terms of how engaged (or distracted) the learner feels and the extent to which their attention is kept directed on the relevant material.
(iv) Decoding printed words can be effortful. This may present a barrier to learning from text that will particularly impact younger children, but can sometimes persist into adulthood.
The proposed research would explore how learning from stories is affected by (i) the learner (e.g., age, vocabulary, reading proficiency), (ii) the language format (e.g., text, audio, video), and (iii) the specific supportive scaffolds provided by the learning context (e.g. opportunity to ask questions).

**6. How do individuals attain status in social hierarchies?**

Dr. Pranjal Mehta, Associate Professor, Experimental Psychology

Status hierarchies are pervasive across species, but the precise mechanisms that influence status attainment in human hierarchies remain unknown. For example, who is more likely to rise to high-status leadership positions, and how? The primary aims of this PhD project are to:

(i) Examine the interplay between the hormonal reproductive axis (testosterone, estradiol), the hormonal stress axis (cortisol), and the social context in influencing status attainment.

(ii) Examine gender differences in the mechanisms for status attainment

(iii) Devise psychological interventions that influence status attainment via hormonal and behavioural changes.

(iv) Examine the consequences of status attainment for stress and well-being

We will use a variety of methods to address these questions, including pharmacological hormone administration, a smartphone application for non-invasive physiological measurement, experimental manipulation of social context, and behavioural observation in laboratory and field studies. Field studies are expected to involve real-world organisational and political hierarchies.