ISRCTN25803759 https://doi.org/10.1186/ISRCTN25803759

Measuring single neuron activity in the brain

Submission date 20/12/2024	**Recruitment status** Recruiting	[X] Prospectively registered [ ] Protocol [ ] Statistical analysis plan [ ] Results [ ] Individual participant data [ ] Record updated in last year
Registration date 06/01/2025	**Overall study status** Ongoing	
Last Edited 02/05/2025	**Condition category** Surgery	

Plain English summary of protocol

Background and study aims
The Single Unit Neurophysiological Architecture of the Neocortex (SUNAN) study aims to describe single-unit neurophysiological activity recorded in the human brain during planned neurosurgery. By leveraging Neuropixels probes, the study seeks to provide insights into brain function and the neurophysiological impact of various neurological conditions. The primary objective is to report the number and characteristics of well-isolated neuronal units recorded intraoperatively, contributing to a deeper understanding of human neurophysiology.

Who can participate?
Patients aged 18 years and over undergoing a transcranial neurosurgical procedure at the National Hospital for Neurology and Neurosurgery (NHNN) in which part of the cerebral cortex will be resected or transgressed as part of the surgical approach to reach a deeper target or by the passage of a surgical implant, or surgery felt to be technically suitable for the neurophysiological recording technique

What does the study involve?
The study involves intraoperative neurophysiological recording using Neuropixels probes during planned brain surgeries. The procedure adds up to a total of 30 minutes to standard surgical time, including a maximum of 15 minutes of recording. In awake surgeries, participants may perform neurological tasks. Sub-studies involving cerebrospinal fluid (CSF) and tissue biopsies are optional components.

What are the possible benefits and risks of participating?
There are no direct clinical benefits to participants. The primary benefit is contributing to neuroscientific knowledge, potentially benefiting future patients. Participants receive a thank-you card with a printout of their neuronal recordings.

The main risks relate to:
1. Neuropixels probe fracture
2. Injury as a result of Neuropixels probe insertion
3. Infection as a result of probe insertion or surgical sterility compromised
4. Planned surgery time extended

Where is the study run from?
The study is run from the NHNN at Queen Square, London (University College London NHS Foundation Trust) and sponsored by University College London and the Comprehensive Clinical Trials Unit (CCTU).

When is the study starting and how long is it expected to run for?
January 2024 to January 2029

Who is funding the study?
The Francis Crick Institute

8. Who is the main contact?
1. Mr William Muirhead (Chief Investigator), Consultant Neurosurgeon, The NHNN, william.muirhead@crick.ac.uk
2. The SUNAN Trial Team, cctu.sunan@ucl.ac.uk.

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Additional identifiers

Integrated Research Application System (IRAS)
314485

Protocol serial number
CCTU TAG: CTU/2022/422, Sponsor R&D: 159671, Funder grant: CR2023/031/20612

Study information

Scientific Title
Single Unit Neurophysiological Architecture of the Neocortex (SUNAN): a single centre, unblinded, basic interventional science study using a Neuropixels probe to record and describe neuronal activity in humans undergoing a planned neurosurgical procedure on the brain

Acronym
SUNAN

Study objectives
SUNAN is a single-centre, unblinded, basic interventional science study using a Neuropixels probe to record and describe individual neuronal activity in human participants who are undergoing a planned neurosurgical procedure on the brain.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 17/12/2024, North East - Newcastle and North Tyneside 1 Research Ethics Committee (Health Research Authority) (2nd Floor, 2 Redman Place, London, E201JQ, United Kingdom; +44 (0)207 104 8000; newcastlenorthtyneside1.rec@hra.nhs.uk), ref: 24/NE/0226

Primary study design
Interventional

Study design
Single-centre unblinded basic interventional science study

Study type(s)
Other

Health condition(s) or problem(s) studied
Patients undergoing planned cranial neurosurgery

Interventions
The SUNAN study is a basic science study involving a procedure to record single-unit neurophysiological activity with human participants who are already undergoing a transcranial neurosurgical procedure on the brain at The National Hospital for Neurology and Neurosurgery.

As part of the surgery, a region of cerebral cortex on the convexity of the brain will be:
1. Resected e.g., as removal of part of a tumour or epilepsy focused

Or
2. Transgressed as part of the surgical approach to reach a deeper target e.g., resection of a deep tumour or cavernoma
Or
3. Transgressed by the passage of a surgical implant e.g., a ventriculoperitoneal shunt catheter or deep brain stimulation electrode.

Within this region of the brain that is going to be resected or transgressed, the research team will undertake a single-unit resolution neurophysiological recording (NR) using a digital neural probe (Neuropixels probe).

Participants may have surgery done under general anaesthesia (“asleep”) or they may be awake during the surgery. This is determined by the type of surgery the participant is undergoing and is decided by their consultant neurosurgeon (outside of the remit of the research team). The research team will perform NR on both types of surgeries (asleep and awake), if deemed appropriate to do so.

If participants are undergoing neurosurgery when awake, during the period of NR the patients may be asked to perform relevant neurological tasks (for example, undertaking particular movements, performing a cognitive test or looking at visual stimuli). These tasks will only be undertaken during surgery if deemed appropriate by the operating clinicians. Patients undergoing awake surgery will be asked to consent to these tasks prior to surgery.

Participants' routine clinical standard of care and post-operative care will remain the same. There will be additional surgical steps required to capture the NR data for this study, including: Extension of planned surgery duration by up to 30 minutes for all participants who take part in this study. This means for asleep participants under general anaesthesia, anaesthetic time will be increased by up to 30 minutes.

Within this time
Neuropixels probe insertion, neurophysiological recording for up to 15 minutes, and Neuropixels probe removal. This 15-minute NR period is included within the total extended surgery time of up to 30 minutes (and not in addition to this).

Intervention Type
Procedure/Surgery

Primary outcome(s)
Descriptive reporting on the number of well-isolated single neuronal units observed during the neurophysiological recording of the brain during planned neurosurgery. The neurophysiological activity of the brain will be described through an analysis of the electrical activity recorded. The detection of spikes represents the depolarisation of single neuronal units (“single units”). Well-isolated single-units will be defined by clustering metrics, interval spike interval violations and /or other neurophysiological analysis. Descriptive reporting will include the number of individual units recorded, their spiking rates and correlation.
Timepoint – At time of planned neurosurgery.

Key secondary outcome(s)
Secondary outcome measures will be reported for each participant to gather information on the recording technique. For example, a description of the recording setting may include the arrangement of ground and reference electrodes as well as the operative setup.

At a minimum of 6-month intervals throughout the study, the secondary outcomes will be reviewed and discussed by the research team.

The following secondary outcome measures will be assessed through study completion, an average of 1 year:
1. Reporting on the experience of using large-scale single-unit recording techniques in humans undergoing neurosurgery
2. Reporting on iterations made to the surgical and electrophysiological technique
3. Reporting on potential refinements that could be made to the described technique which could enable better quality data and that could be of benefit to other researchers conducting similar work. For example, equipment set-up/noise restrictions in the theatre

Completion date
01/01/2029

Eligibility

Key inclusion criteria
1. Aged 18 years and over
2. Able to give their own consent and written informed consent to participate
3. Undergoing a transcranial neurosurgical procedure at the National Hospital for Neurology and Neurosurgery in which part of the cerebral cortex will be:
3.1. Resected e.g., as removal of part of a tumour or epilepsy focused
Or
3.2. Transgressed as part of the surgical approach to reach a deeper target e.g., resection of a deep tumour or cavernoma
Or
3.3. Transgressed by the passage of a surgical implant e.g., a ventriculoperitoneal shunt catheter or deep brain stimulation electrode
4. Surgery felt to be technically suitable for the neurophysiological recording technique by the Chief Investigator and responsible Consultant Neurosurgeon. For example, participants having surgery in an unusual position may present problems for the neurophysiological recording step.

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 Years

Sex
All

Key exclusion criteria

1. Participants who lack the capacity to give informed consent.
2. Participants who are pregnant or breastfeeding at the time of surgery.
3. Participants deemed to be unsuitable for recruitment to the study by the responsible Consultant Neurosurgeon. If in the view of the treating consultant involvement in the study would compromise the patient's surgery or present an unacceptable risk to them, they will not be recruited to the study. For example, if the participant does not meet the standard of care preoperative checks.
4. Concern from the Consultant Neurosurgeon or treating Anaesthetist that there would be an unreasonable burden on the patient to participate in the study. For example, risk due to increased length of anaesthetic time.
5. For participants requiring anaesthesia for their pre-planned brain surgery, an American Society of Anaesthesiologists (ASA) physical status classification system score of 4 and higher.
6. Participants unable to understand English sufficiently well to read the patient-facing documents and consent in English.
7. Participants not undergoing their treatment through NHS care (i.e. private patients are excluded).

Date of first enrolment
01/06/2025

Date of final enrolment
01/02/2028

Locations

Countries of recruitment
United Kingdom

England

Study participating centre
National Hospital for Neurology & Neurosurgery
Queen Square
London
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Sponsor information

Organisation
University College London

ROR
https://ror.org/02jx3x895

Funder(s)

Funder type
Research organisation

Funder Name
Francis Crick Institute

Alternative Name(s)
Francis Crick Institute Limited, The Francis Crick Institute, Crick Institute, Francis Crick Institute Ltd, The Francis Crick Institute Limited, The Crick, UK Centre for Medical Research and Innovation, FCI, UKCMRI

Funding Body Type
Government organisation

Funding Body Subtype
Research institutes and centers

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan
The data sharing plans for the current study are unknown and will be made available at a later date.

IPD sharing plan summary
Data sharing statement to be made available at a later date