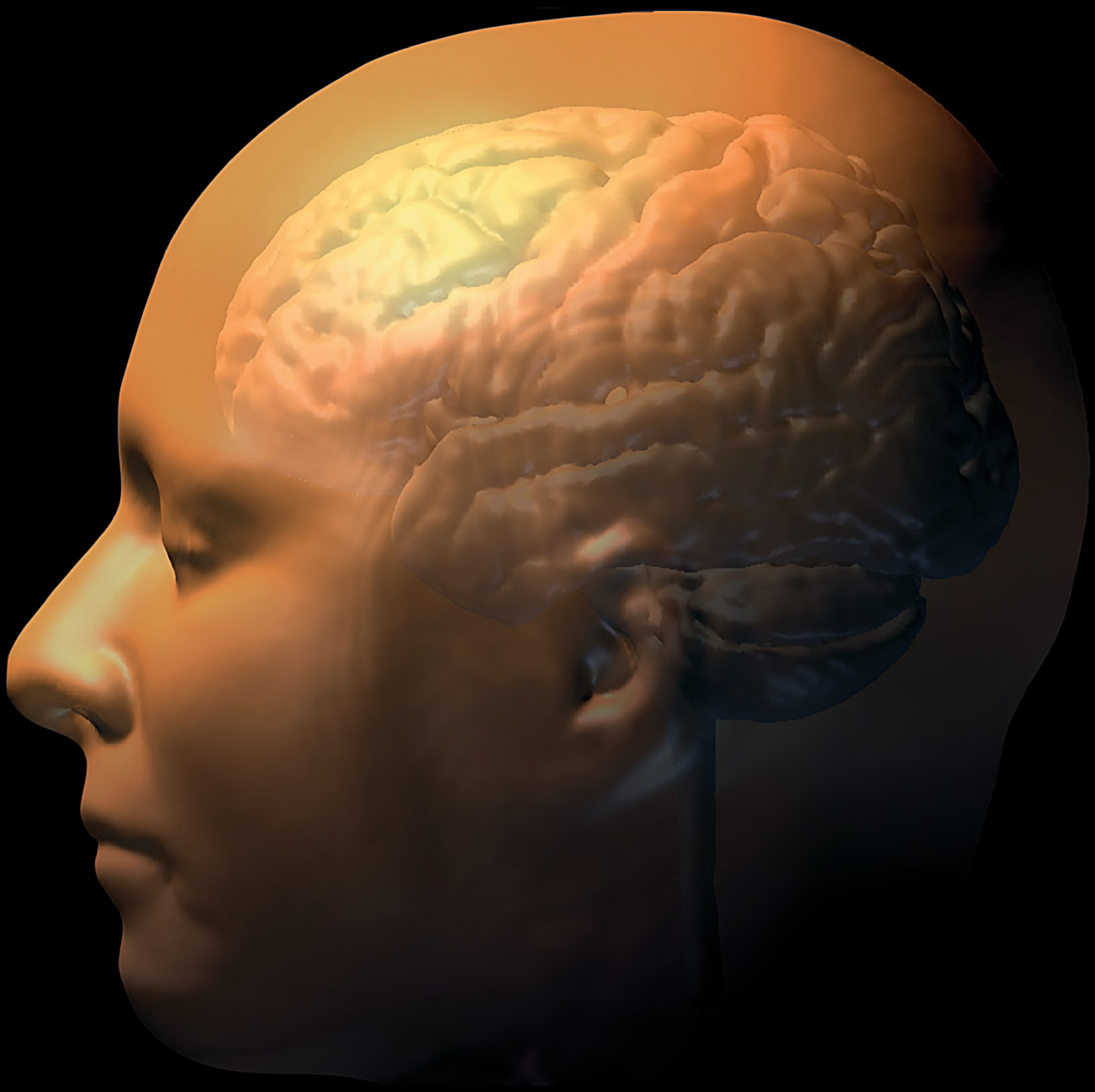
wellcome centre
human neuroimaging



UCL

Contents

About the Centre

We develop and use non-invasive techniques to investigate how the human brain generates behaviour, thoughts and feelings and how this knowledge can be used to help patients with neurological and psychiatric disorders.

As well as conducting scientific research (page 9) we offer educational and training opportunities to support the development of imaging neuroscience (page 12) and have an active public engagement agenda (page 13).

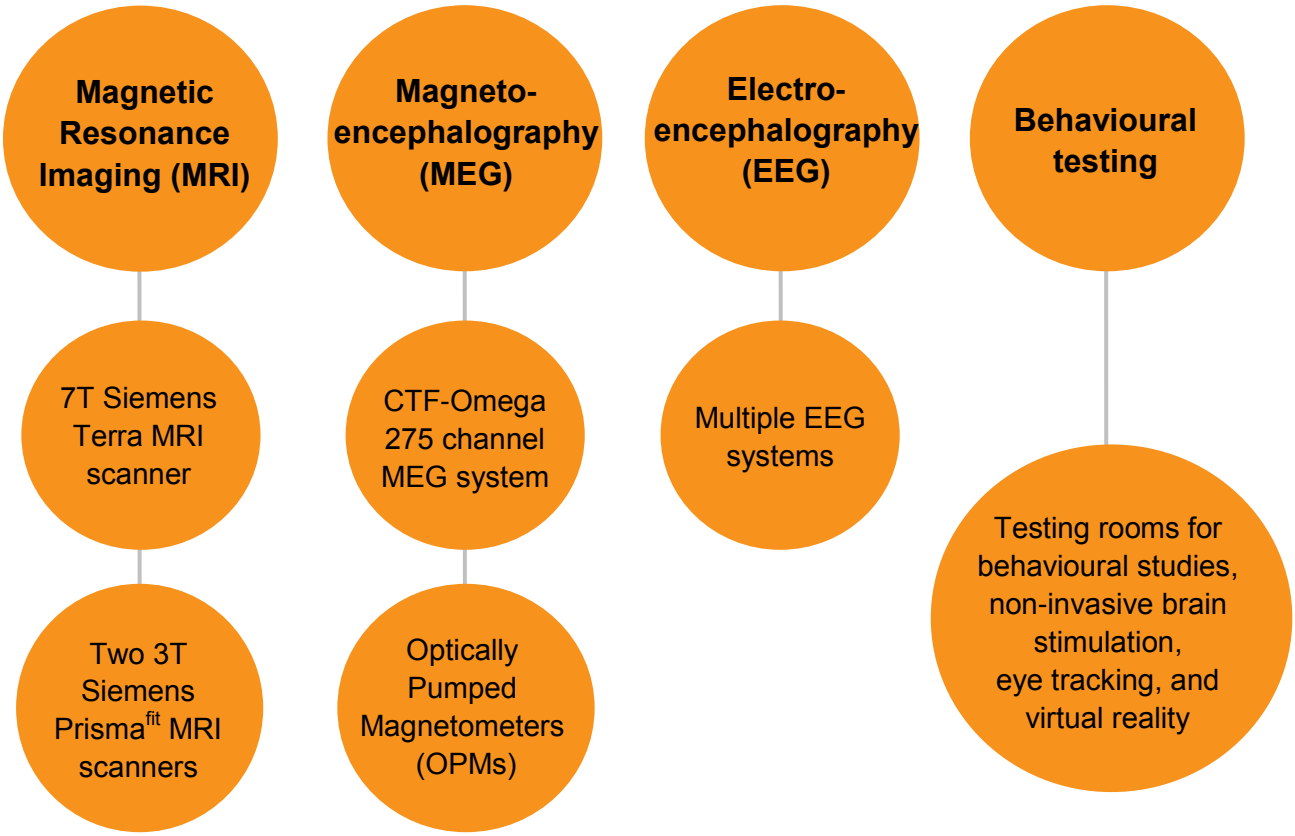
What is neuroimaging?

A set of non-invasive techniques we are continuing to develop, which enable the investigation of the structure and function of the human brain.

Why is neuroimaging important?

It helps to identify what goes wrong in neurological and psychiatric disorders and how these might be treated.

We do this research using the following facilities and techniques:



Our History

Over 25 years we have pioneered innovation and applications in imaging neuroscience, addressed fundamental biological questions, and played a leading role in transforming cognitive and systems neuroscience.

1994 Founding Director: Richard Frackowiak

The **Functional Imaging Laboratory (FIL)** was founded at 12 Queen Square in 1994, following a major award from the Wellcome Trust. It was incorporated within UCL's Institute of Neurology as the Wellcome Department of Cognitive Neurology. Our early work pioneered and openly shared new neuroimaging techniques and analyses for understanding human cognition.

2002 Director: Ray Dolan

Scientific Director: Karl Friston

In 2006, we were awarded Wellcome Trust Centre status (renewed in 2011), becoming the **Wellcome Trust Centre for Neuroimaging**. A key development was our computational models of behaviour that could be linked to dynamic brain activity. In 2014, we opened the Max Planck UCL Centre for Computational Psychiatry and Ageing Research, which is located in Russell Square, a short walk away from the FIL.

2015 Director: Cathy Price

Deputy: Eleanor Maguire / Martina Callaghan

Renamed the **Wellcome Centre for Human Neuroimaging** after funding renewal in an open competition in 2016, the focus of our mission is to promote the clinical translation of human neuroimaging (Page 6).

Our Clinical Vision

Our goal is to use neuroimaging and computational analyses to understand and help patients with neurological and psychiatric disorders.

We start by understanding brain structure and function in healthy people, then identify how these change in neurological and psychiatric disorders, thereby offering new insights for clinical solutions.

Learning about disorders

To understand the causes and consequences of neurological and psychiatric disorders, we ask:

How does it go wrong?

We use neuroimaging to study patients with neurological and psychiatric disorders so we can identify abnormalities in their brain structure and function.

Can we reclassify disorders?

We aim to reclassify disorders in terms of the structural and functional brain abnormalities that cause symptoms.

Applications for clinical practice

Neuroimaging discoveries can be used to improve patient diagnosis, prognosis and treatment.

Early Diagnosis

Can we detect hidden abnormalities in brain structure and activity before clinical symptoms?

Prognosis

Can we accurately predict how patients' symptoms will change over time?

Treatment

How are prognoses improved by treatment?

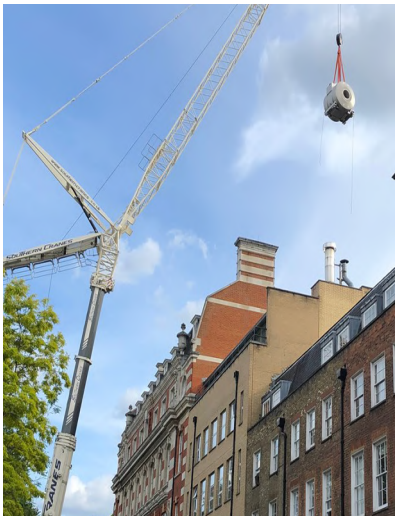
Highlights

We are currently developing two new neuroimaging technologies.

MRI to the Max

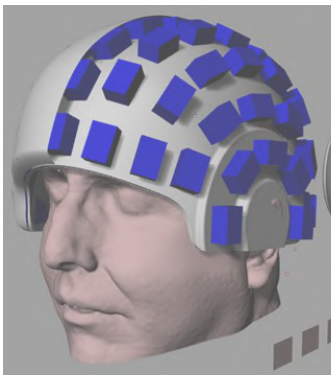
In May 2019, we installed an ultra-high field 7T MRI scanner, which offers vast increases in signal and contrast level and is the second of its kind in London. This increased sensitivity will allow us to identify very small, subtle changes in the brain's microstructure at early stages of disease, ideally before clinical symptoms are present.

Such advances would allow us to develop and assess therapies targeting several different neurodegenerative diseases with our clinical partners across Queen Square. We also plan to identify more informative ways to use existing hospital scans.



Our 7T scanner being lifted over the Centre

MEG in Motion



In collaboration with Nottingham University, we are leading the development and application of a new generation of wearable magnetoencephalography (MEG) systems which are much smaller in scale than traditional systems (artist rendering of helmet on left).

The new technology is based around optically pumped magnetometers (OPMs) that do not need to be cooled by a large cryogen-based traditional MEG machine. OPMs bring an array of other advantages over traditional MEG:

>5 times more sensitive

No movement restrictions

Portable

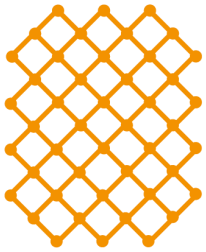
Lower cost

This makes OPMs clinically important for patients who cannot comply with the movement restrictions of traditional MEG, such as epilepsy patients. We are collaborating with Young Epilepsy to design OPM helmets and protocols (page 13).

Methods

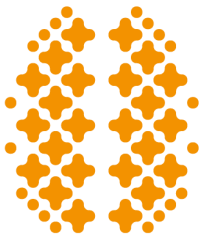
We measure, probe, and interpret neural signals obtained with neuroimaging instruments using carefully-designed experiments, and cutting-edge computational analyses.

Our methods research aims to improve our ability to detect brain signals with high spatial and temporal resolution.



Instruments

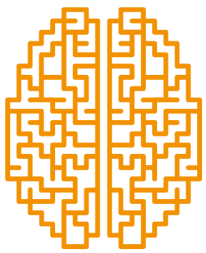
We use MRI to measure brain structure, and fMRI, MEG and EEG to measure brain activity. We monitor how neural signals are influenced by development, ageing, training, stimulation, disease, or medical interventions. This allows us to generate new measures relevant to clinical assessments and treatment and also informs our development of new technologies.



Experimental design

Each neuroimaging study requires a tailored experimental design to answer questions about brain anatomy or function in a very controlled way. To study anatomy, a typical experiment will compare how anatomical brain scans differ between populations, or in the same participant at different time points.

To identify which regions are involved in functions of interest, experiments engage participants in behavioural tasks that require these functions, and compare activity to tasks that control for factors that are not of interest.



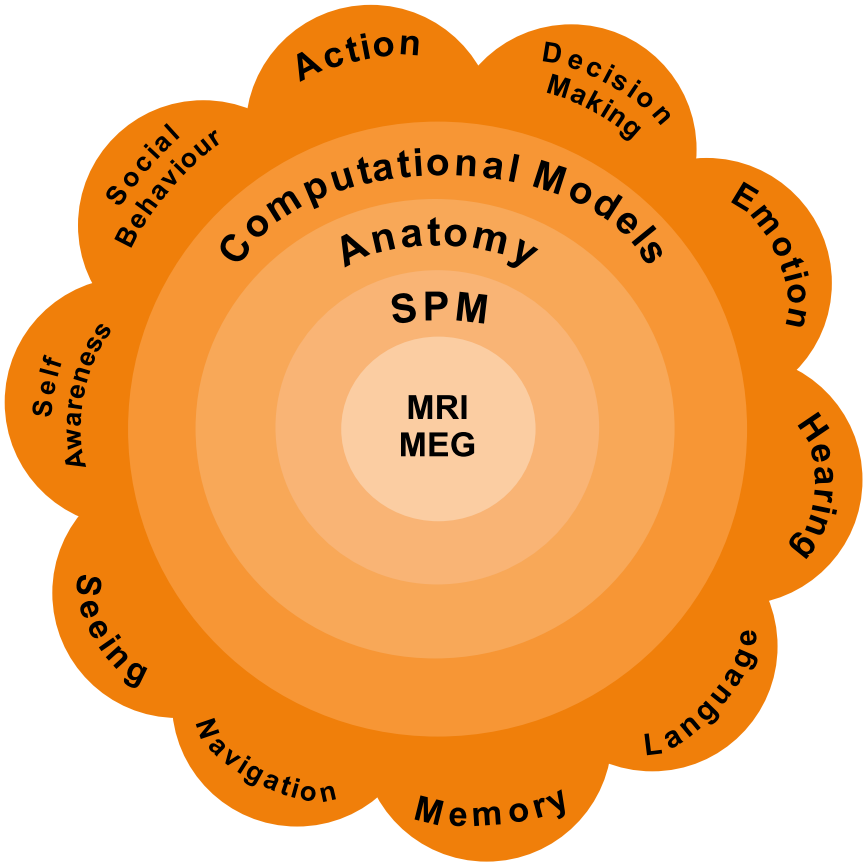
Modelling and analysis

To analyse our data, we use mathematical models that describe how brain activity or structure are converted into neuroimaging signals, comparing how well our observations fit a range of possible models.

The analytical methods we invent, develop, and use are distributed to the neuroimaging community via our world-leading statistical parametric mapping (SPM) software. Our SPM team develops novel analysis methods as well as providing support and training.

Research Areas

We use neuroimaging techniques (MRI, MEG) and computational models to investigate brain anatomy and the neural systems that support different perceptual, cognitive, emotional and motor functions.



Our research approach

Brain structure and function in normal health → **Brain structure and function in brain disorders** → **Finding clinical solutions for these disorders**

Research Areas

Anatomy

How can we detect structural brain features and organisation that are not visible to the human eye?

Bayesian Brain

How does the brain use its knowledge of the world to predict and understand what will happen?

Action

How do we plan our movements and turn these plans into actions?

Decision Making

How do we choose between different options, and assess their value?

Emotion

How does brain activity generate emotions and how do emotions affect our behaviour?

Hearing

How do we interpret the sounds around us?

Research Areas

Language

How does the human brain understand and produce speech?

Memory

How are memories formed, stored and changed?

Navigation

How do we know where we are and where to go?

Seeing

How do we make sense of our vision?

Self-awareness

How do we recognise our own thoughts and form beliefs about our abilities?

Social Behaviour

How do we interpret and respond to another person's social signals?

Education

Our goal is to nurture and promote the careers of the next generation of neuroimaging researchers and clinicians, providing them with interdisciplinary skills in a culture of responsible, open and inclusive science.

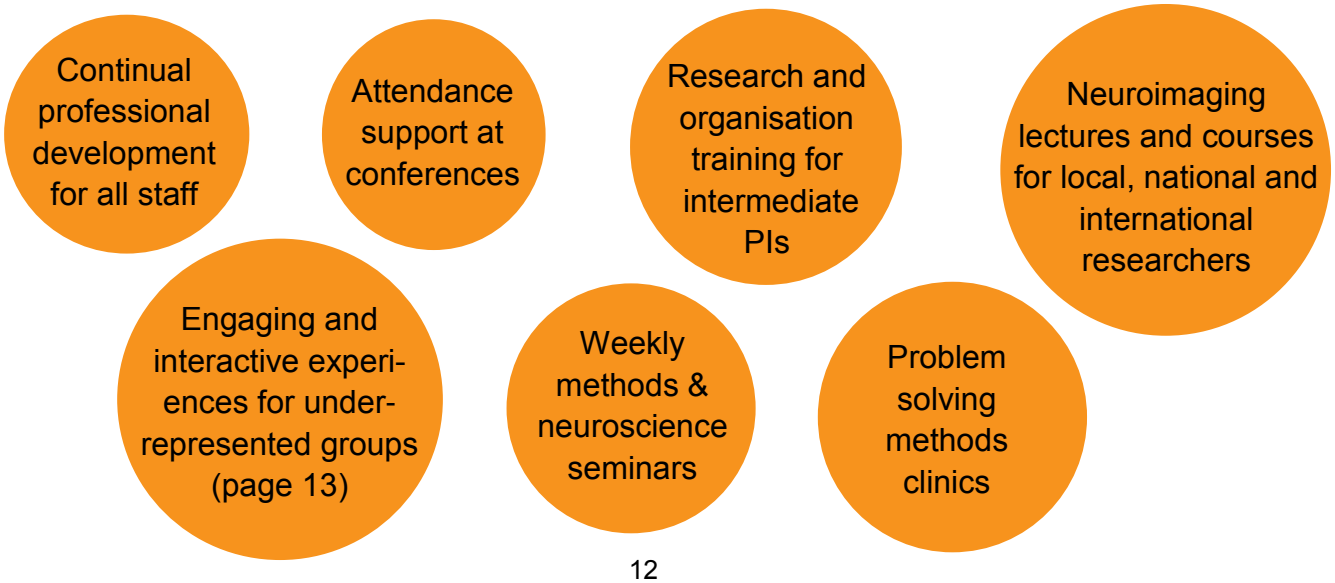
Our trainees range from students (PhD and MSc) to professors and clinicians.

Student training

Our student-centred training promotes future generations of neuroscientists, highly skilled in technical development and neuroscientific methods, and confident in conducting collaborative, cross-disciplinary projects. To support this, we provide:

Wider training

To support our in-house staff and widespread collaborators, we provide:



Public Engagement

Our public engagement programme aims to empower people with neurological and psychiatric conditions to contribute to, and influence, neuroscience research.

We embed our researchers in a culture where they can develop the skills and experience to readily engage public groups in the evolution of neuroscience. To support this, we are creating platforms to build relationships with and engage targeted audiences that are traditionally under-represented in neuroscience.

Our Core Programmes

Working with students from Young Epilepsy, we are co-producing three elements of the new OPM scanning process (see OPM in *Highlights,* page 7); (1) the design and implementation of new child-friendly wearable scanners; (2) the process and experience around the scanning procedure; and (3) an engaging room interior.

UCL WORLD STROKE DAY FORUM

Our annual World Stroke Day Forum brings together researchers, clinicians, charities, stroke survivors and their families. We hope to empower stroke survivors to engage with, and contribute to, our work, with the aim to improve prognosis and rehabilitation after stroke.

Our Dear World Project invites people to talk about their perceptions of mental health and explore how this interacts with approaches taken by researchers and clinicians. Through our Dear World Exhibition in 2020 we will explore the use of labels in mental health. Are they helpful? For whom?

Further Initiatives

Public Engagement Awards

The annual Public Engagement Awards recognise and reward the outstanding public engagement work of the staff in our Centre.

In2Science UK

Each year we host six students from disadvantaged backgrounds for a two week internship, providing experience of, and motivation for, a career in research.

Our Laboratory at Work

4th floor

Seminar room

Fellows rooms

3rd floor

Management

2nd floor

Open plan

fellows rooms

1st floor

Board room

Computing

Fellows rooms

Ground - floor

Reception

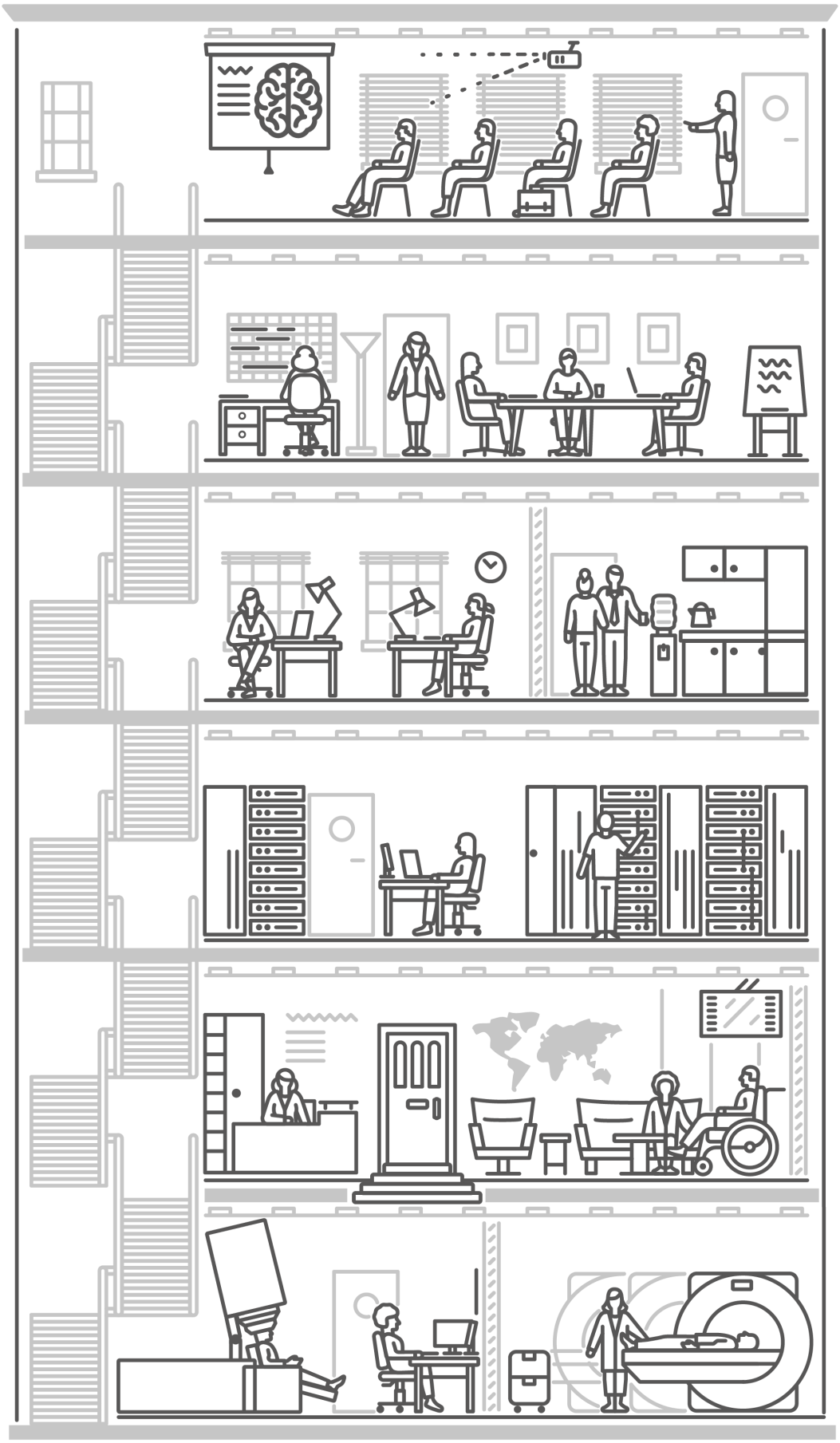
Administration

& SPM team

Basement

Scanners

& testing rooms



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Please see our website at **www.fil.ion.ucl.ac.uk**
for more details about our centre