KING'S College LONDON

INSTITUTE OF PSYCHIATRY,
PSYCHOLOGY & NEUROSCIENCE

Module:
Techniques in Neuroscience

Week 2:
Electrophysiology: Looking at live neurons in action

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Topic 1:
An introduction to electrophysiology
Part 2 of 3

Part 2

Extracellular recording of electrical activity

1

Extracellular recording (ER):

- field potentials
- whole nerve activity
- multi-unit activity
- single unit activity
- multi-electrode arrays (MEAs)

2

Intracellular recording (IR):

- activity within single cells
- sharp electrodes
- patch suction electrodes

3

Single channel recording (SCR):

- recording activity of single ion channels
- patch clamp-type electrodes

Definitions to aid understanding

Definitions:

Field potential: this is the electric potential in the extracellular space around neurons.

Nerve: a bundle of axons.

Compound axon potential: the sum of the activity in a number of nerve fibers (or axons).

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Extracellular recordings

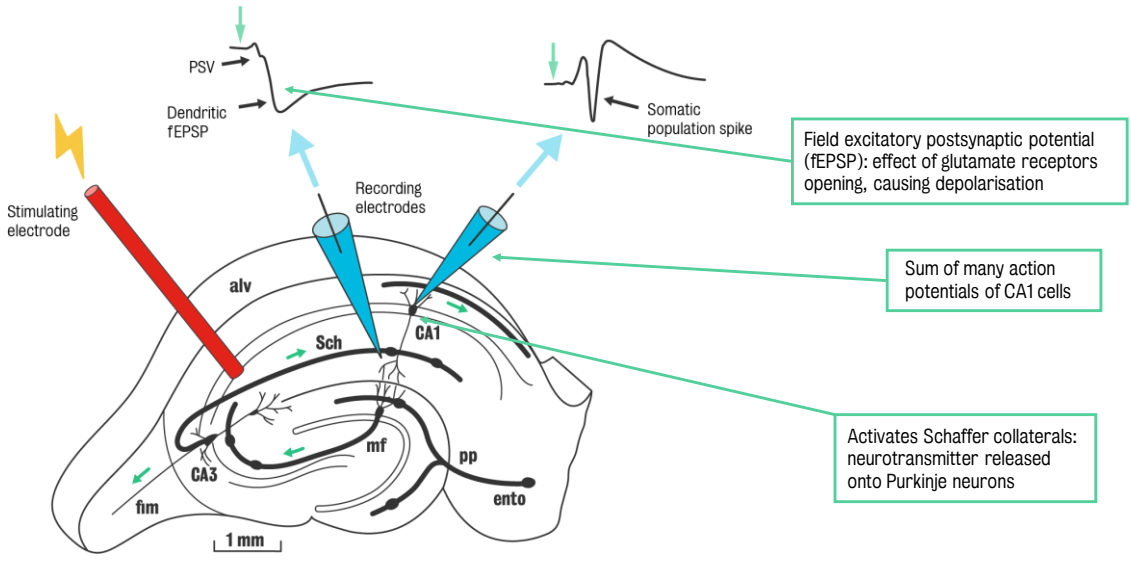
There are five versions of extracellular recordings:

- field potentials
- whole nerve recordings
- multicellular (multi-unit) recordings
- single unit recordings
- MEAs

In each case

- the electrode is outside but close to the neurons
- the electrodes pick up only field potentials and low frequency filtered action potentials
- it is not possible to record Vm rest or post-synaptic potentials

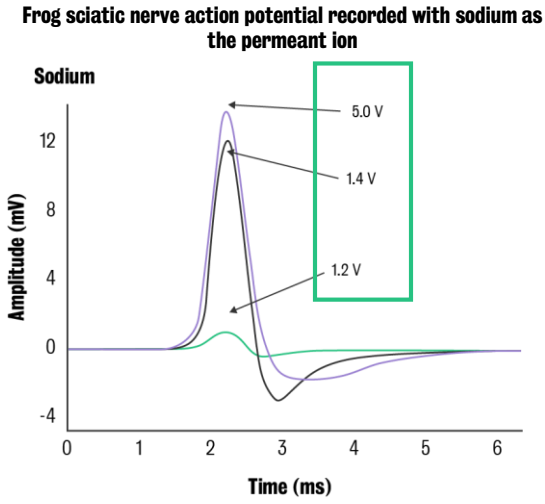
Field potentials

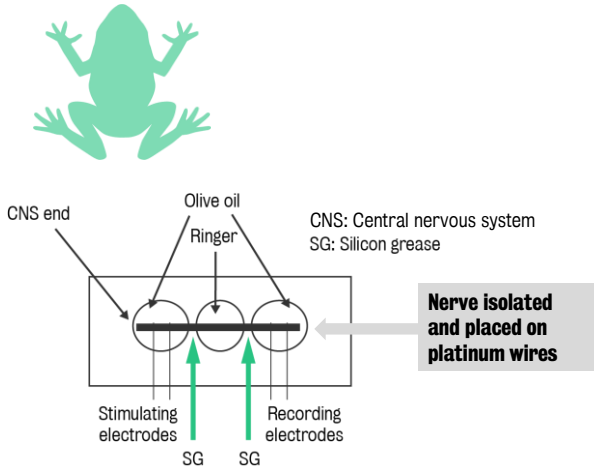


O'keefe & Nadel (1978); The Scripps Research Institute (2008)

Whole nerve activity (1)

The compound action potential of a whole nerve can be recorded extracellularly.





Lilley & Robbins (1998), Robbins (unpublished data)

Whole nerve activity (2)

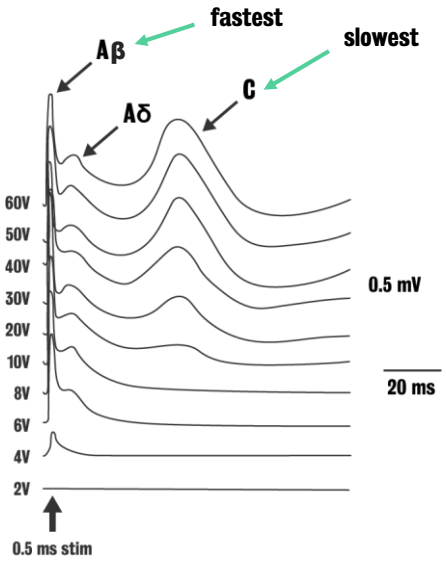
Galvani – a recreation of his experiment on frogs

The isolation of a whole nerve from a frog and recording of the action potential

These videos will comprise topic 2 for this week.

Whole nerve activity (3)

Rattus rattus vagus nerve



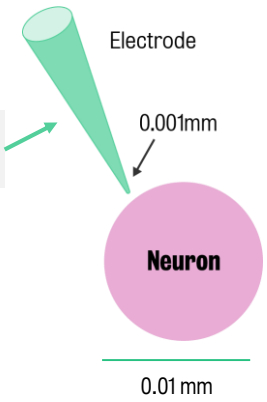
Different axons can be separated by the intensity of the stimulus and their conduction velocity.

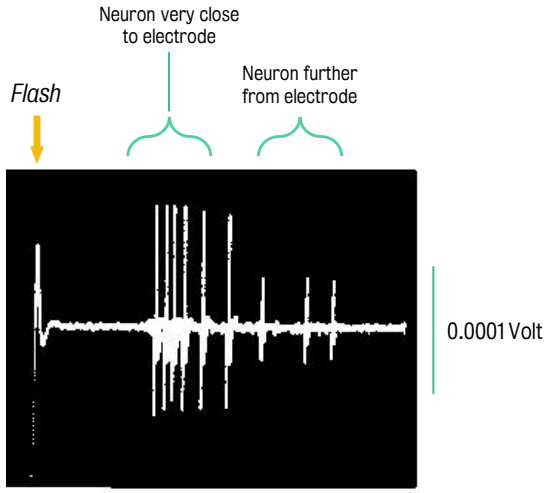
Docherty et al. (2005)

Multi-unit activity

Multi-unit extracellular recordings can be done *in vivo*.

Electrode placed in anaesthetised rat brain - the lateral geniculate nucleus, part of the visual pathway.

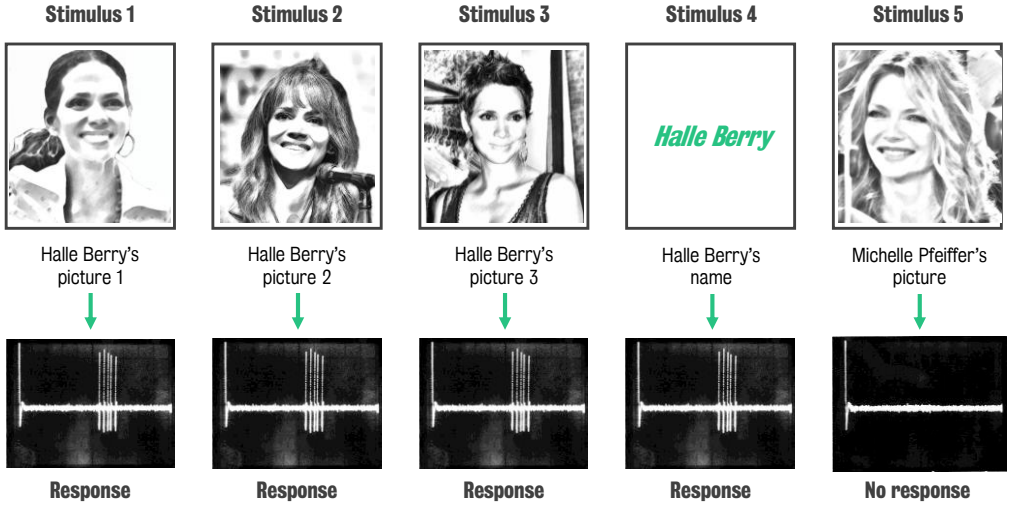




Robbins (unpublished data)

Single unit activity

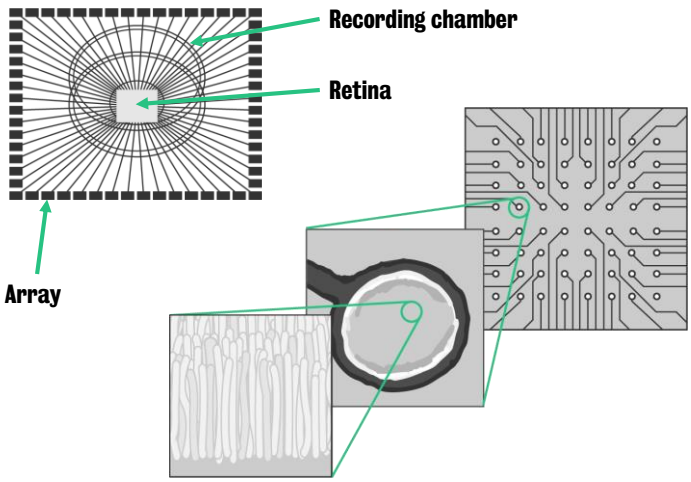
An example of single unit recordings in the human medial temporal lobe.



Quiroga et al. (2009)

Multi-electrode arrays (1)

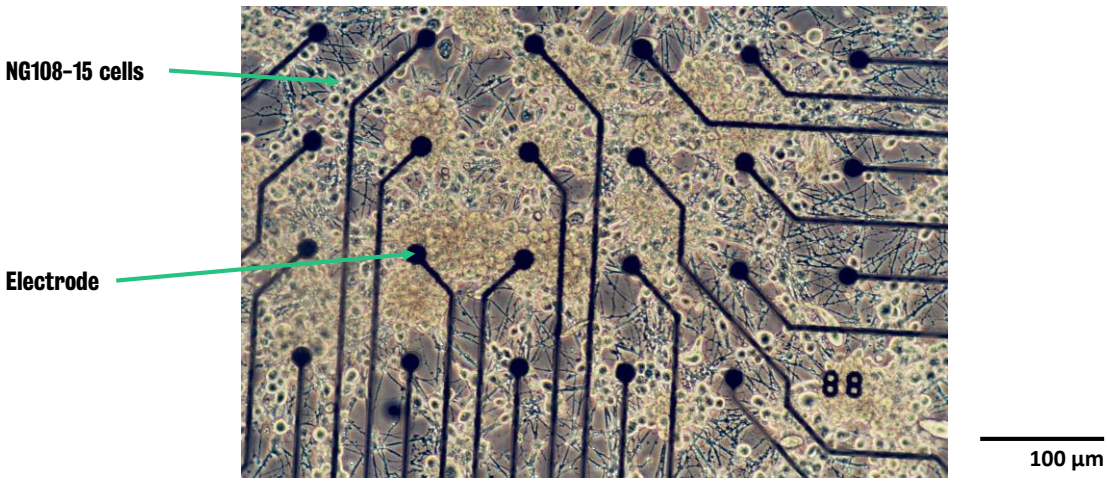
Multi-electrode array electrodes are bedded in the bottom of a dish.



Characteristics:
- 64 electrodes
- inert to cells
- pick up extracellular electrical activity

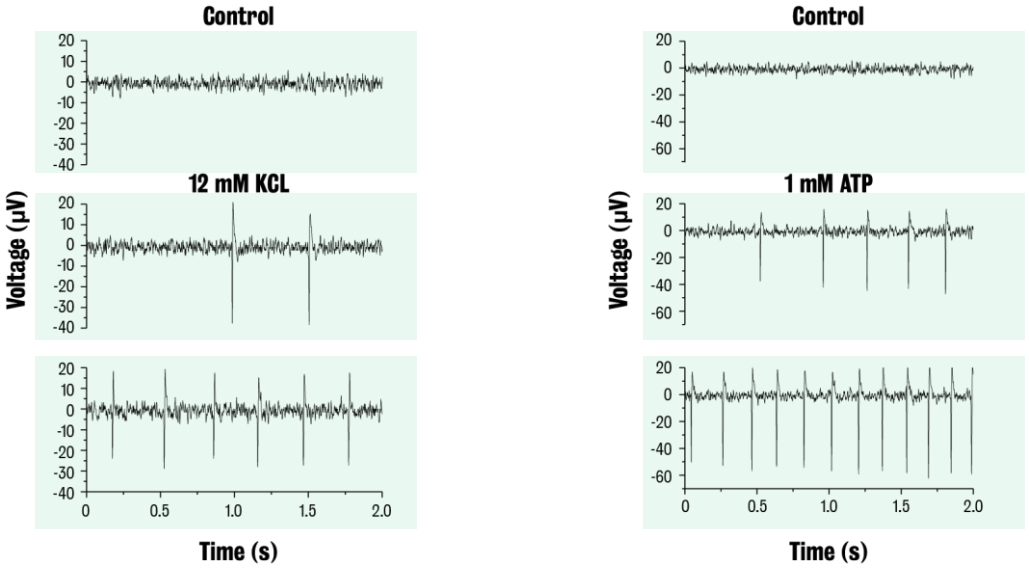
Neurons are grown inside these dishes in an incubator and monitor the electrical activity in a non-invasive manner.

Multi-electrode arrays (2)



Robbins (unpublished data)

Multi-electrode arrays (3)



Robbins (unpublished data)

Summary on extracellular recordings

Technique	Advantages	Disadvantages
Field potentials	Large number of neurons Record network activity *In vivo & in vitro*	Cannot identify individual cells Cannot monitor PSPs or Vm
Whole nerve	Large number of axons Can identify subgroups of axons by conduction velocity and stimulus threshold *In vivo & in vitro*	Cannot identify individual cells Cannot monitor PSPs or Vm
Multi-unit	Monitor a few cells simultaneously Characterise single axon or neuron *In vivo & in vitro*	Cannot monitor PSPs or Vm
Single units	Characterised single axon or neuron *In vivo & in vitro*	Difficult to do *in vivo* Cannot monitor PSPs or Vm
MEAs	Minimally invasive Large number of cells Record network activity Characterised single axon or neuron	Cannot target particular cells Not *in vivo* Cannot monitor PSPs or Vm

Click ***Next*** to continue

End of part 2