



Professor Ruth Empson

Brain Health Research Centre
Department of Physiology
University of Otago

Saturday, August 10, 2019

(Plenary)

8:35 - 8:55 Mapping Sensory Perception and Neuroplasticity in Health and Disease

Mapping Sensory Perception and Neuroplasticity in Health and Disease



Prof Ruth Empson
Dan Potapov
Javier Jimenez-Martin

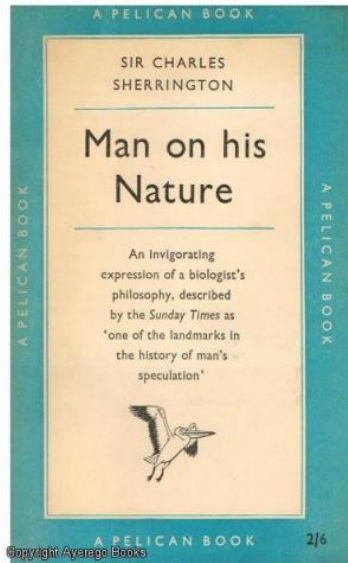


Prof Thomas Knöpfel¹

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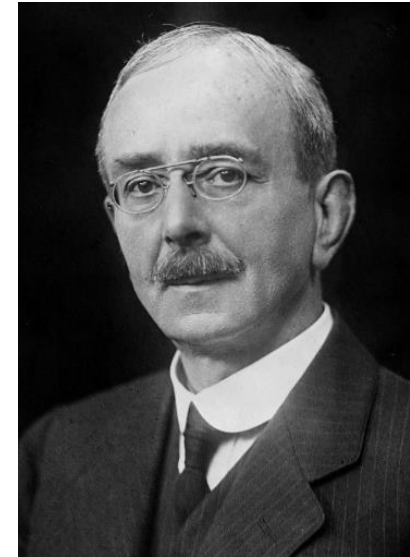




CS Sherrington –
Man on his Nature – 1942

Sherrington's Sparks

ELECTRICAL BRAIN



The great topmost sheet of the mass, that where hardly a light had twinkled or moved, becomes now a sparkling field of rhythmic flashing points with trains of traveling sparks hurrying hither and thither. The brain is waking and with it the mind is returning. It is as if the Milky Way entered upon some cosmic dance. Swiftly the head mass becomes an ***enchanted loom*** where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one; a shifting harmony of subpatterns.

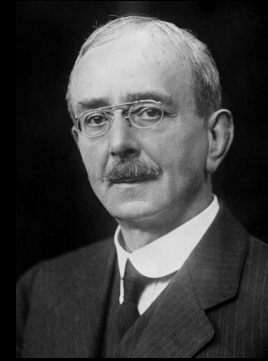
Enchanted Loom

Metaphor
Early computing

Jacquard Carpet Loom, around 1860.

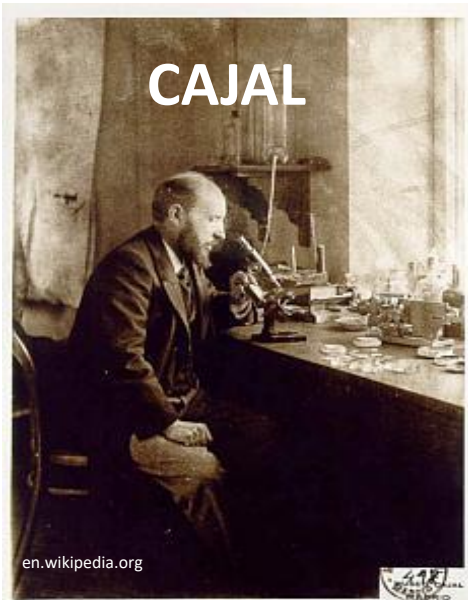


“Seeing electrical activity in the brain ”



CS Sherrington –
Man on his Nature - 1942

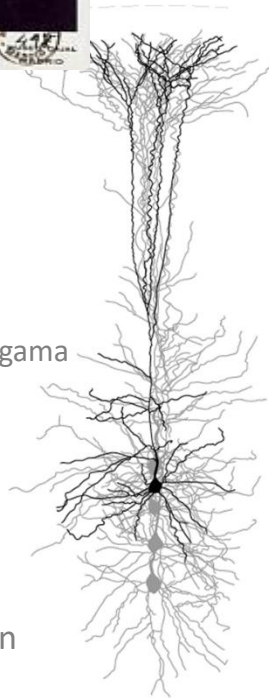




Brain, Neurons, Circuits

Oswald, Tantirigama
et al 2013

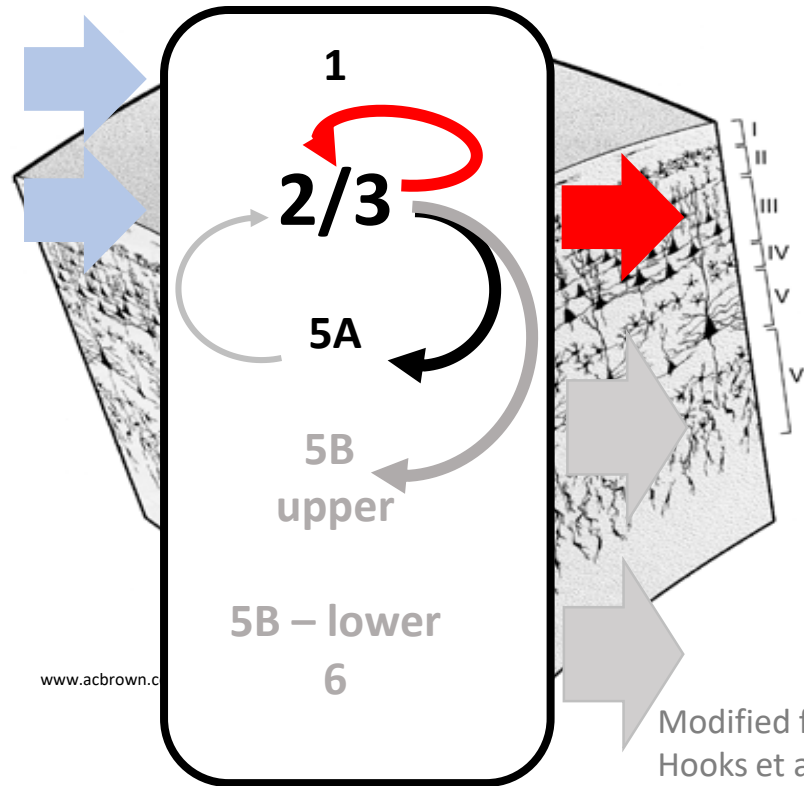
Layer 5b
PT type
Corticospinal
Motor Neuron



INPUTS



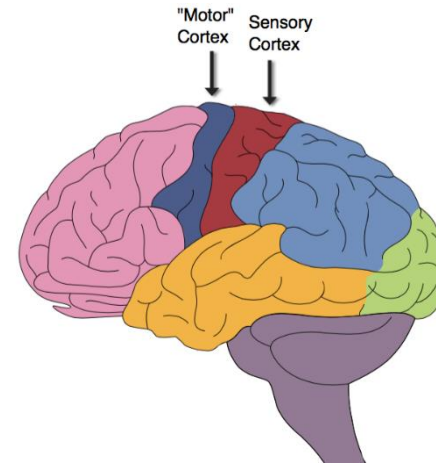
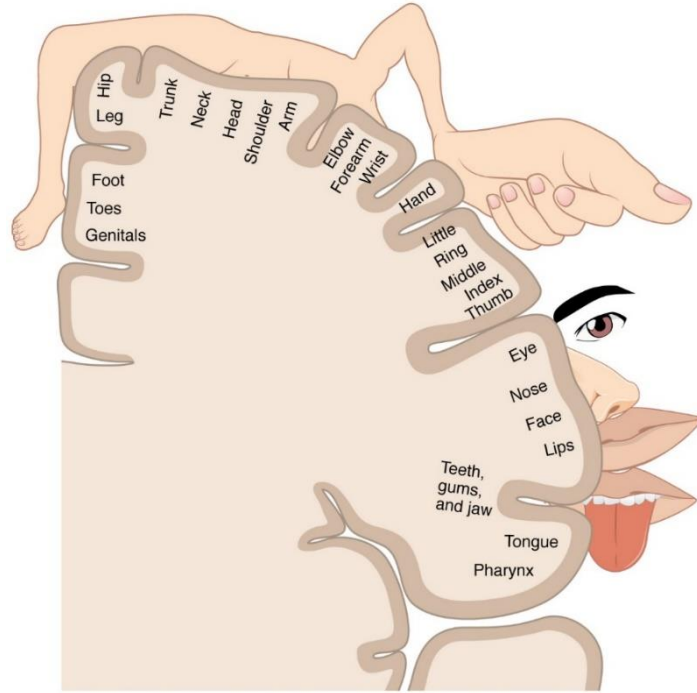
OUTPUTS



www.acbrown.c

Modified from
Hooks *et al* 2014

modular brain - homunculus

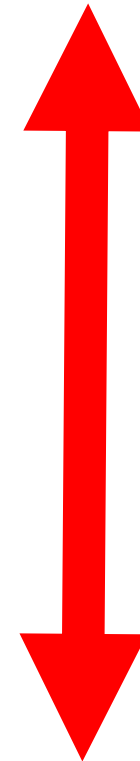


visualising electrical brain activity

Fast
Mesoscopic
Voltage Imaging

brain
circuits
neurons

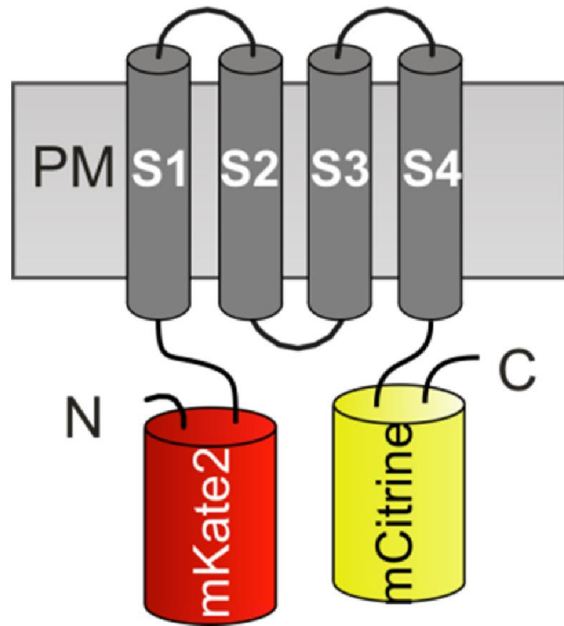
Fast Single cell
Voltage
Imaging



“Seeing” Electricity



Transforming Brain Electrical Activity (voltage) to Light



Transgenic Mice



Madisen et al 2015



Thomas Knöpfel

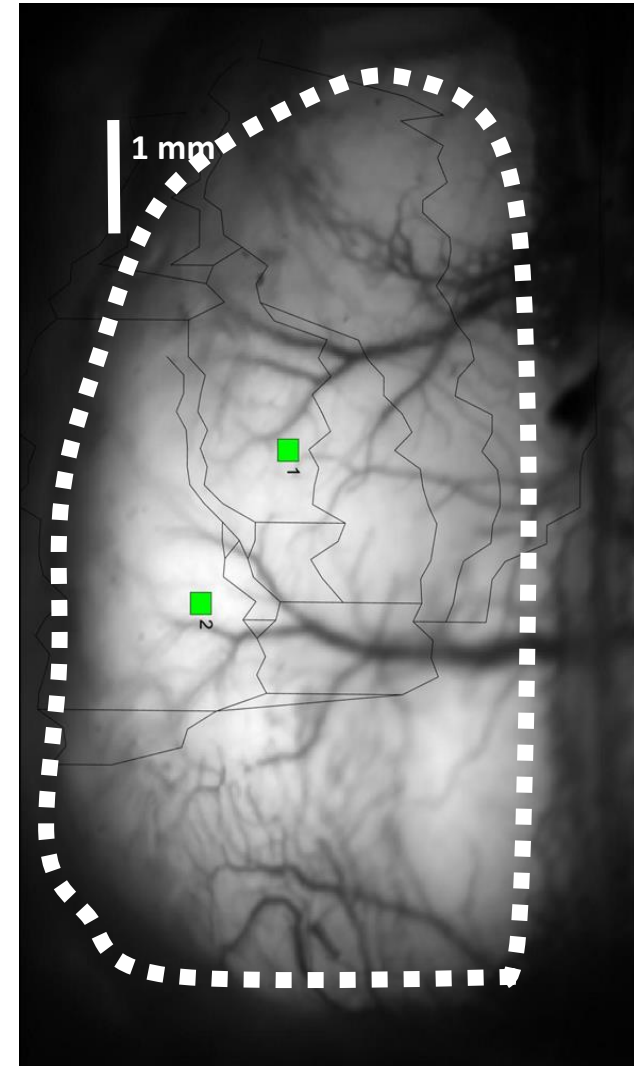


 ALLEN INSTITUTE
for BRAIN SCIENCE
Fueling Discovery

Seeing is believing ...

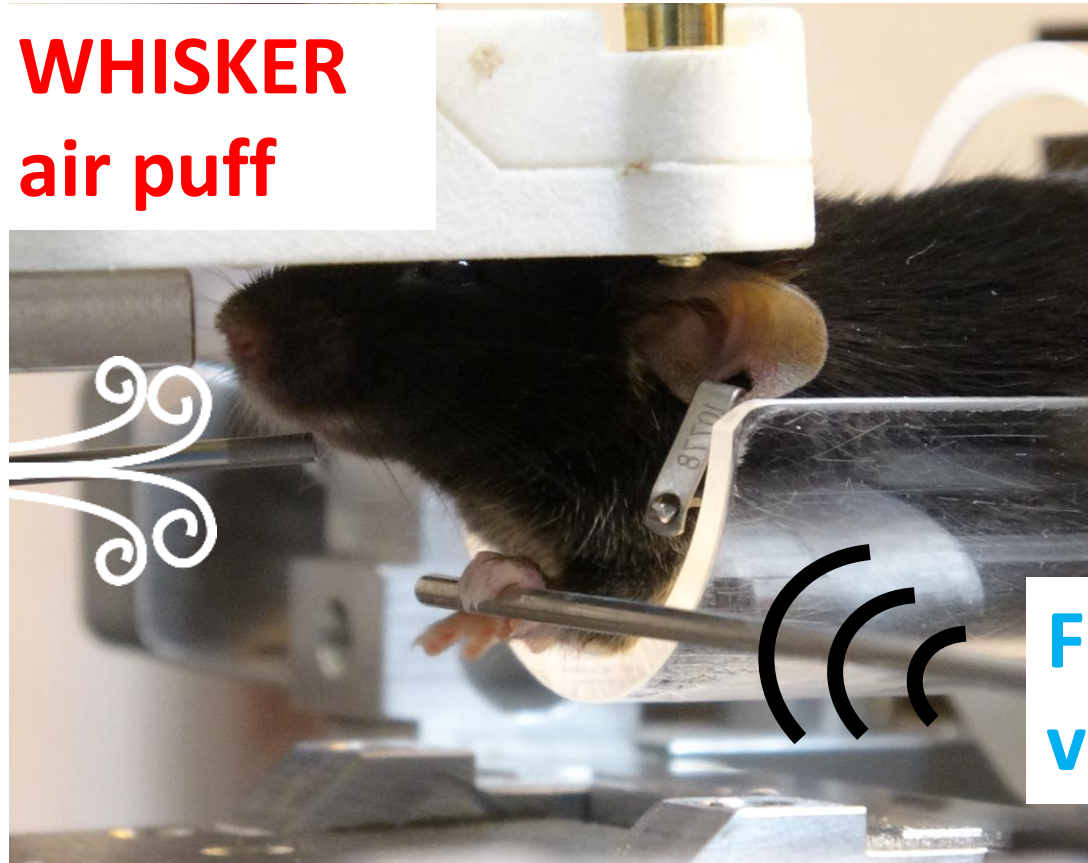


Awake and behaving ...



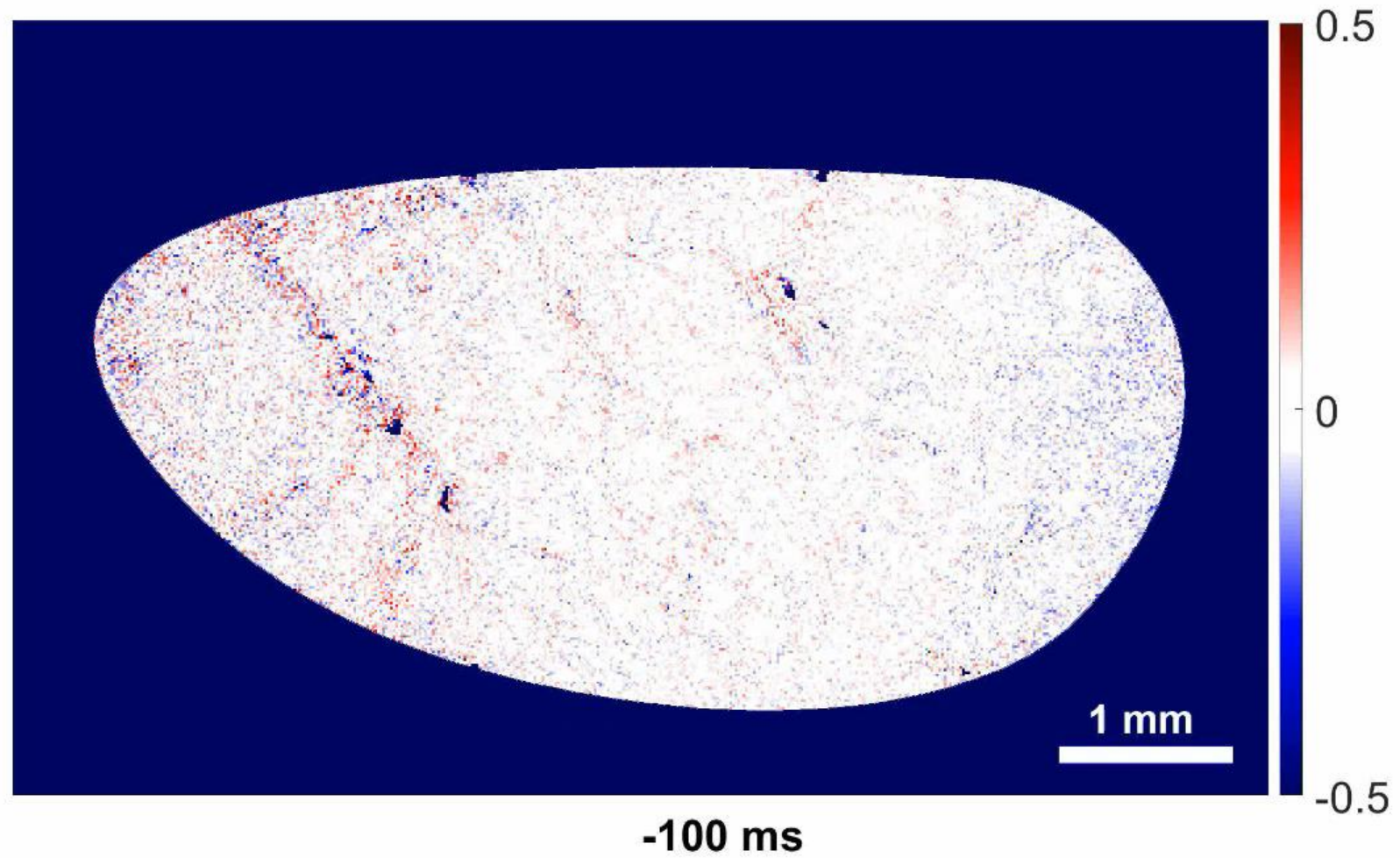
Awake *Sensory* Responses

WHISKER
air puff

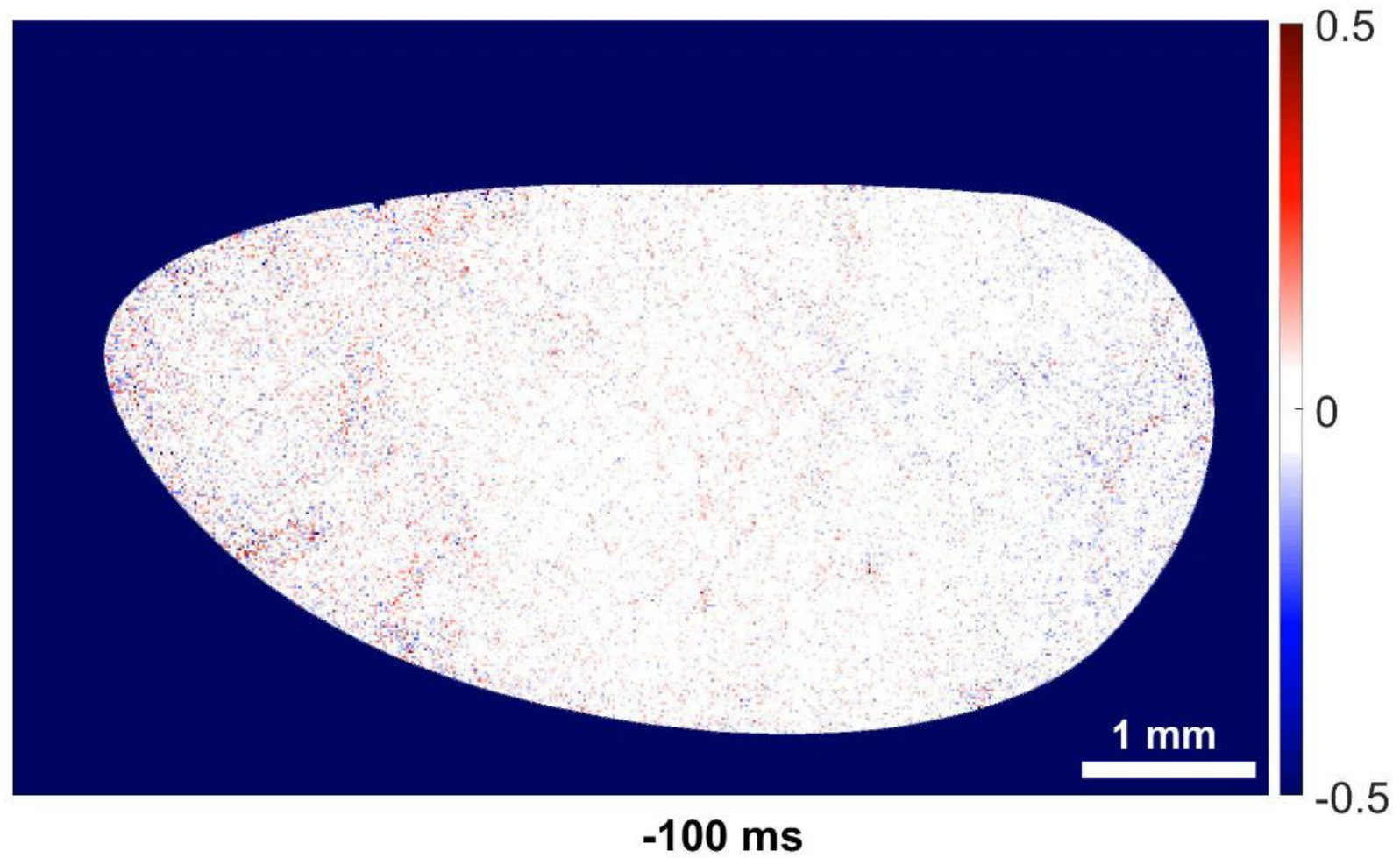


FOREPAW
vibration

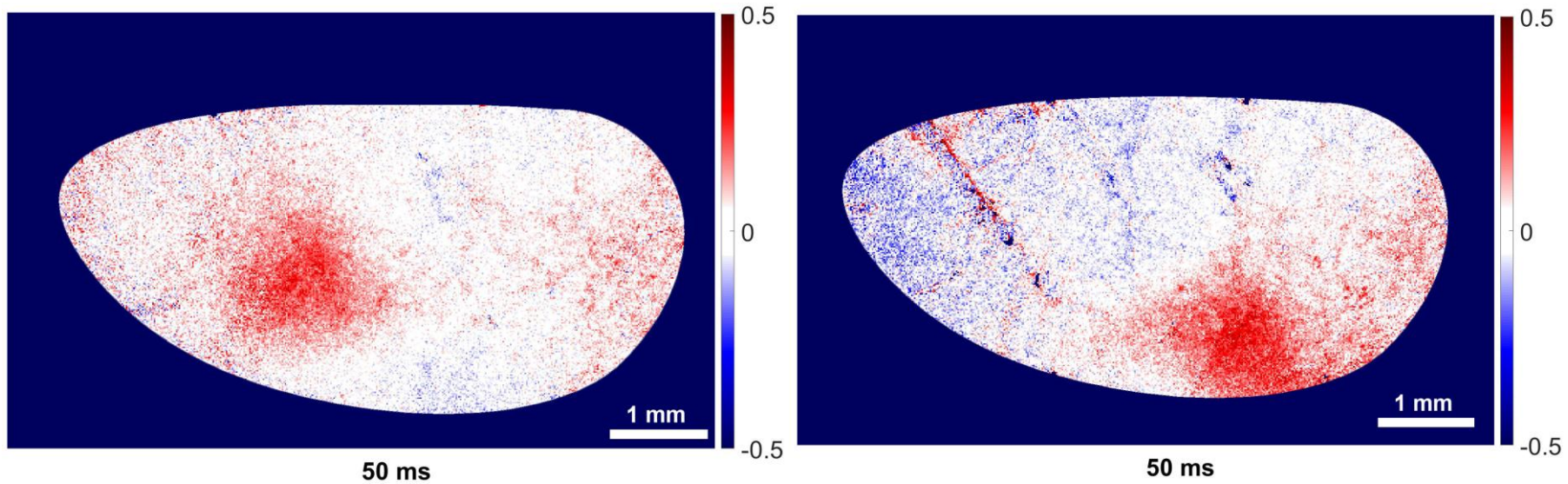
WHISKER SENSATION MAP



FOREPAW SENSATION MAP



Distinct Sensation Maps



Forepaw

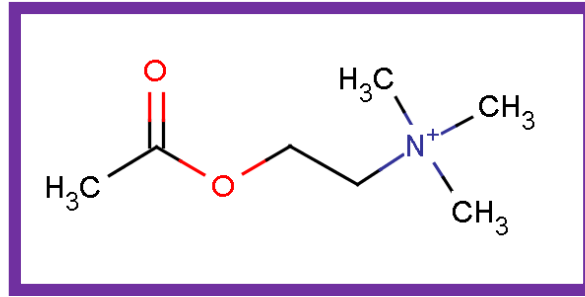
Whisker

NEUROPLASTICITY

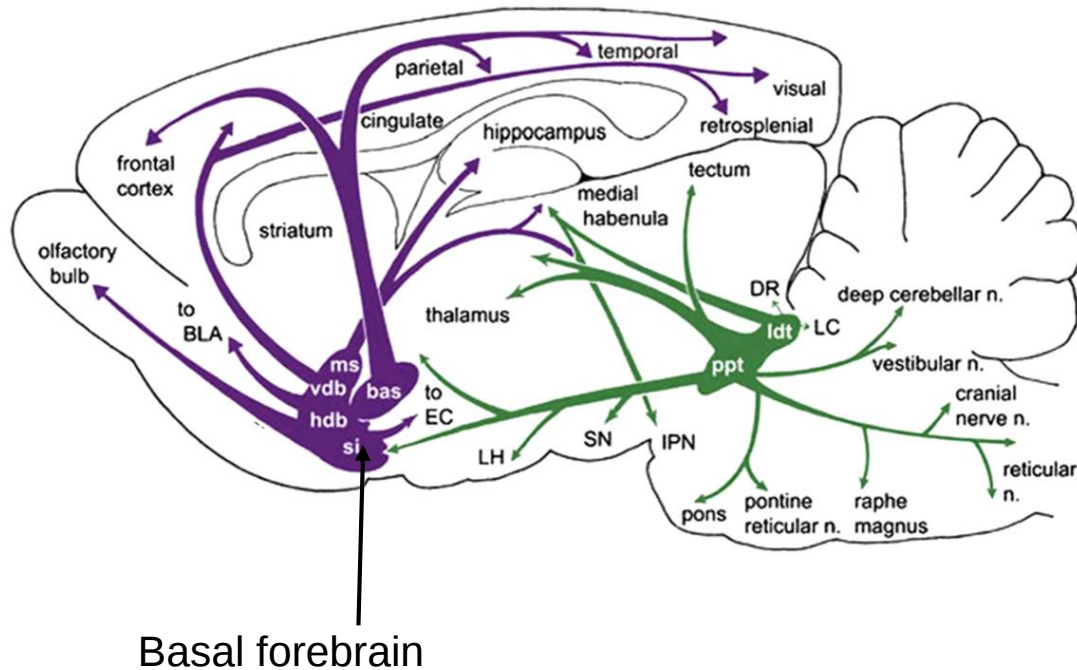
changes in brain responses



makelifegr8.com



Acetylcholine

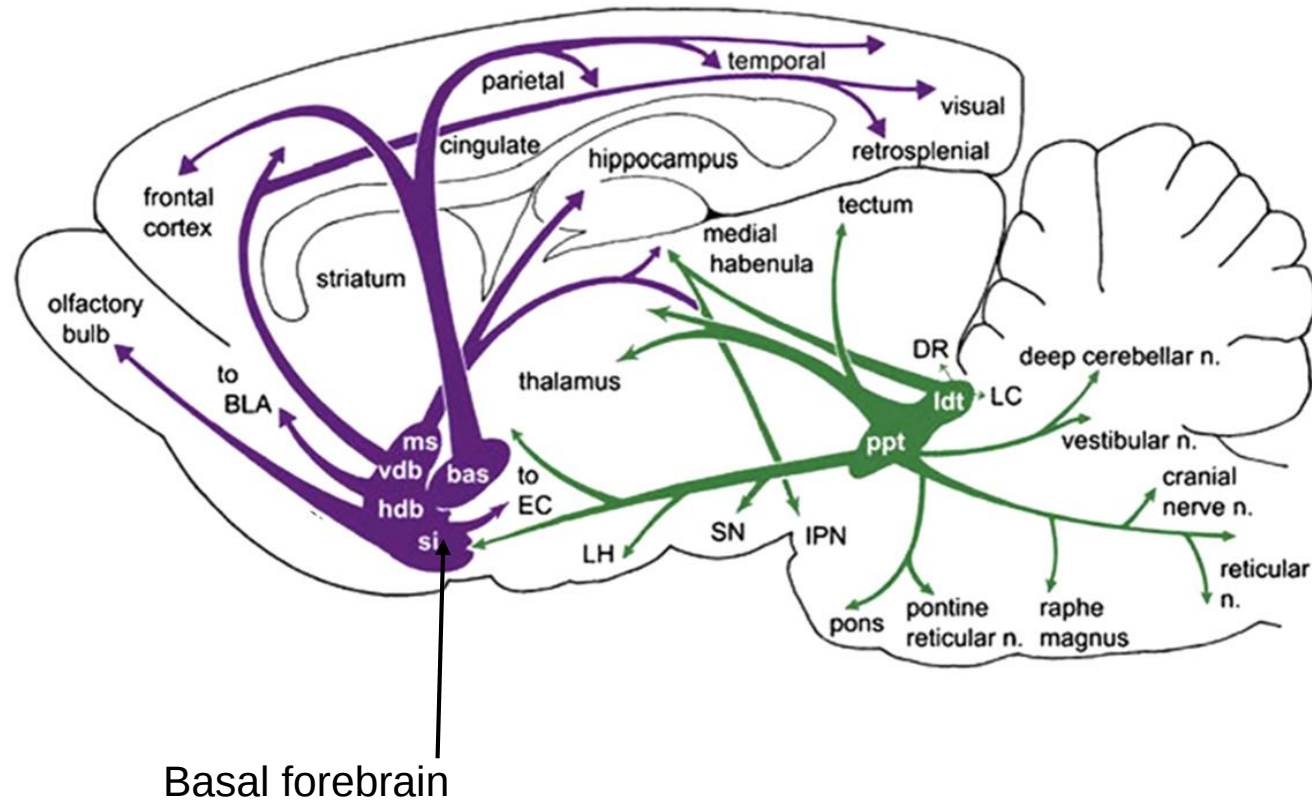


Peripheral
Nerve – muscle junction

Autonomic Nervous
System

Brain
Arousal and Memory

Acetylcholine is depleted in AlzD
and during anaesthesia + sleep



Blocking Acetylcholine Receptors

Shortcuts
Drugs



Emine Saner

🐦 @eminesaner

Wed 2 Sep 2015 18.54 BST



1,162 76

'Devil's breath' aka scopolamine: can it really zombify you?

The substance has been blamed for thousands of crimes in South America. Now there are reports of the incapacitating drug being used in street robberies in Paris. From use by Nazis to obstetricians, it certainly has a colourful history

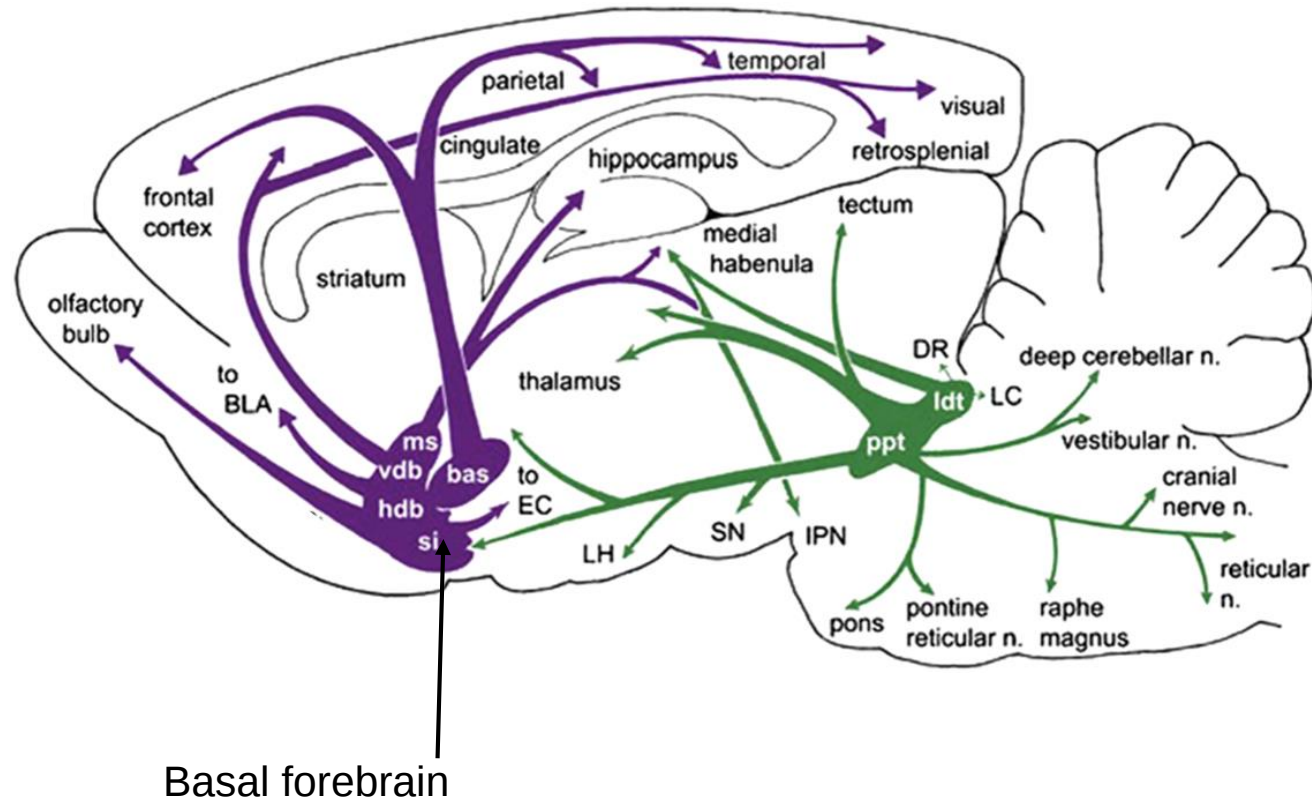


▲ Brugmansia, from which scopolamine is extracted. Photograph: Roberto Nistri

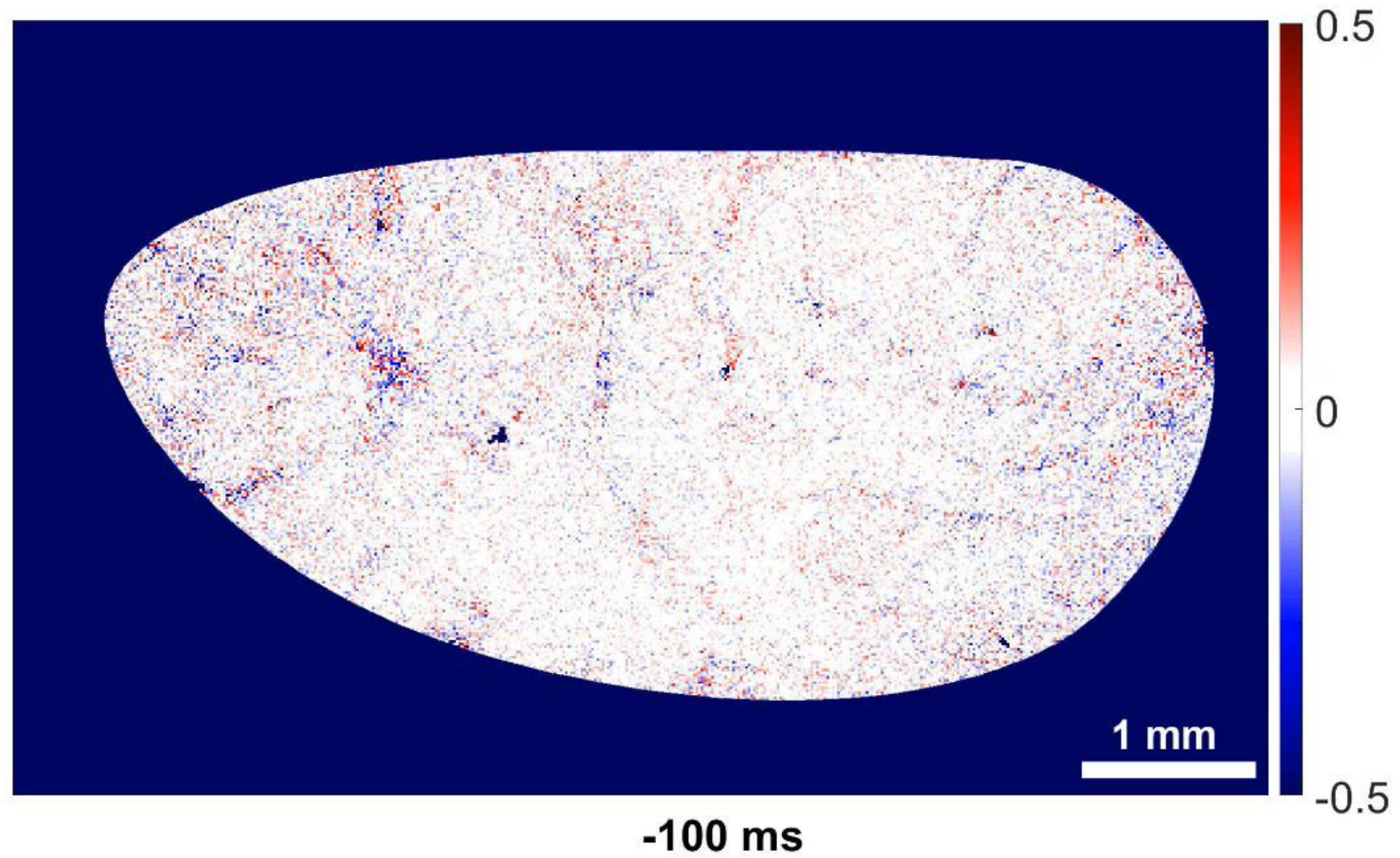


ne of the most enduring hoaxes you might hear in a backpacker

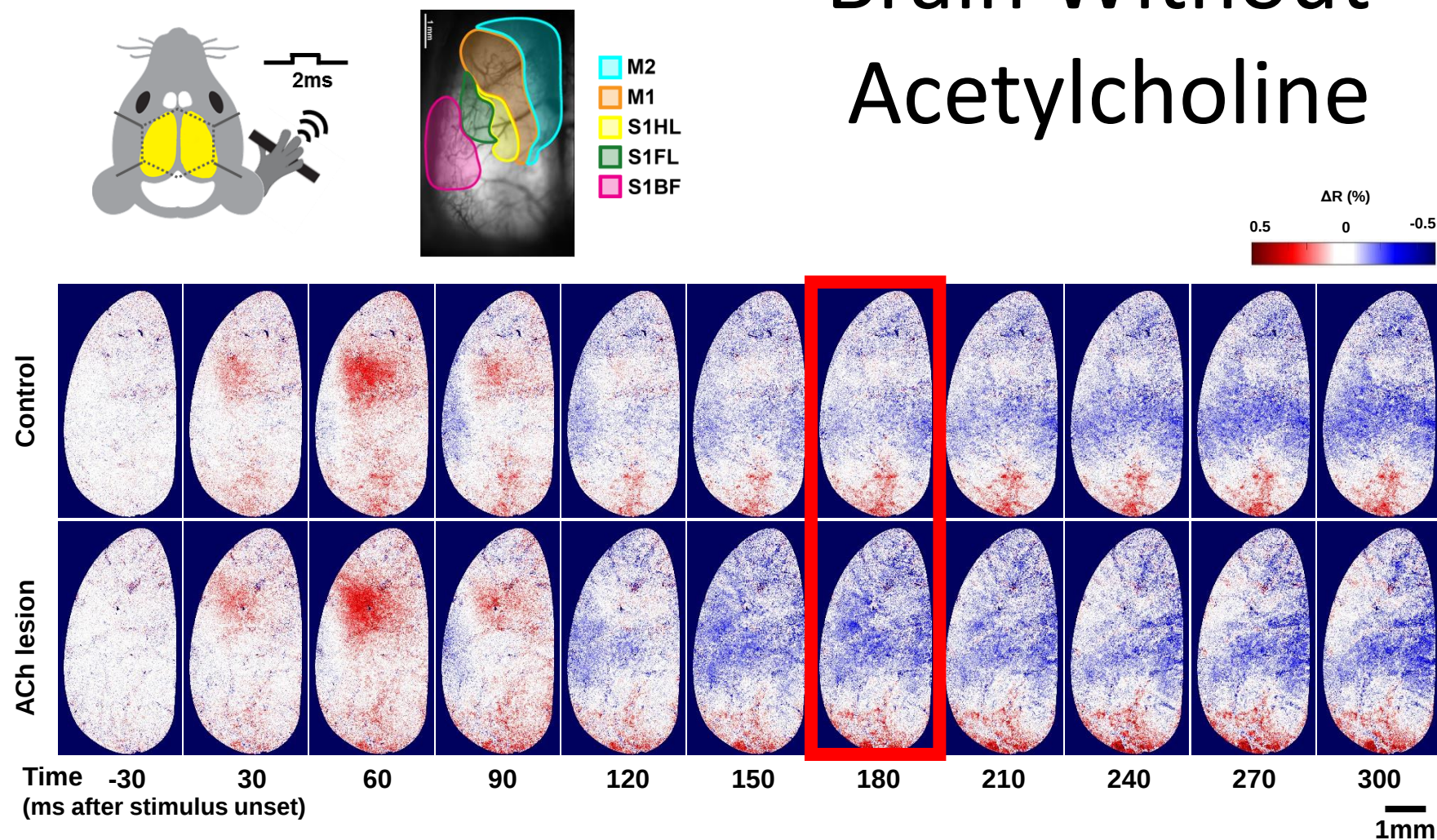
Specific & Tiny Lesion of Acetylcholine in the Cortex



FOREPAW SENSATION MAP after Lesion



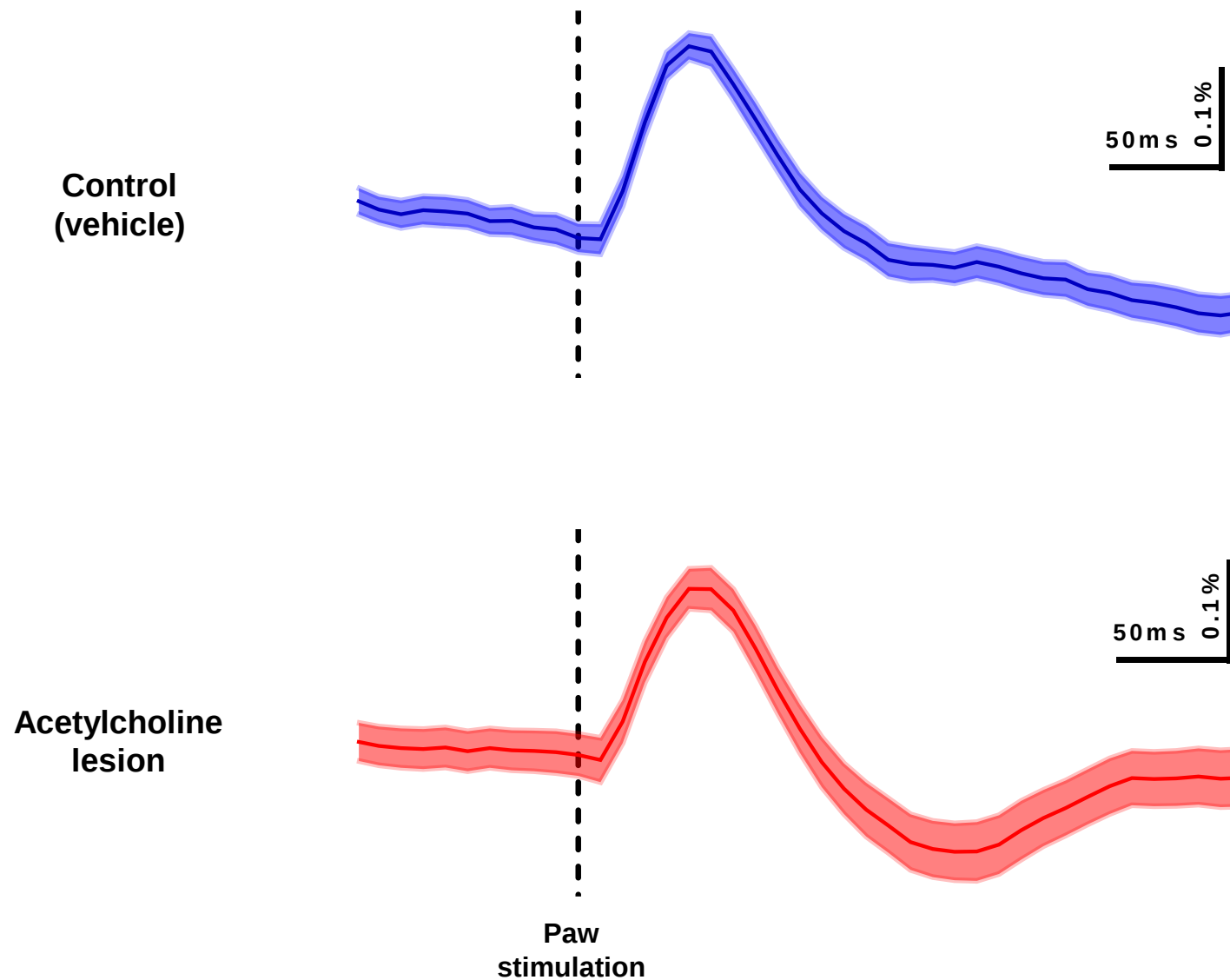
Neuroplasticity = Super-Cools Brain Without Acetylcholine



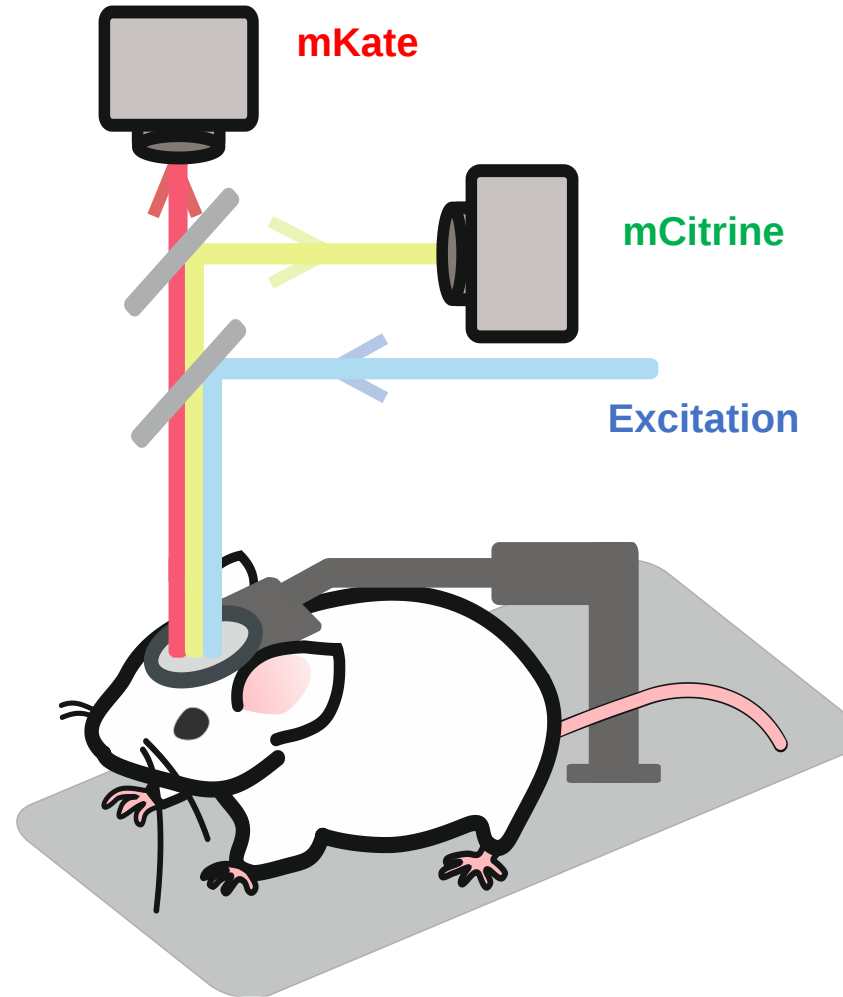
Thank-you & Take Home Messages

1. **Innovative technology** to study brain activity maps in awake, behaving mice --- International, collaborative, capacity-building in NZ.
2. **Visualising Brain** Sensation Activity Maps
very fast time scale
“dynamic homunculus”
3. **Neuroplasticity** of Sensation Maps
deplete acetylcholine – supercools the brain
implications for **ALZ and cognition / memory** loss
neuroplasticity is not always excitatory

Reshaping of Sensation Maps



Mesososcopic Brain Voltage Imaging



100Hz frame rate
Excitation: 470nm
mCitrine emission:
542/27nm
mKate emission:
>594nm

On a scale between microscopic and macroscopic.