Biology of Brain and Behavior

Lecture 2 – neuroscientific methods and experiments. Looking for relevant information

Introduction

→ Today we will discuss neuroscientific experiments: how they are performed and how to understand their results

→ We will also cover looking for relevant information and navigating a scientific publication

Brain atlases

https://github.com/mmagnuski/Biology-of-Brain-and-Behavior/wiki/Brain-3D-atlas

→ For the next meeting I expect you to take a look at brain 3D atlases that I link to at GitHub

→ You should look into Allen Brain Atlas, but others too

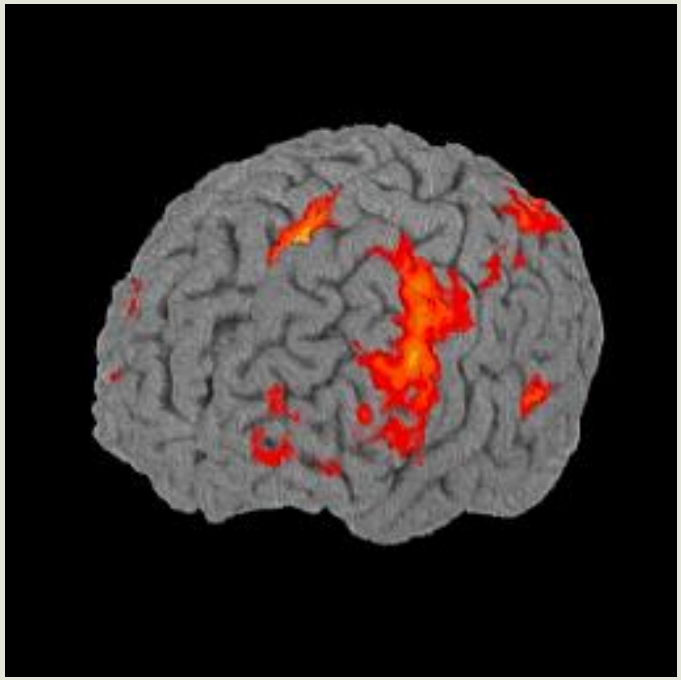
→Try to learn the location of structures like:

- Frontal, parietal, temporal and occipital cortex
- Hippocampus, amygdala, cerebellum
- Thalamus, caudate nucleus, putamen, globus pallidus

True or false?

- Three groups
- A statement appears on the screen
- Each group has to decide whether it is true or false
- Even if you do not know the answer – try to guess!

True or false?

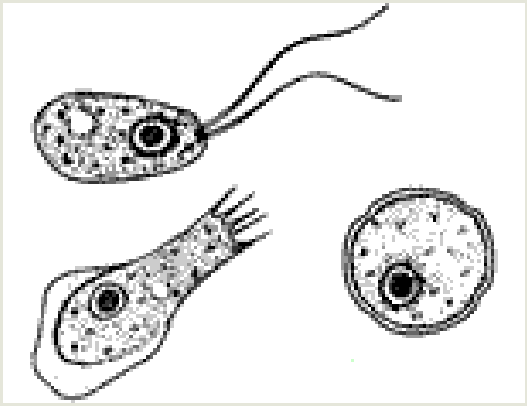


Average human being uses only 10% of their brain

True or false?

Some animals sleep only with one brain hemisphere at a time

True or false?

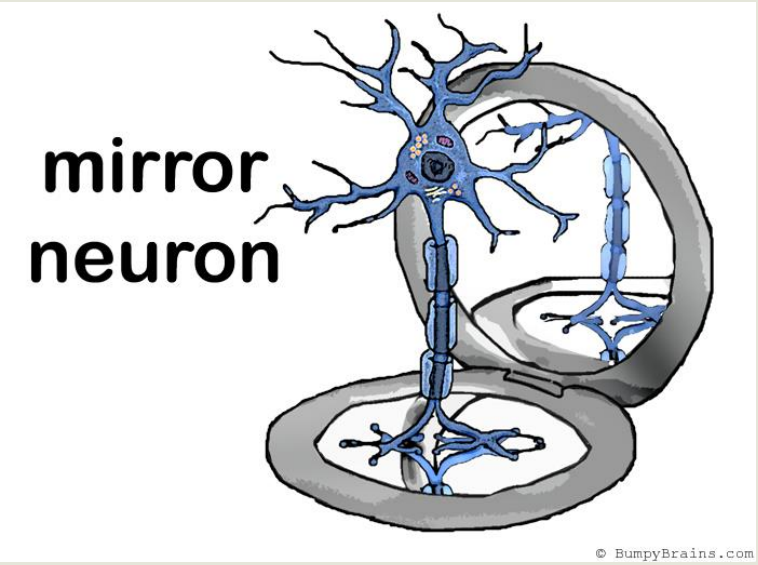


There exists a brain-eating amoeba

True or false?

Left brain hemishpere is analytic and right brain hemishpere is artistic

True or false?

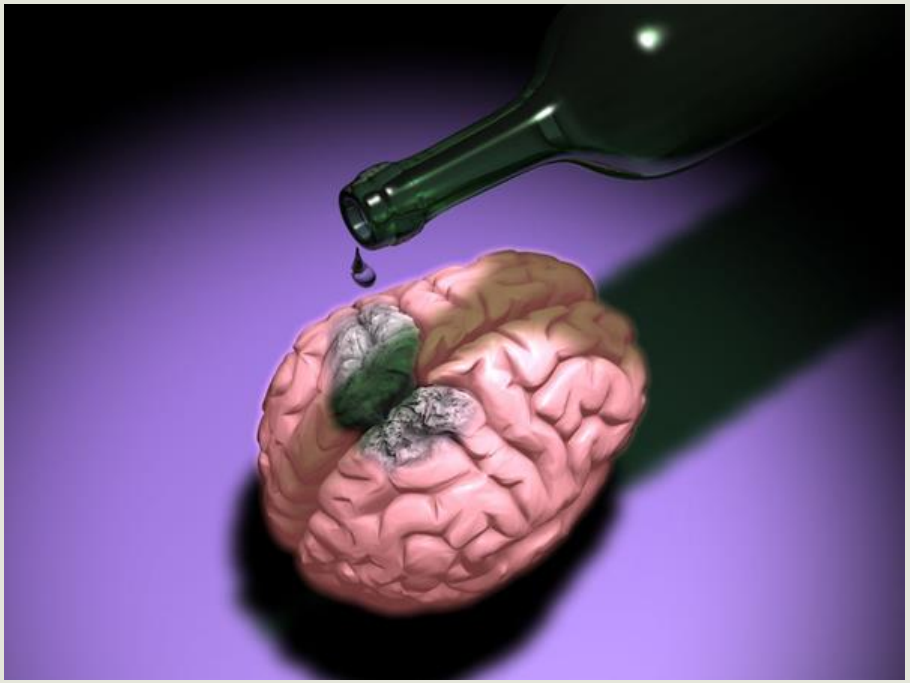


Mirror neurons are responsible for empathy

True or false?

People with high IQ live longer

True or false?

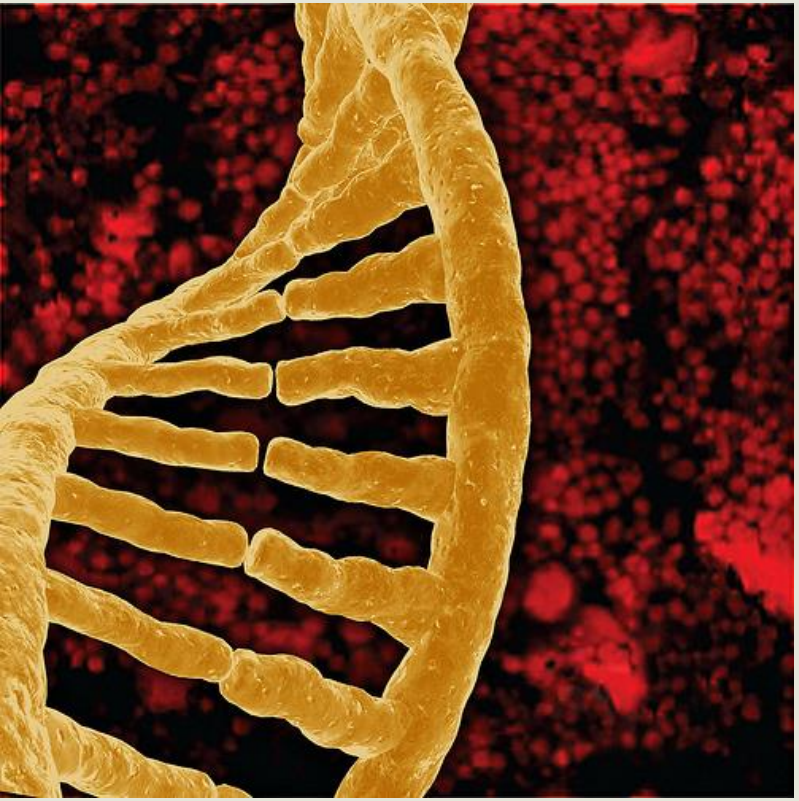


Alcohol kills brain cells

True or false?

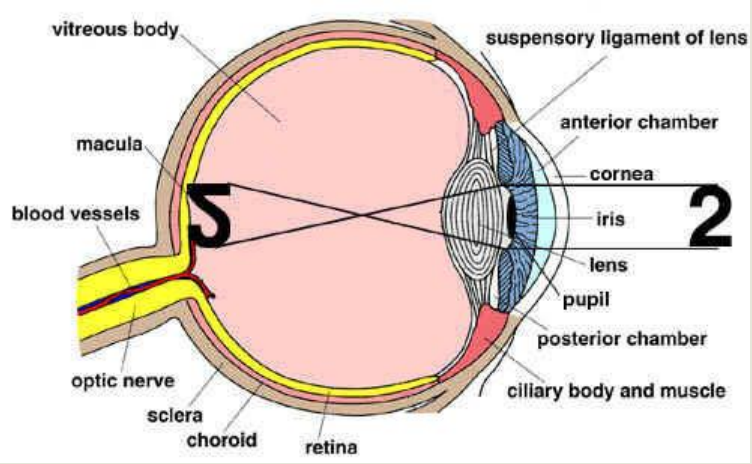
Your brain makes up only 2% of the body mass but uses about 20% of the total oxygen and blood used by the body.

True or false?



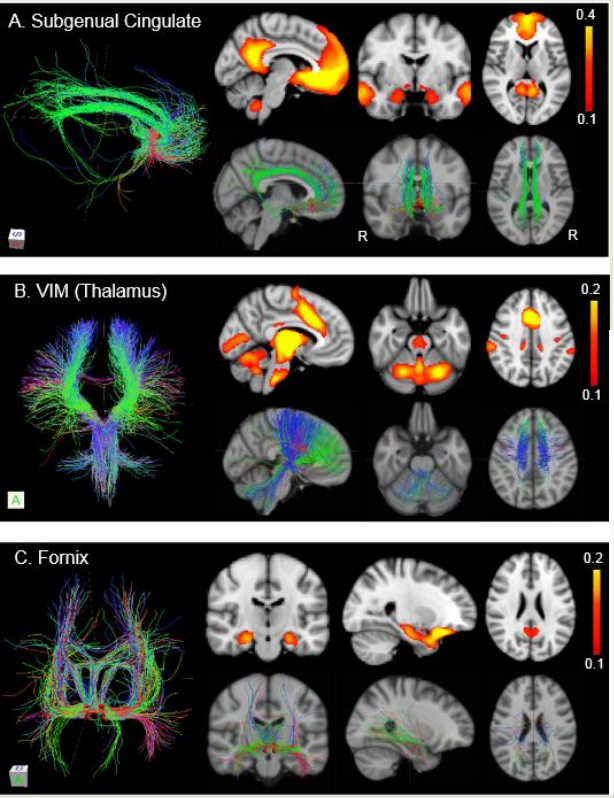
There's a virus that attacks human DNA making people less intelligent, impairing brain activity, learning and memory.

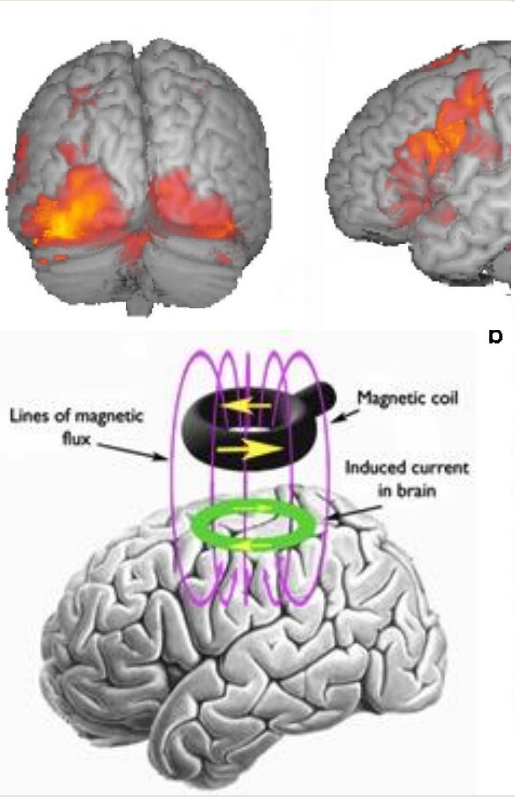
True or false?

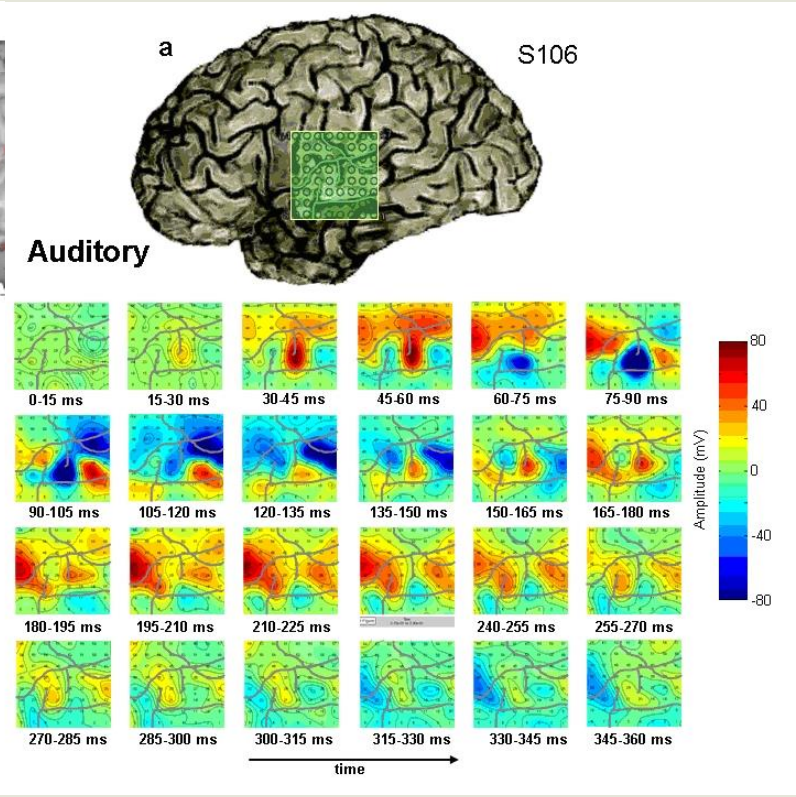


Because the image is projected upside-down onto the retina, newborns first see everything inverted and only later adapt and see normally.

METHODS


A. Subgenual Cingulate
0.4
0.1
R
R
B. VIM (Thalamus)
0.2
0.1
C. Fornix
0.2
0.1


Lines of magnetic flux
Magnetic coil
Induced current in brain


a
S106
Auditory
b
0-15 ms
15-30 ms
30-45 ms
45-60 ms
60-75 ms
75-90 ms
90-105 ms
105-120 ms
120-135 ms
135-150 ms
150-165 ms
165-180 ms
180-195 ms
195-210 ms
210-225 ms
240-255 ms
255-270 ms
270-285 ms
285-300 ms
300-315 ms
315-330 ms
330-345 ms
345-360 ms
time
Amplitude (mV)
80
40
0
-40
-80

MRI – Magnetic Resonanse Imaging

- High spatial resolution ✓
- Allows to study brain structure ✓
- Relatively cheap ✗

MRI

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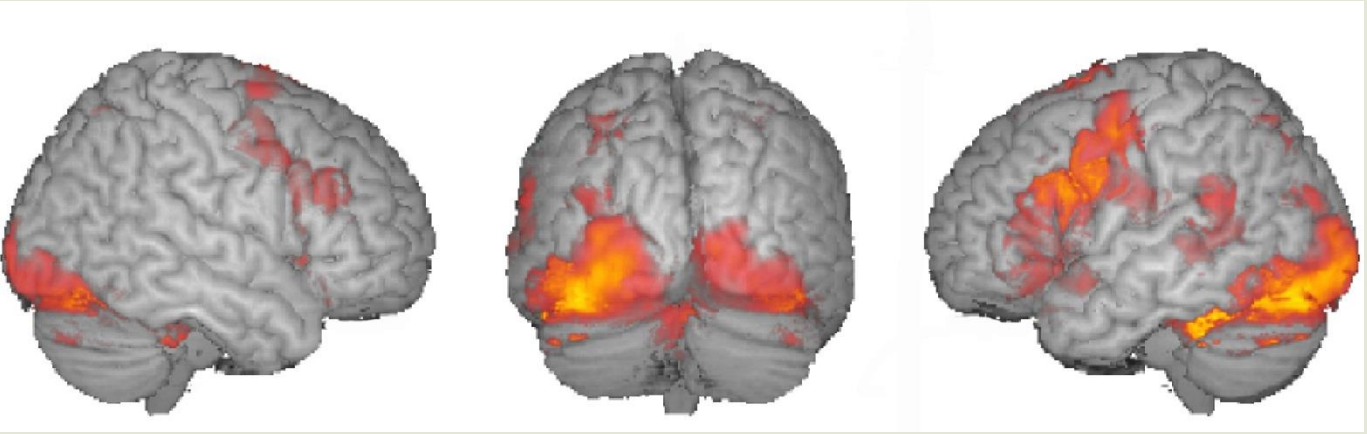
- Relatively cheap ✗

fMRI – functional Magnetic Resonanse Imaging

- High spatial resolution ✓
- Direct meausre of brain activity ✗
- High temporal resolution ✗
- Allows to study brain function ✓

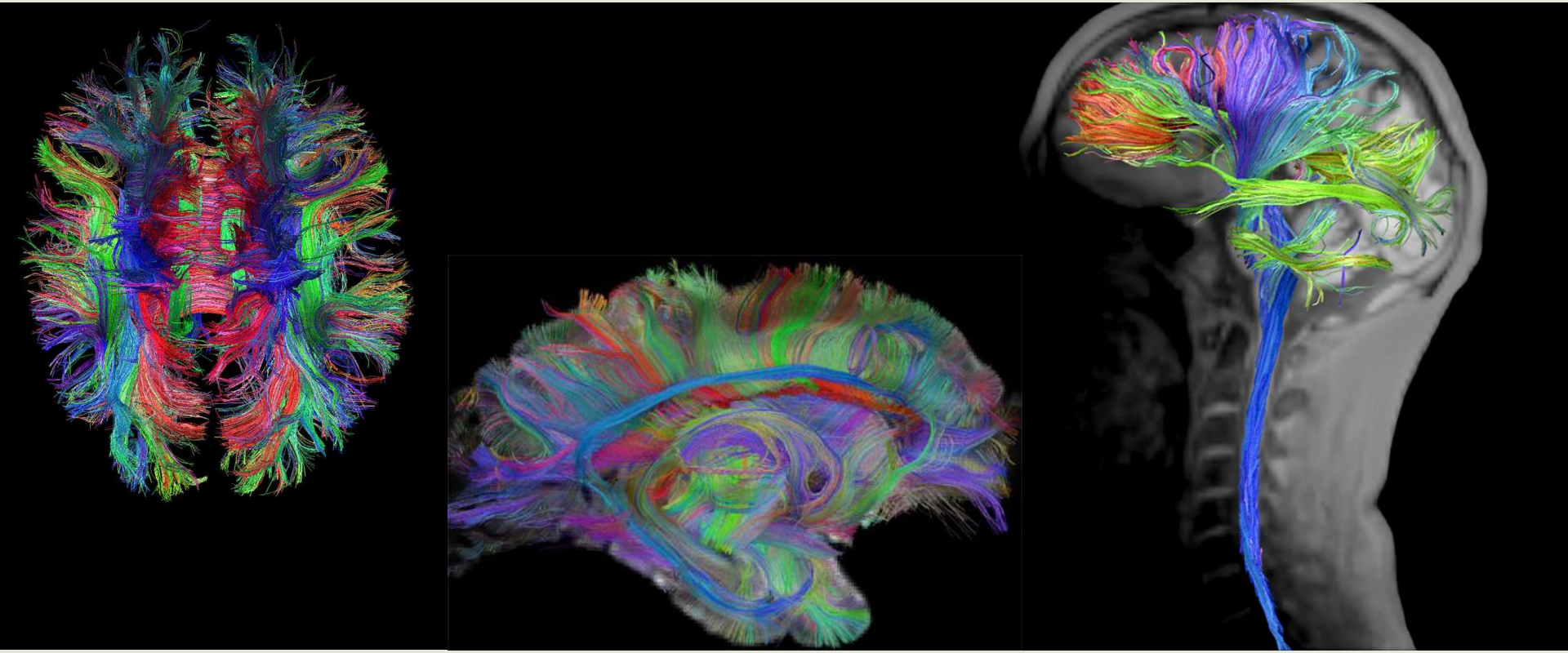
fMRI results



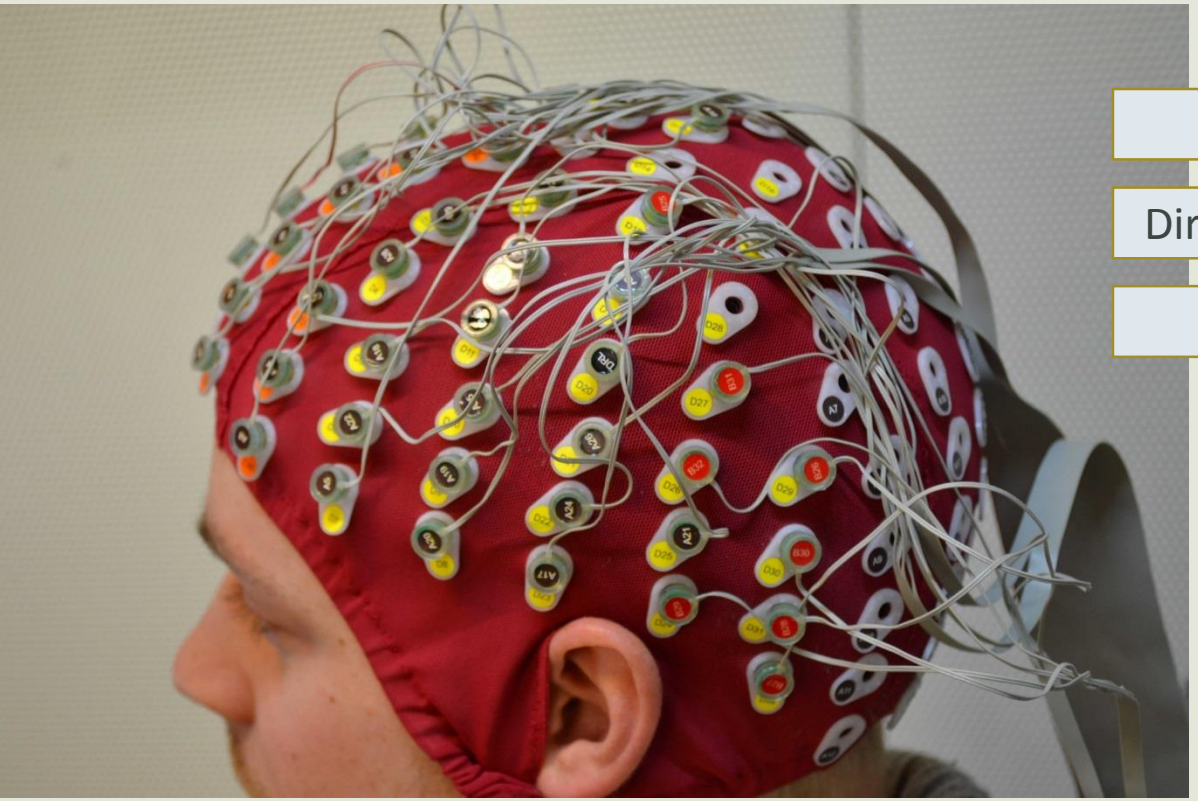
DTI – Diffusion Tensor Imaging

- Shows neurotransmitter density ✗
- Allows to study brain function ✗
- Shows connections ✓

DTI

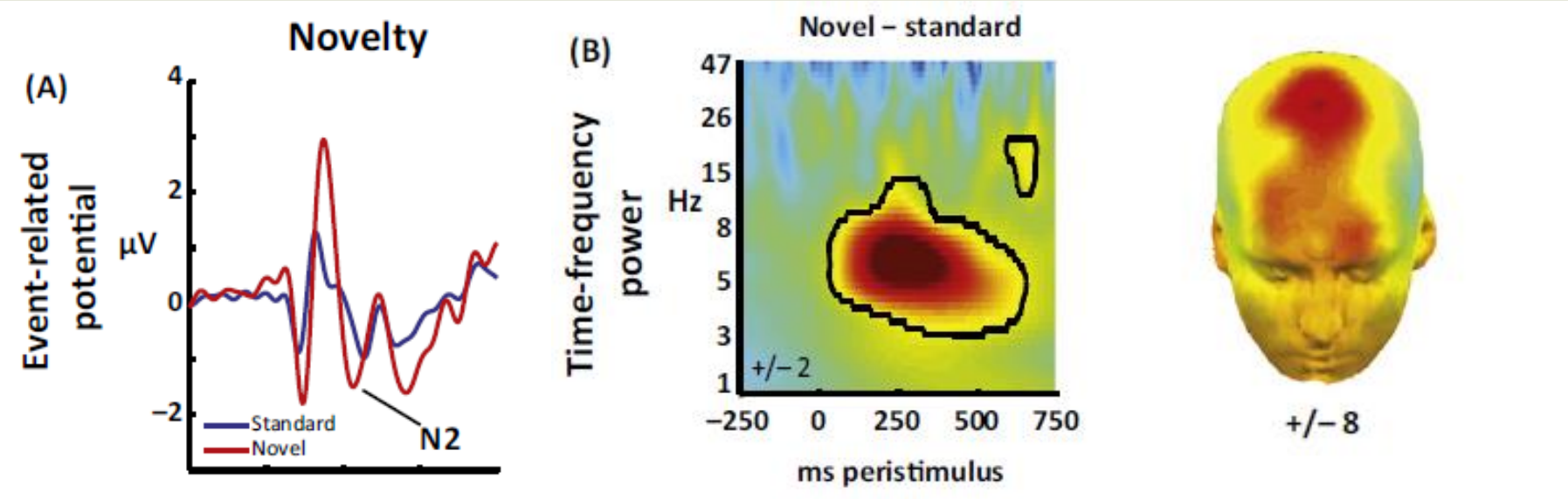


EEG

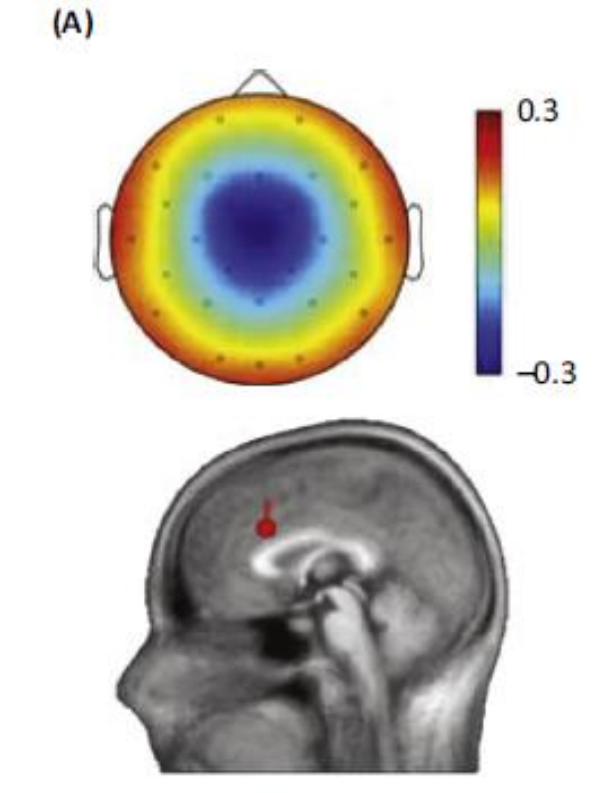


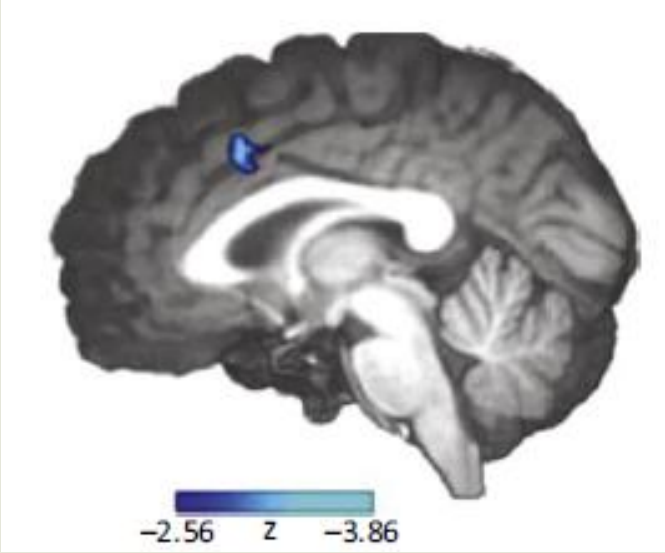
- High spatial resolution ✗
- Direct meausre of brain activity ✓
- High temporal resolution ✓

EEG results

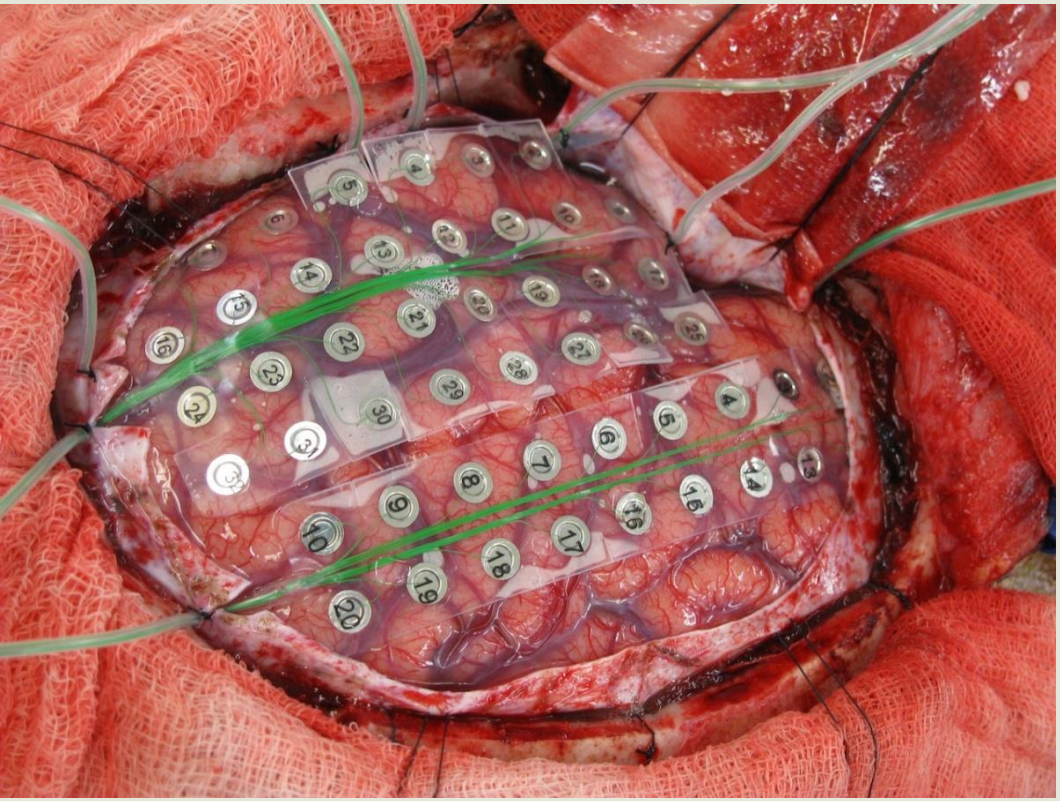

(A)
Novelty
Event-related potential
μV
4
2
0
−2
Standard
Novel
N2
(B)
Novel – standard
Time-frequency power
Hz
47
26
15
8
5
3
1
+/− 2
−250
0
250
500
750
ms peristimulus
+/− 8

EEG results



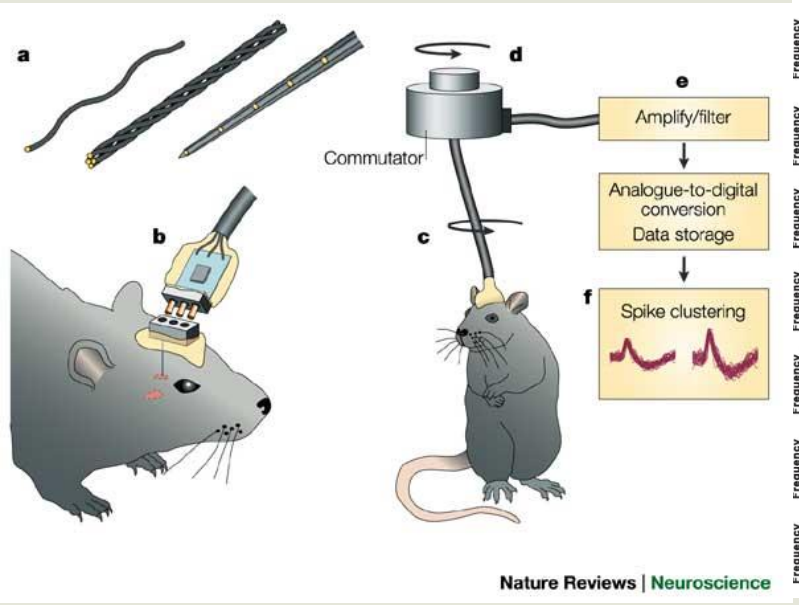


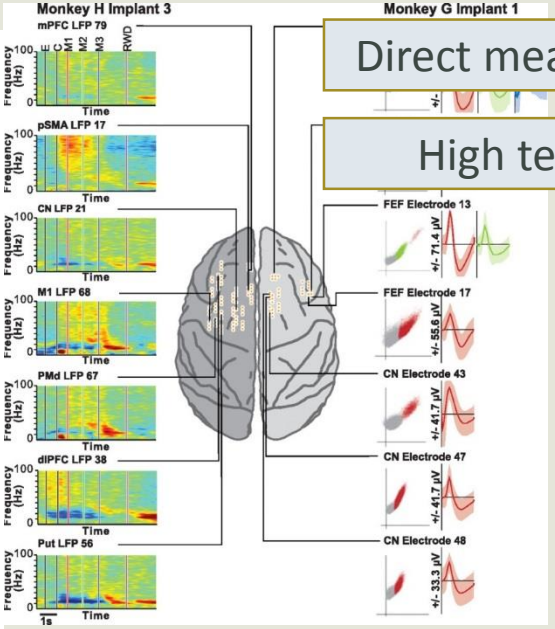
Intracranial recordings



- High spatial resolution ✗
- Direct meausre of brain activity ✓
- High temporal resolution ✓

Intracranial recordings

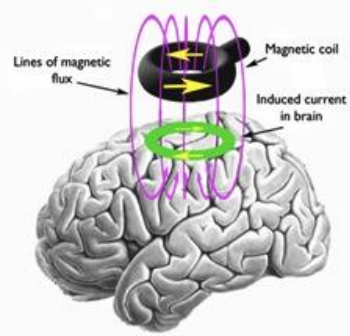


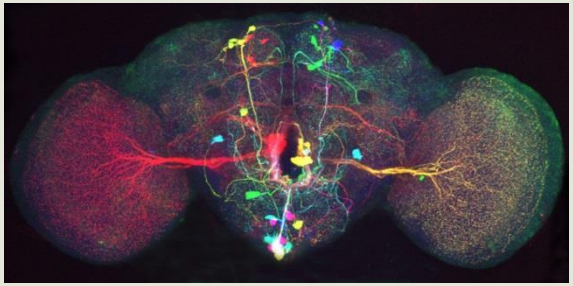


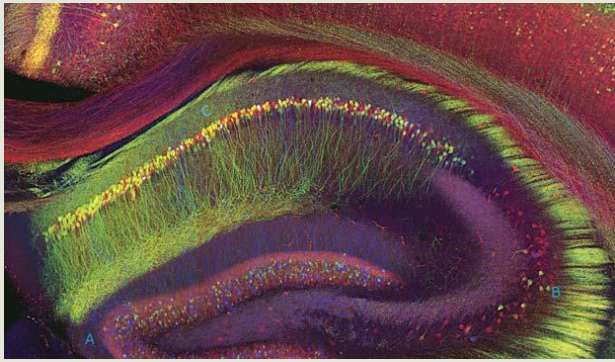
- High spatial resolution ✓
- Direct meausre of brain activity ✓
- High temporal resolution ✓

There is plenty of other methods!

- TMS – Transcranial Magnetic Stimulation
- TACS – Transcranial Alternating Current Stimulation
- Tracing methods, Brainbow
- MEG – MagnetoEncephaloGraphy







Neuroscientific experiments

How do we get to know what we know?

How do you conduct a study?

- ?

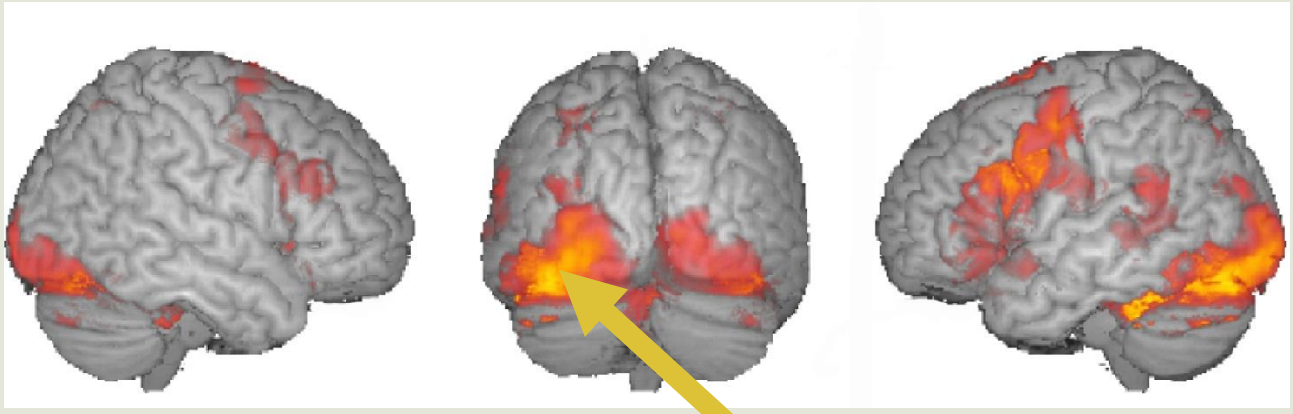
(neuro)scientific experiment

- We start out with some question (most likely – hypothesis)
- We gather a group of subjects by **random sampling from the population**
- To some extent – the more subjects we include – the better
- We come up with experimental conditions that will help us

(neuro)scientific experiment

- The most basic experimental setup is two conditions (or two groups) that we contrast
- In the end we can only say whether the difference between these conditions is **significant** (improbable to have been obtained by chance)
- Therefore we prepare the conditions such that the only difference between them is what we want to study

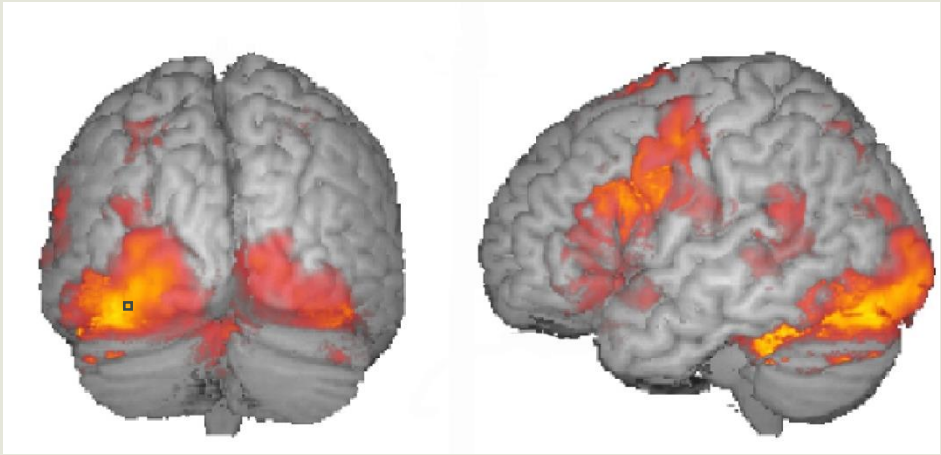
fMRI results



The result of contrasting condition A and condition B

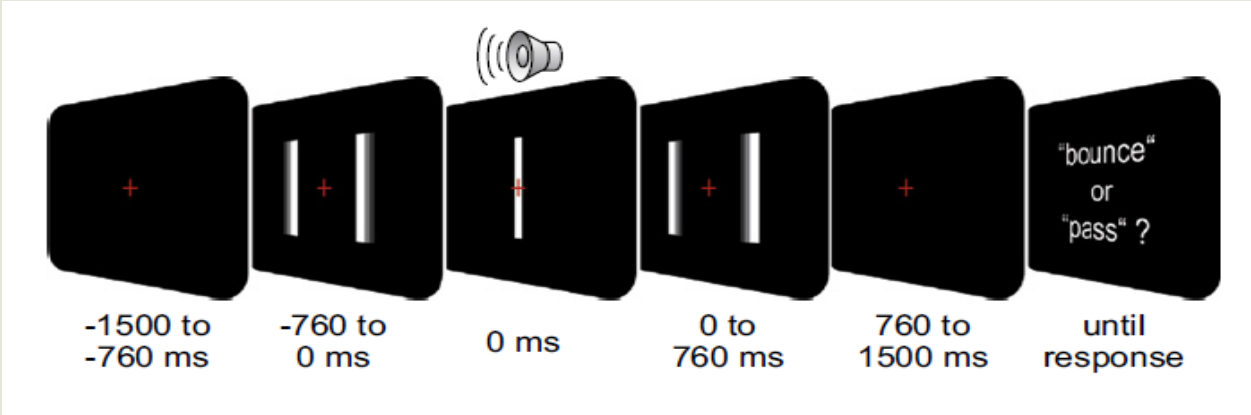
Contrast

Experiment results

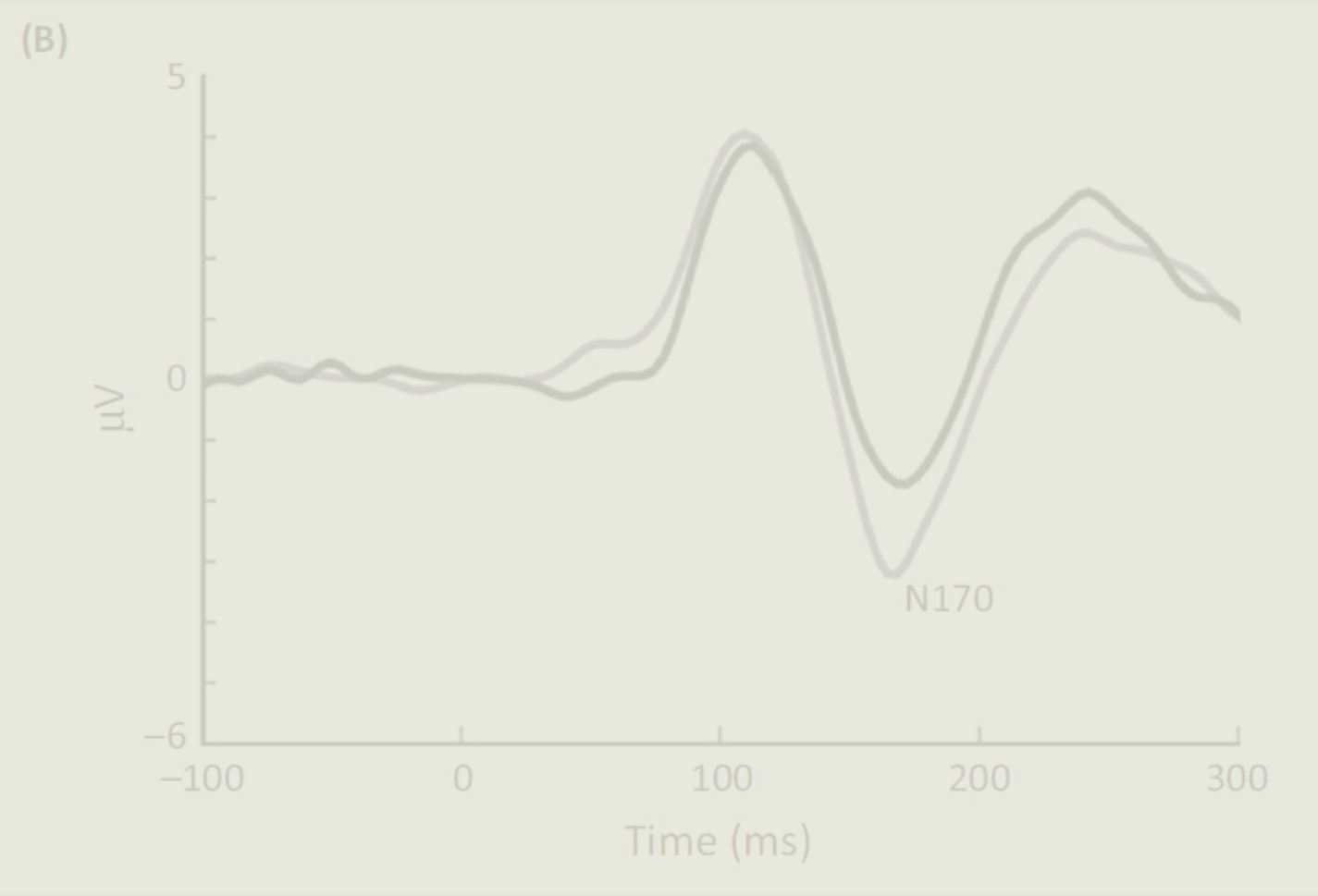


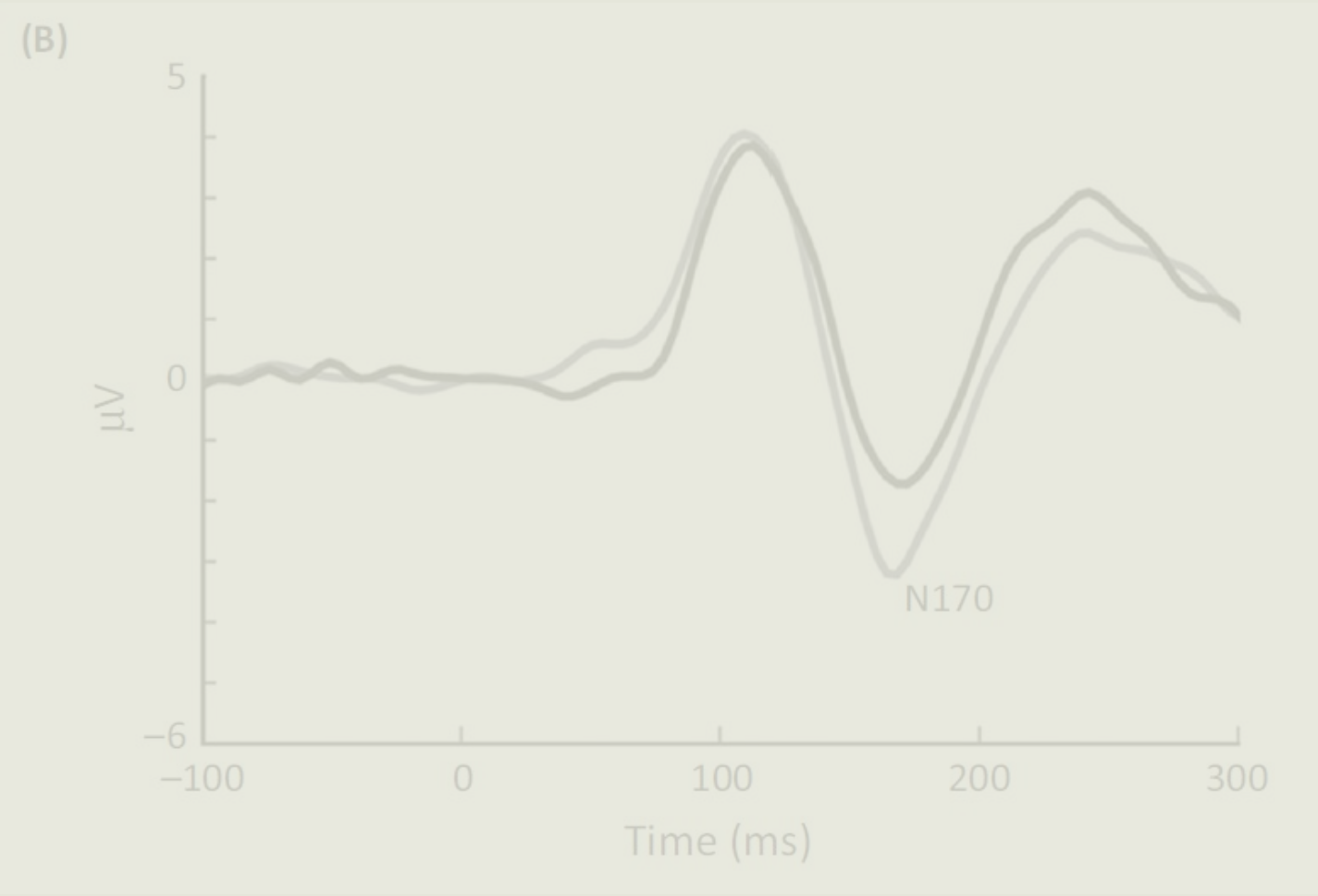
condition A condition B

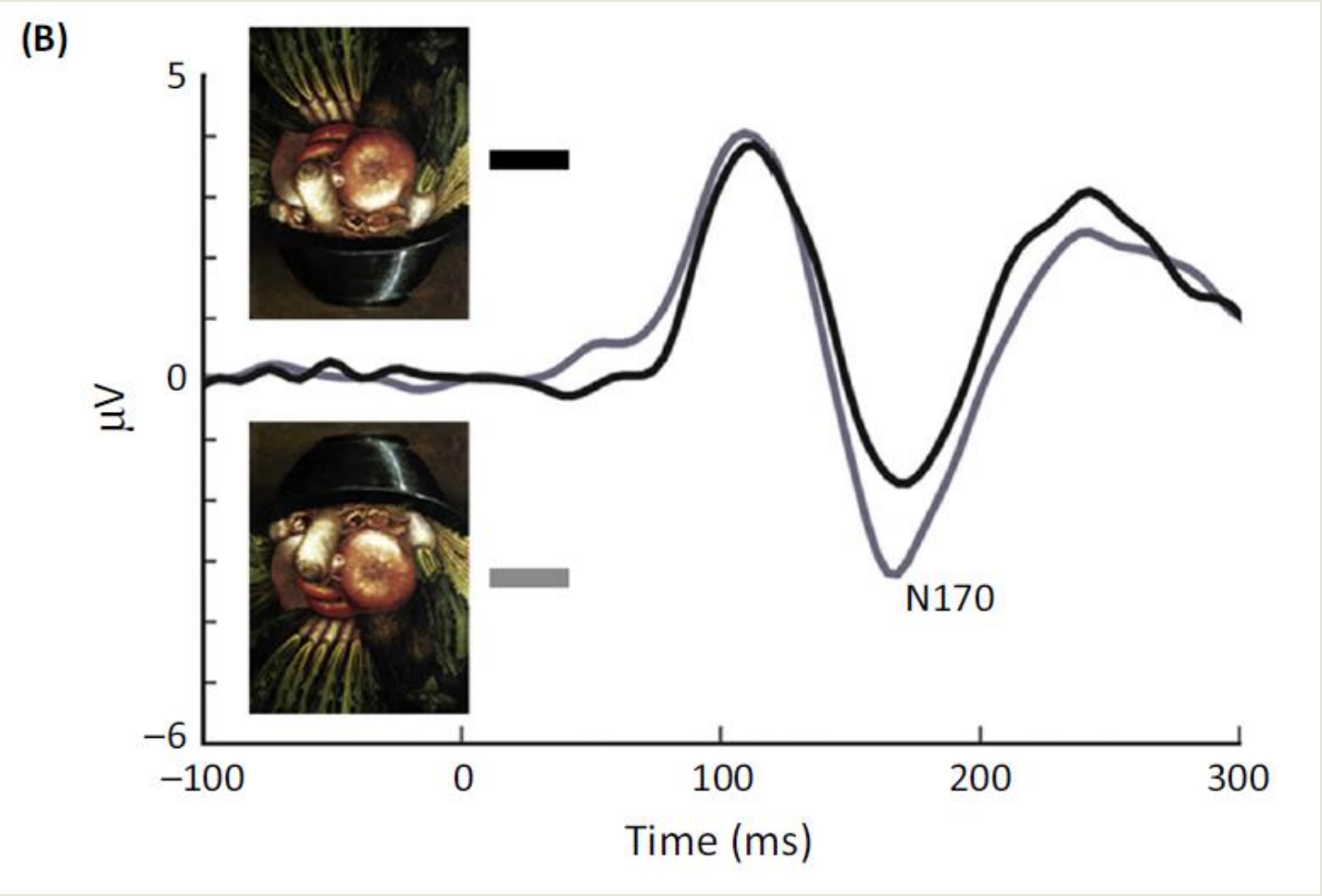
Experiment Example

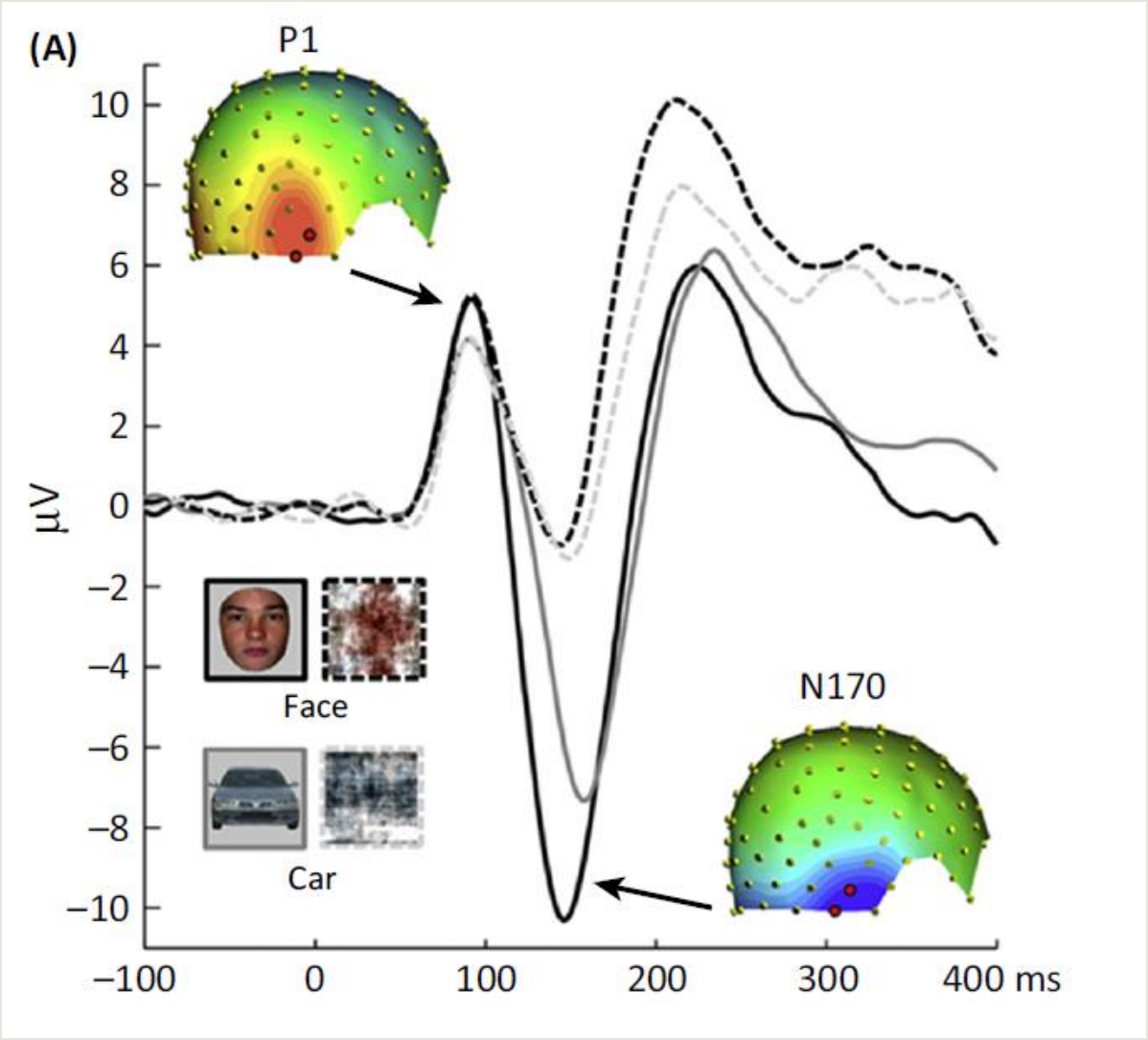


DEMO

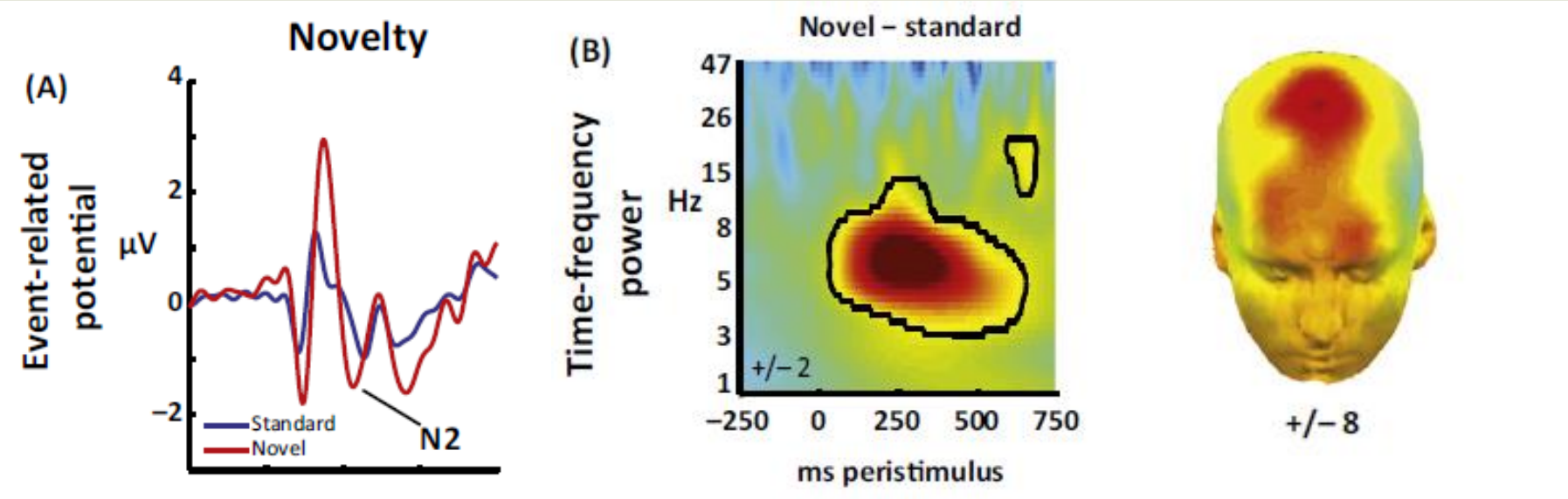

(B)
5
0
−6
μV
N170
−100
0
100
200
300
Time (ms)


(B)
5
0
−6
μV
N170
−100
0
100
200
300
Time (ms)


(B)
5
0
−6
μV
−100
0
100
200
300
Time (ms)
N170


(A)
P1
N170
Face
Car
μV
10
8
6
4
2
0
−2
−4
−6
−8
−10
−100
0
100
200
300
400 ms

EEG results


(A)
Novelty
Event-related potential
μV
4
2
0
−2
Standard
Novel
N2
(B)
Novel – standard
Time-frequency power
Hz
47
26
15
8
5
3
1
+/− 2
−250
0
250
500
750
ms peristimulus
+/− 8

EEG results