Lecture 8

Selected topics on free will

Plan of the Lecture

Connection between randomness, (in)determinism and free will

1 Defining free will

2 Free will and the practice of science

3 Quick notes on the brain

4 Libet’s experiment

WHAT IS “FREE WILL”?

Reminders

- Randomness = unpredictability
  - Need to specify *for whom* it is unpredictable
- Physical determinism = whether all that happens in the physical world is pre-determined
  - At any rate, not everything is predictable *for someone in our universe*
    - With unlimited computation power: quantum phenomena
    - With limited computational power: also classical phenomena: complex, or even simple ones; formally deterministic models

Definition from experience

Free will = capacity of making choices that are not completely pre-determined

- Any definition must try to capture this experience
- Unquestionable relevance for our lives: moral responsibility
- Impossible to keep fully separated from *Weltanschaaung*
  - What is a “human being”? Is there a “meaning” to our lives?
- It would deserve a full course…

Free will and randomness

- My choices are unpredictable *for* someone who does not know me.
- But I do not make my choices by tossing a coin!
- What *determines* each choice of mine?
  - Predispositions
    - Somatic (genetic, neuronal…) → Not in my control
    - Formation → Partly in my control
  - Immediate circumstances → Partly in my control
  - "My" judgment and decision to act → In my control

Various philosophies of action differ on the relative importance of these factors

Partial control

A famous story from the Christian religious tradition: the denial of Peter

6pm: Jesus announces that he is going to die. Peter says:
“Lord, I am prepared to go to prison and to die with you”.

9pm: Jesus is being captured. Peter indeed fights for him, until he is told to stop

12pm: while Jesus is being interrogated, Peter is waiting to see what is going to happen. A maid servant asks him if he is a disciple of Jesus and he replies:
“Woman, I do not know him”. He denies two more times.

(Gospel of Luke, chapter 22)

What he wanted to do

What he ended up doing, only a couple of hours later, out of tiredness and shame

Balance of elements

“Free will” is not

- The possibility of completely unpredictable behavior
  - Usually, this is called “to have lost one’s head”
- The denial that somatic or external factors may influence our choices

“Free will” is

- The capacity of making choices that are not fully determined, and the ensuing responsibility.
  - Whatever your philosophy, conclusions like “Hitler has done nothing wrong” are abhorrent.

What has science to say about this?

FREE WILL & THE PRACTICE OF SCIENCE

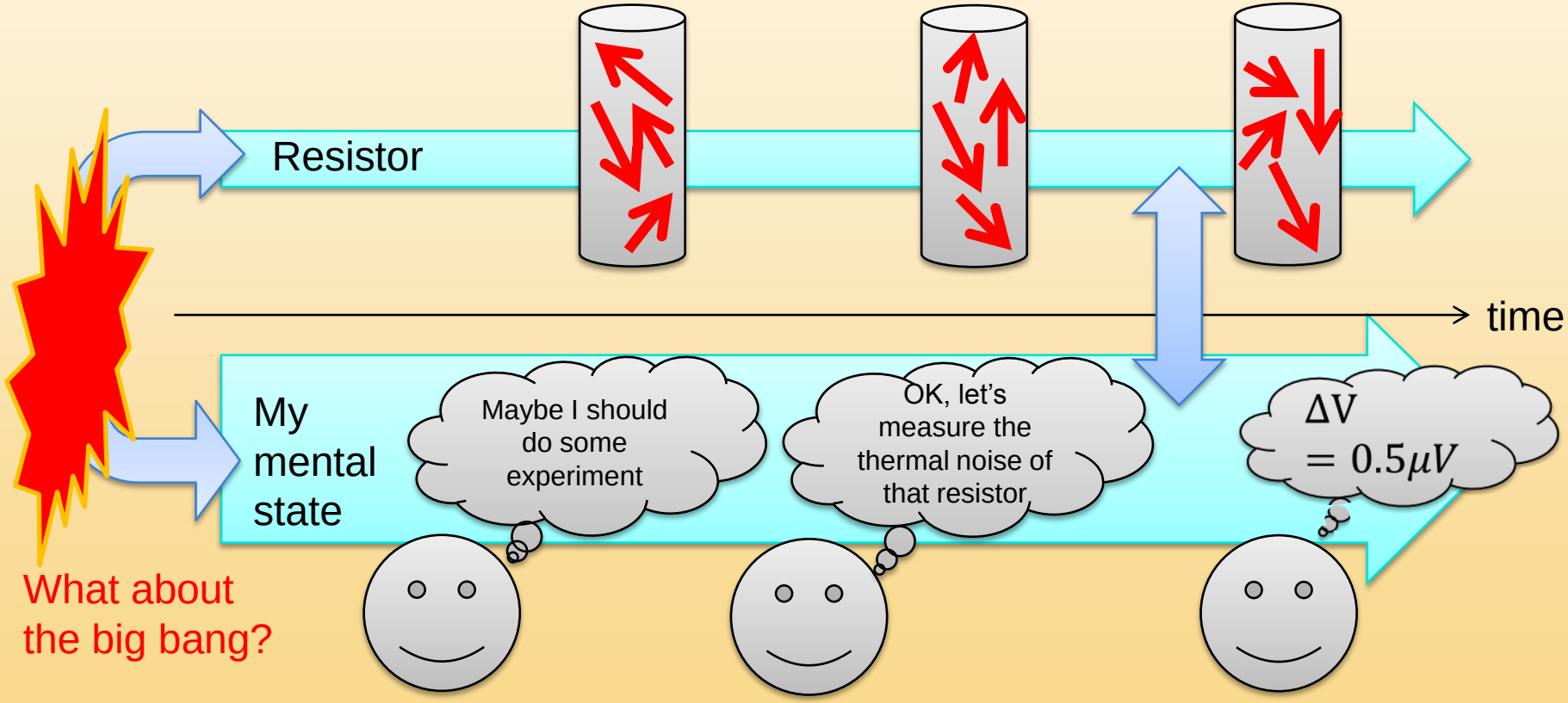
“Measurement independence”

A fundamental tenet of the scientific method: the possibility by the experimenter to perform different measurements, to change only some parameters.

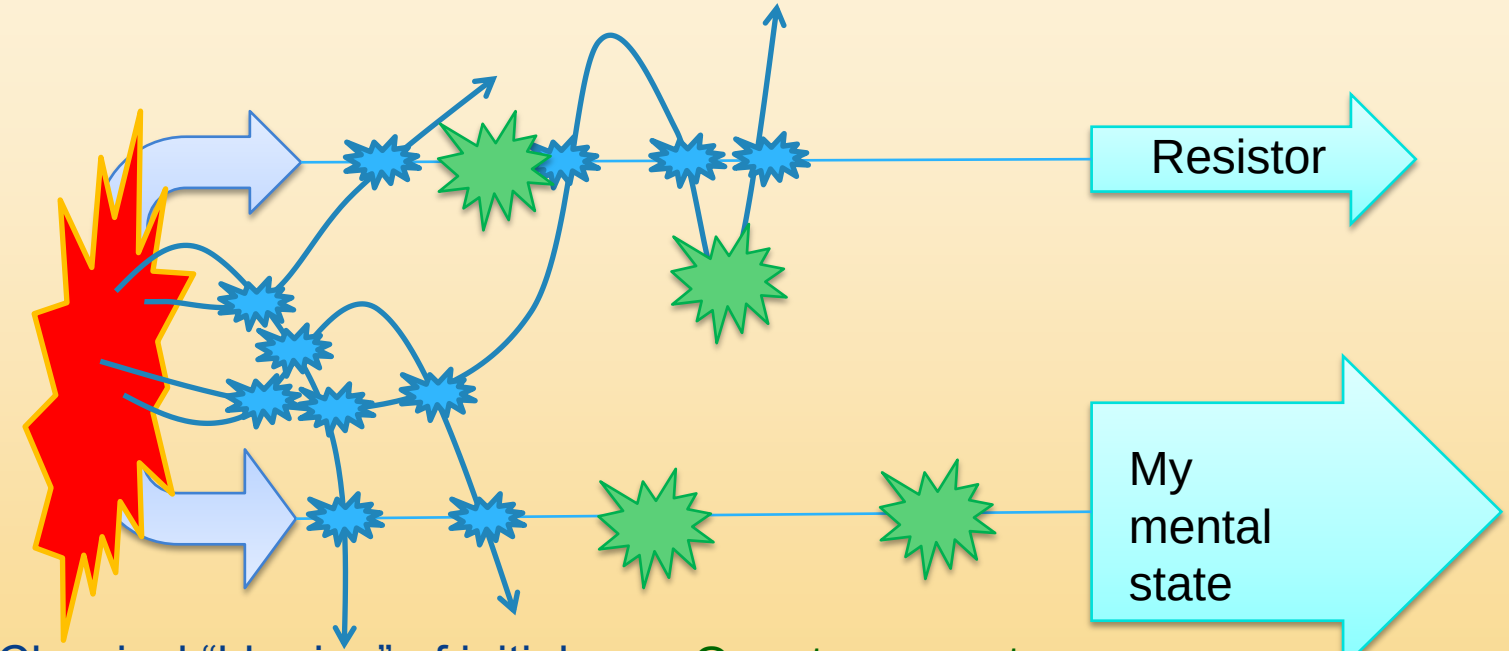
- Recall lecture 4 in the lab: change only the value of R
- Measure gravity: drop the same mass from different heights
- Calibration: measure what the detector sees before the sample is put into place
- Drug tests: give the same drug to persons with various conditions

This has little to do with morality, consciousness etc. But it says that at least some events must be uncorrelated, i.e. there must be independent chains of events (in the theater of conspiracy, also science is pointless)

Independent causal chains



Common cause in the past?



Classical “blurring” of initial correlations by other events

Quantum events: creation of information

Is free will needed to do science?

- The scientific method requires measurement independence
  - Free will is not strictly needed (cf. previous slide)
  - From the existence of free will, some measurement independence comes for free
- Scientists have some moral responsibility
  - If your favorite ethics ends up approving cheating, bullying, falsification of data… think again!

ENTERS THE BRAIN

No-brainers

- The (human) brain is extremely complex
- Physical and chemical processes happen in the brain
- The brain is somehow related to free will, consciousness etc.

The science of the brain is relevant for the discussion on free will

Quanta in the brain?

- Needless to say, quantum physics ultimately describes the chemical processes happening in the brain, like everywhere else.
- The tempting question is: can quantum indeterminism be related to “free will”?
  - Valid scientific question, in principle testable
  - Materialists: ☺ it would prove that our free will is nothing else than a physical process.
  - Dualists: ☺ it would allow the “ghost in us” to shape decisions without violating the laws of physics.

Prudent objections

- There is no evidence of the use of quantum statistics in the brain
  - Is the brain a “quantum computer”? Aaronson: well, we don’t seem to be particularly good at factoring integers…
- In fact, there is little evidence of quantum phenomena in any “hot and wet” environment
- Above all, the explanation does not take into account the complexity of the brain
  - If it were true, a photon on a beam-splitter would exhibit free will.

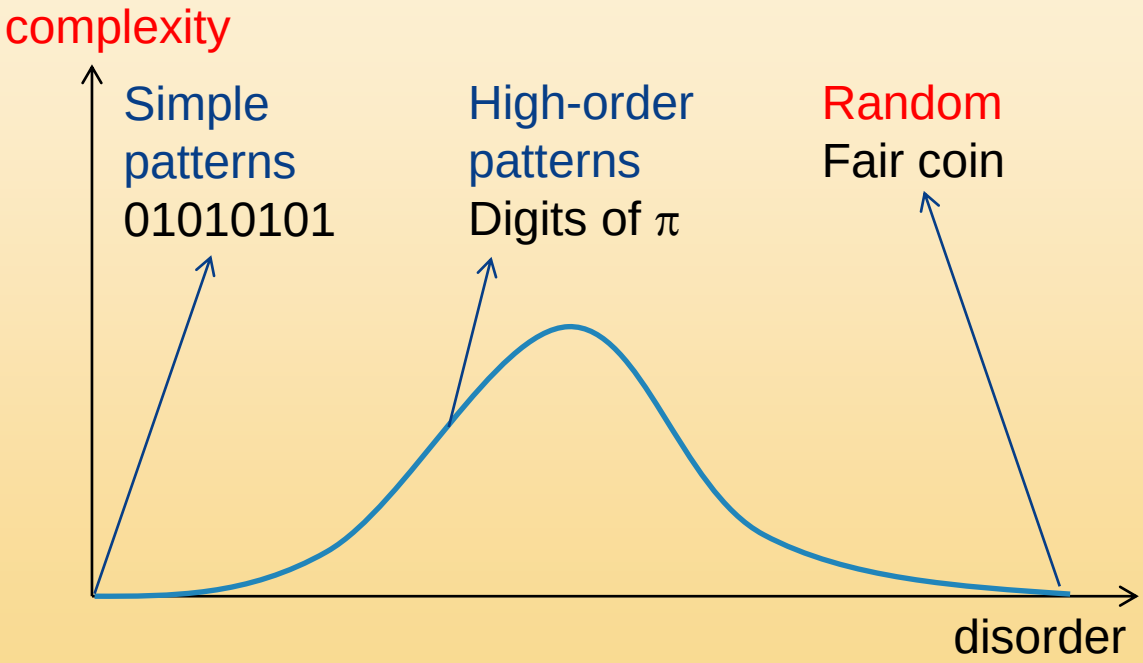
Rather, emergence?

Emergence = cooperative phenomena in complex systems, that could not have been predicted by studying the individual components

Fits the brain!

- Widely used concept
  - Many atoms, under some conditions, form a solid, or a liquid… and with higher order, a living being!
  - Many grains of sand form some patterns
  - Behavior of crowds
- Applied to the brain: impossible to describe its activity by focusing only on *elementary* constituents or processes

Complexity and randomness



(inspired from a slide of Daniel Stein)

Take-away for us:

- Complex is different from random
- Although it may be possible to use a complex phenomenon as RNG, since it is hard to predict

Suggested Readings

- Chapter “indeterminism and free will” in P. Davies, God and the new physics (1983)
- R.Y. Chiao et al. (eds), Visions of discovery (Cambridge University Press, 2011):
- several relevant essays
- Two recent reflections on free will by prominent quantum scientists:
  - Scott Aaronson: http://arxiv.org/abs/1306.0159
  - Seth Lloyd: http://arxiv.org/abs/1310.3225

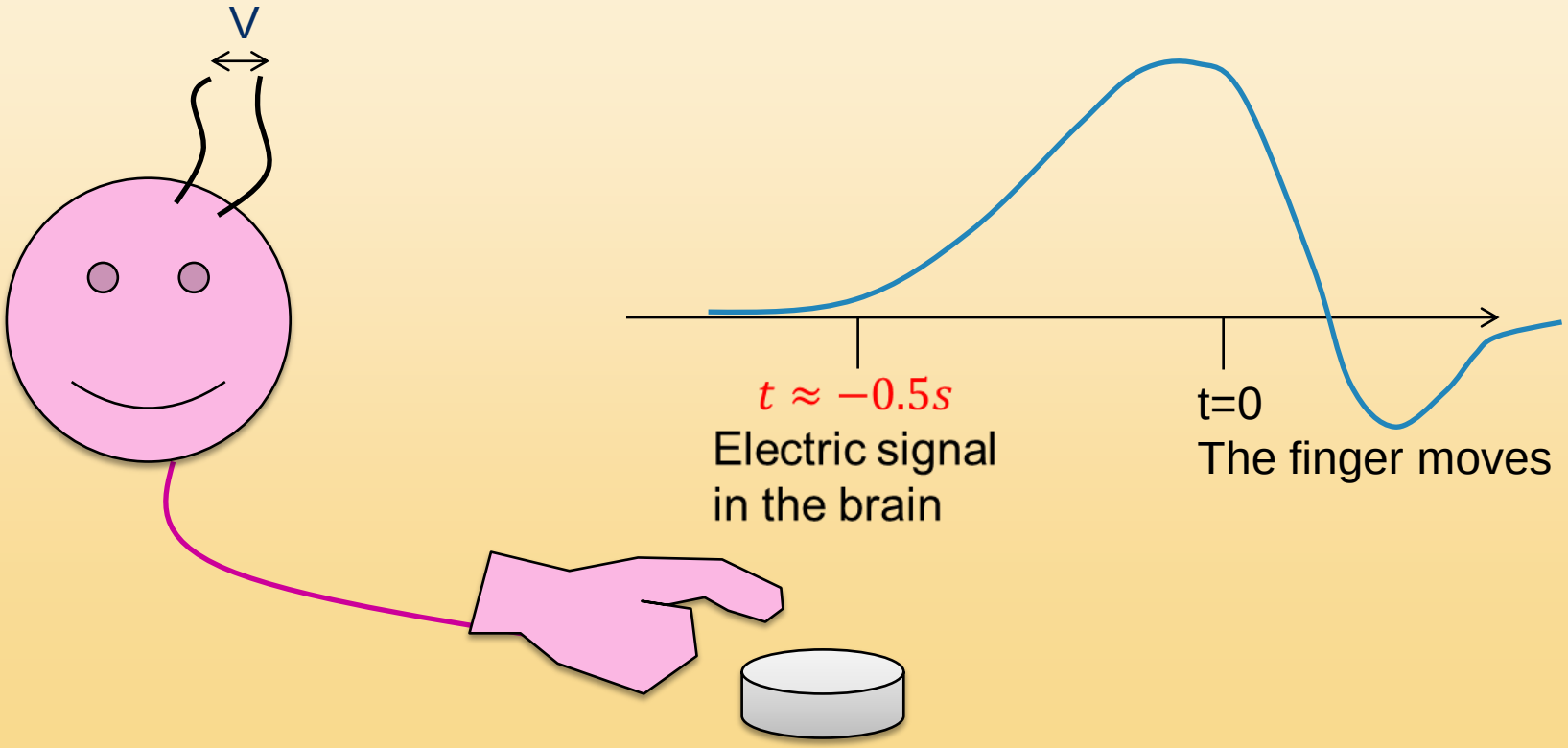
Wikipedia pages:

- http://en.wikipedia.org/wiki/Complexity
- http://en.wikipedia.org/wiki/Emergence

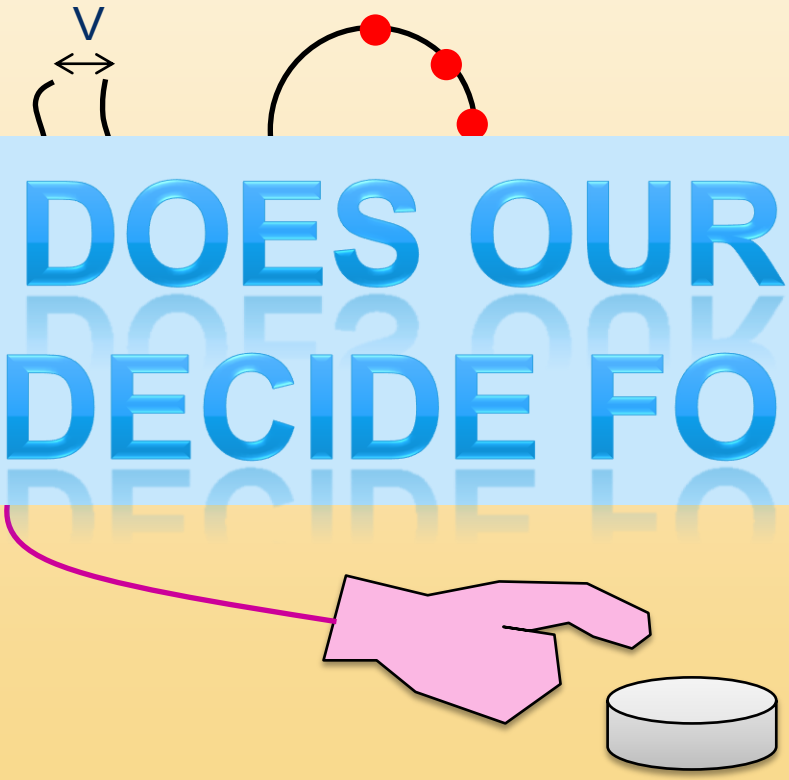
LIBET’S EXPERIMENT

Readiness potential

Kornhuber, Deecke 1964

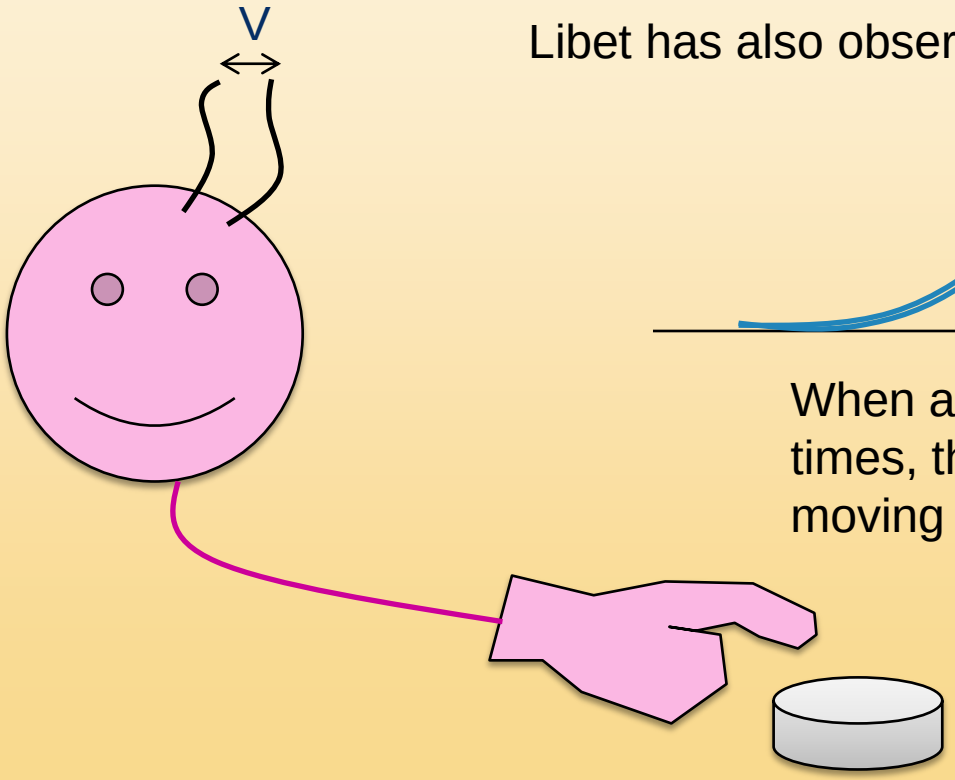


Libet's experiment (1980s)

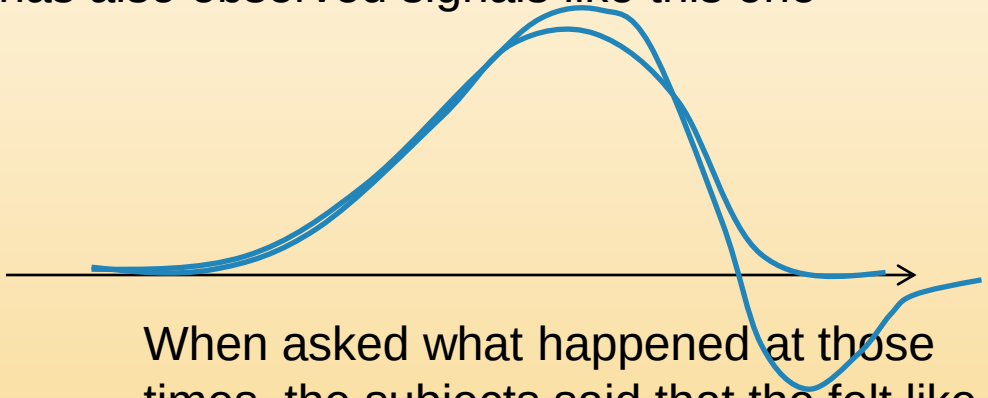


DOES OUR BRAIN DECIDE FOR US??

Free to say no?



Libet has also observed signals like this one



When asked what happened at those times, the subjects said that the felt like moving the finger, then changed their mind

Our “consciousness” is free to say “no” to the brain.

Lots of comments

- The method of “saying where was the dot” is not precise: there is also a lag from the eye to the brain…
  - But several later experiments have confirmed the observation
- The task is not particularly “meaningful”
  - Recent experiments have tried more “meaningful” tasks

No fundamental discrepancy from Libet’s findings

Balance

- Mental states and consciousness are not identical
  - In particular, it is not obvious at all that consciousness is just a later illusion: lots of debates there!
- Some mechanisms in the brain *bias* our decisions
- Tests done in simple, controlled situations
  - Very meaningful decisions are usually the result of complex elaborations
    - When does one decide to marry someone? Certainly not half a second before proposing.

Summary of Lecture 8

Connection between randomness, (in)determinism and free will

- Free will is neither randomness nor total lack of determination. It relates to responsibility.
- Measurement independence
- Science of the brain: complexity more than quantum
- Libet’s experiment

Suggested Readings

Wikipedia pages:

- http://en.wikipedia.org/wiki/Benjamin_Libet
- http://en.wikipedia.org/wiki/Neuroscience_of_free_will