Consciousness

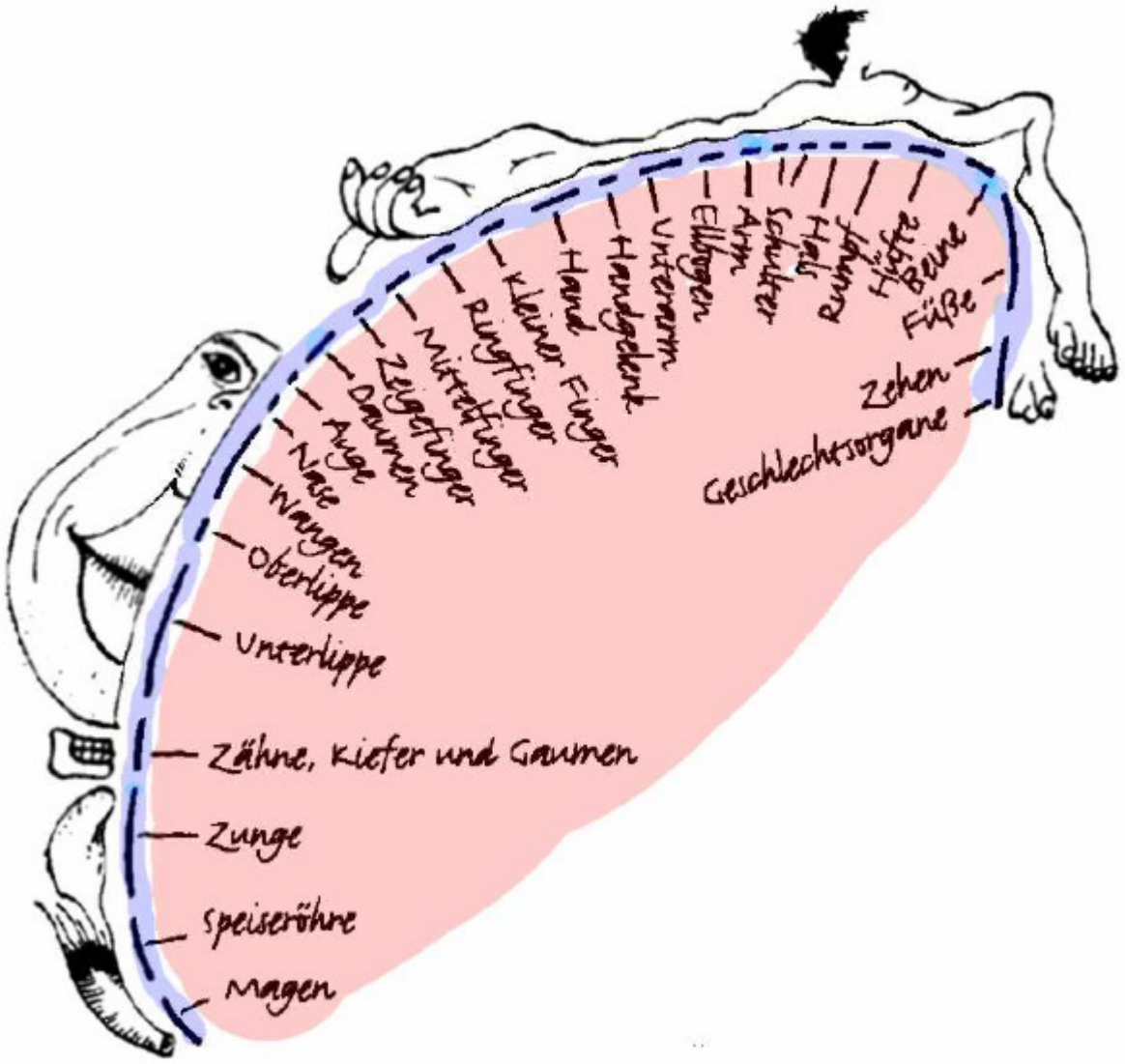
The greatest gift which humanity has received is free choice. It is true that we are limited in our use of free choice But the little free choice we have is such a great gift and is potentially worth so much that for this itself life is worthwhile living. (Isaac Bashevis Singer 1968)

In many cases we do not do what we will but we will what we do. (Modern Neuroscience)

1 Libet's 1979 experiments

In the 60s the brain surgeon Bertram Feinstein allows his friend Benjamin Libet to perform experiments with uncovered brains. In the breaks during Feinstein’s surgical work Libet amused the patients by performing simple experiments with electrical stimulations of certain brain areas, and the patients had to report what they felt.

What is the inner experience of an outer stimulation? In some way, he began to replicate Wilder Penfield’s investigations about topographic maps (relating brain and body regions).


Lippen
Nase
Wangen
Oberlippe
Unterlippe
Zähne, Kiefer und Gaumen
Zunge
Speiseröhre
Magen
Auge
Daumen
Zeigefinger
Mittelfinger
Ringfinger
kleiner Finger
Hand
Handgelenk
Unterarm
Ellbogen
Arm
Schulter
Hals
Rumpf
Hüfte
Beine
Füße
Zehen
Geschlechtsorgane

However, Libet's main interest was concentrated on the *time characteristics* of the relation between external stimulus and internal experience.

- His first important finding was that it needs at least a 500 ms cascade of electrical stimulation to trigger a conscious experience.

- In a later experiment Libet and his colleagues found a very elegant experimental arrangement for investigating the timing of external stimulus and internal experience:

  Libet et al. (1979): Subjective Referral of the Timing for a Conscious Sensory Experience. *Brain* 102, 193-224.

The Experiment

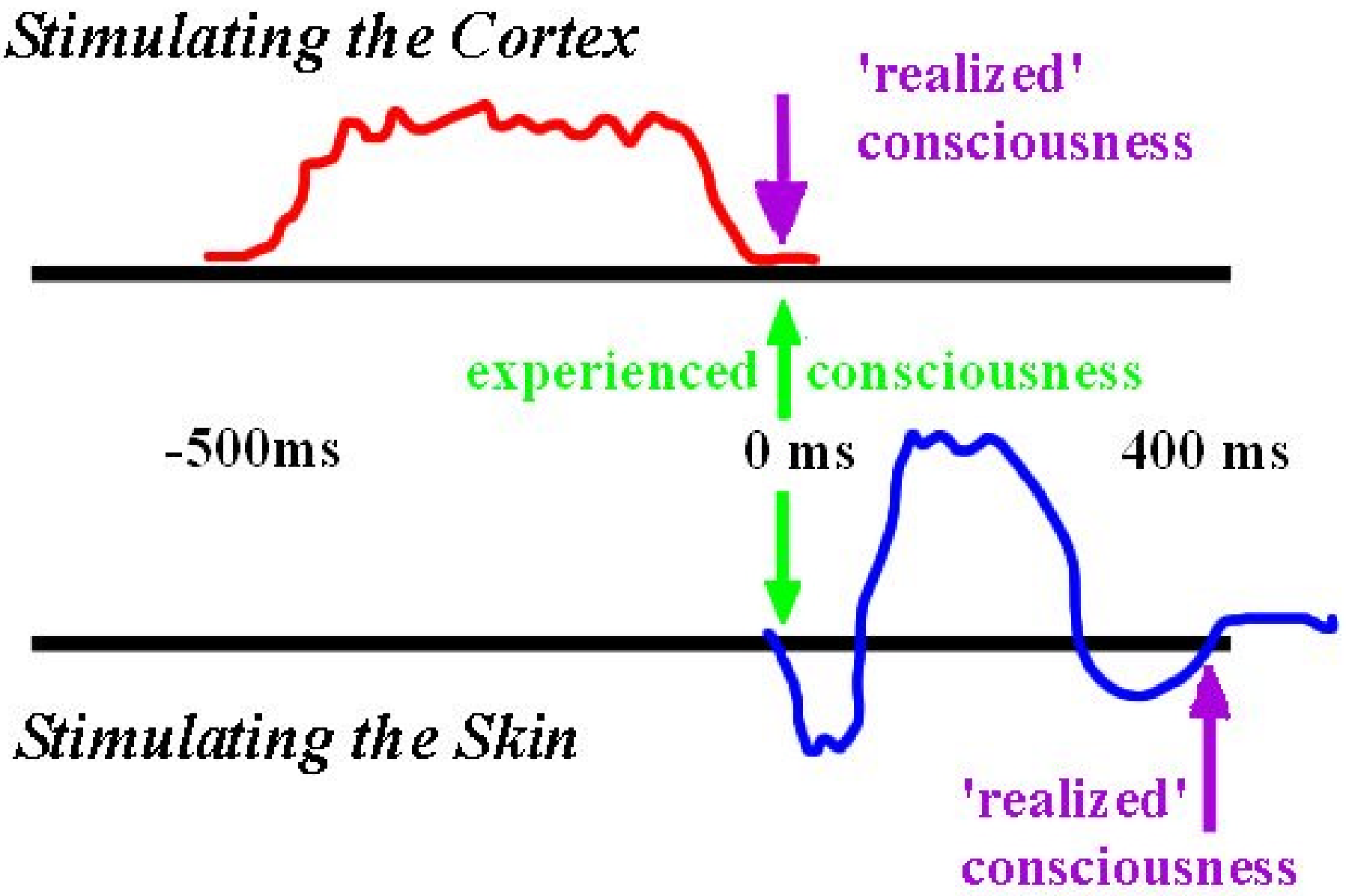
More or less simultaneously the experimenter

(1) stimulated a brain region such that the subject felt a tickle in her left hand.

(2) stimulated the right hand directly.

The subject had to decide where she felt the stimulation first, in the right hand or in the left hand or at the same time. It was possible for the experimenter to shift the onsets of the stimulations

Libet's expectation was that that in each case approximately a half second is necessary to prompt a conscious experience (since it needs always approximately a half second before a stimulation can trigger conscious experience). However, the outcome was completely unexpected.


Stimulating the Cortex
'realized'
consciousness
experienced consciousness
-500ms
0 ms
400 ms
Stimulating the Skin
'realized'
consciousness

The stimulation of the brain and the stimulation of the skin were experienced simultaneously if the stimulation of the brain started a half second earlier!

Conclusion

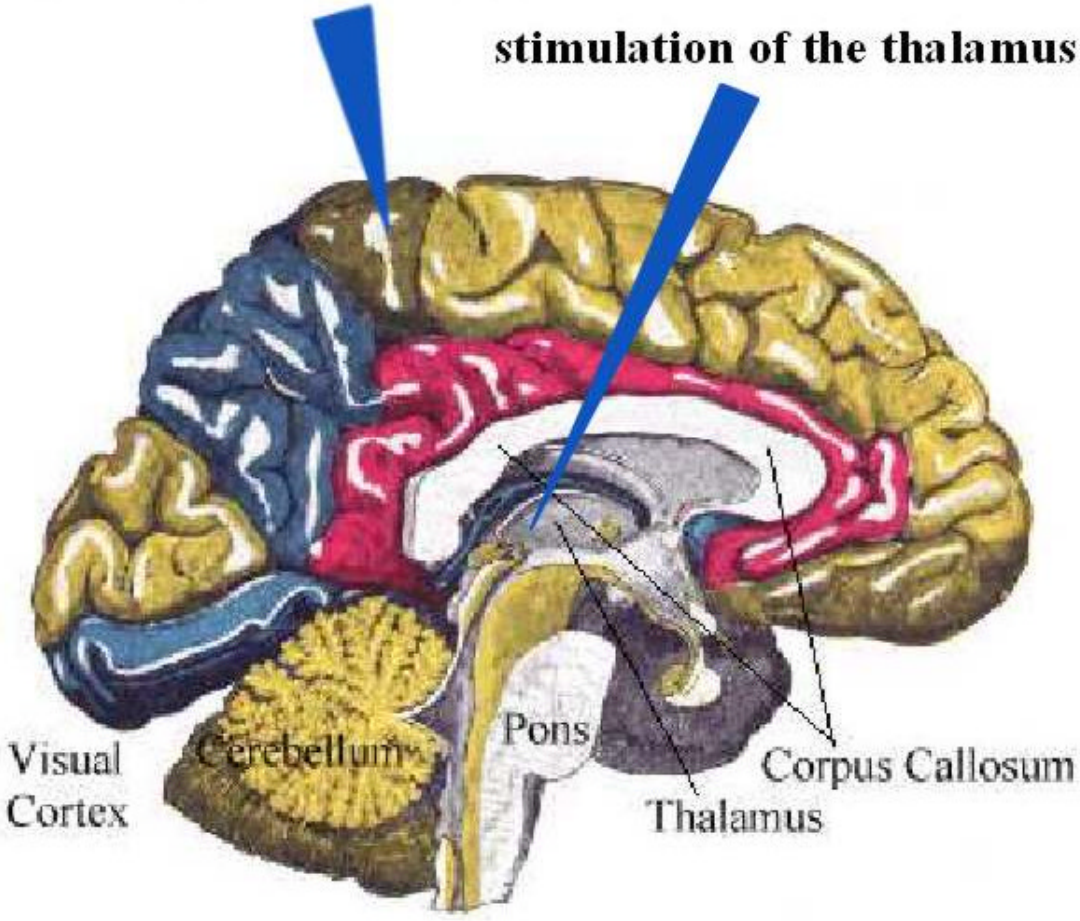
In case of the external stimulation of the skin our 'conscious mind' it subtracts a half second and predates subject's conscious experience. In this way, we experience the outer world in the correct way. It takes a while until we experience a event in the outer world. However, our 'conscious mind'dates it back and we think we experience the world in the temporally right moment. (The same phenomenon as with the Blind Spot: Our perceptual system is insufficient. However, we do not become aware of its errors)

Replication

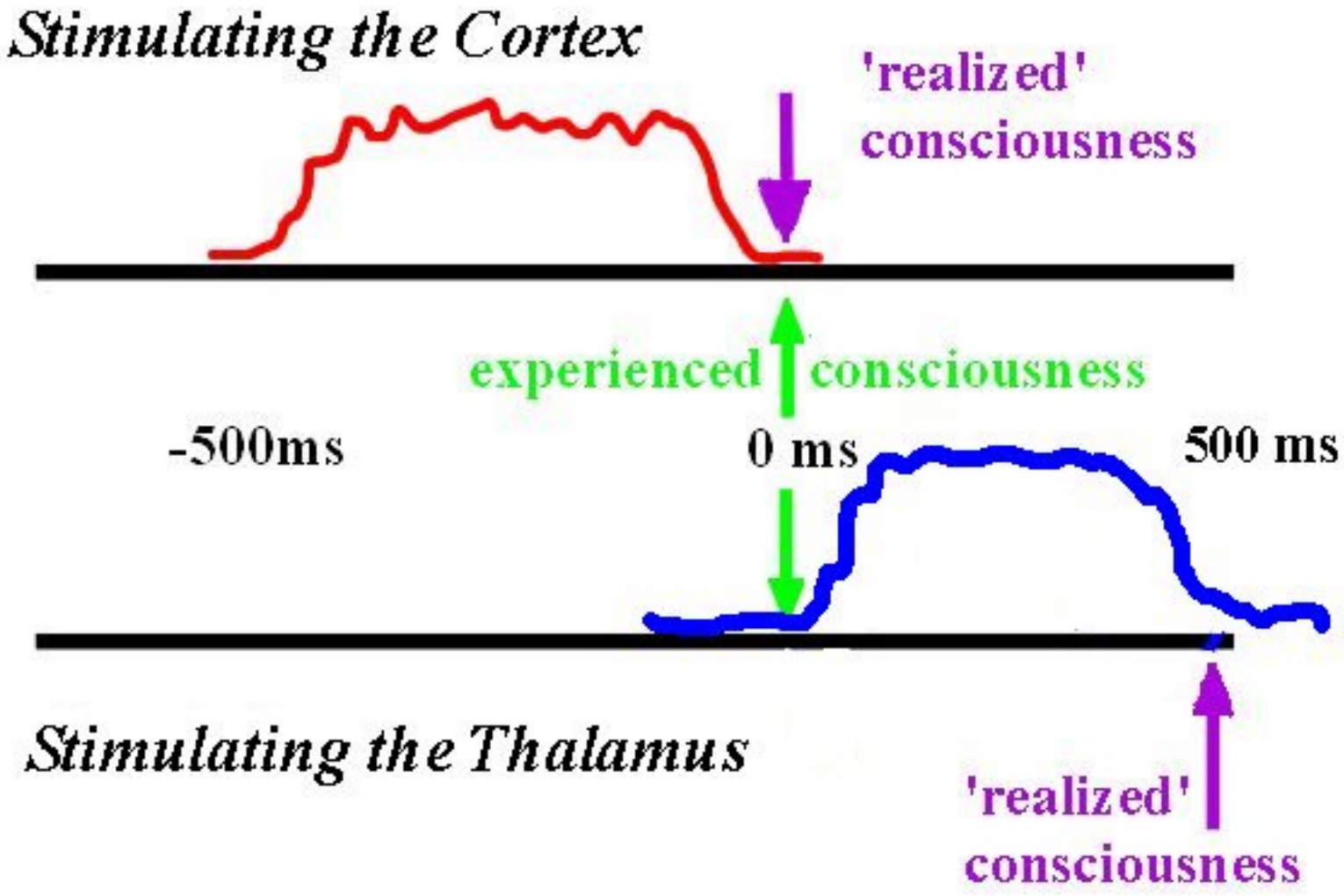
A direct test of this hypothesis is possible if the incommensurability of the two stimuli (i.e., the direct stimulation of the brain and the stimulation of the skin) can be overcome. In the critical experiment two different regions of the brain were stimulated electrically:

(1) a brain region of the cortex such that the subject felt a tickle in her left hand.

(2) a brain region in the thalamus (phylogenetically old; so-called unspecific system; this system collects information from the whole body and sends it to the cortex)


stimulation of the thalamus
Visual
Cortex
Cerebellum
Pons
Thalamus
Corpus Callosum

The finding was that in this case very the same pattern is occurring:



2 Is an experimental approach to the question of free will possible?

The question of free will goes to the root of our views about human nature and how we relate to the universe and to natural laws.

- Are we completely defined by the deterministic nature of physical laws? Are we essentially sophisticated automatons only, with our conscious feelings and intentions tacked on as epiphenomena with no causal power? (cf. Thomas H.Huxley)

- Or do we have some independence in making choices and actions, not completely determined by the known physical laws?

What we need first for approaching the problem in a experimental way is a good operational definition of free will. This approach should be in accord with common views.

That means

- There should be no external control or cues to affect the occurrence or emergence of the voluntary act under study; i.e. it should be endogenous.

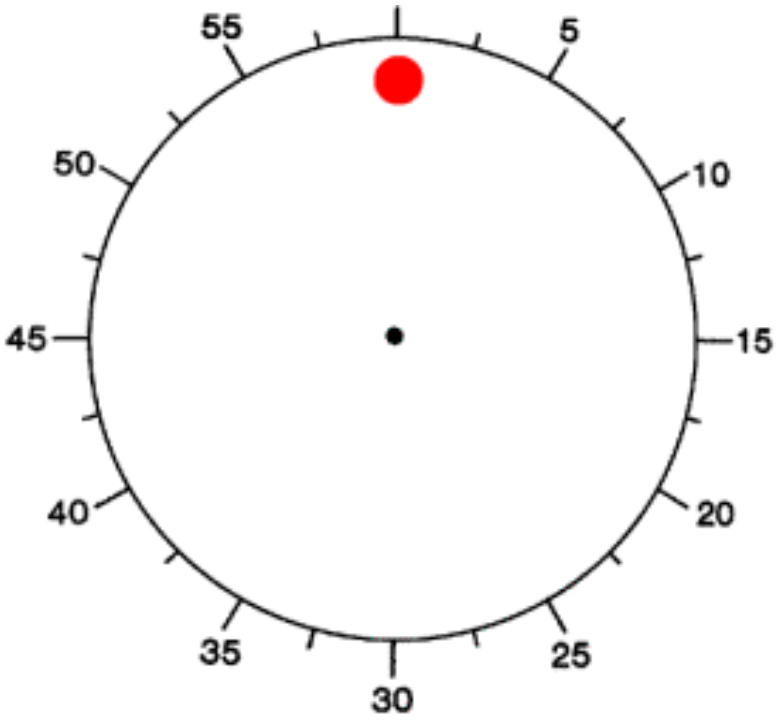
- The subject should feel that he/she wanted to do it, on her/his own initiative, and feel he could control what is being done, when to do it or not to do it. Many actions lack this second attribute. For example,

when the primary motor area of the cerebral cortex is stimulated, muscle contractions can be produced in certain sites in the body. However, the subject (a neurosurgical patient) reports that these actions were imposed by the stimulator, i.e. that he did not will these acts. Clinical disorders with a similar effect are Parkinson and even obsessive compulsions to act.

Simple examples of 'self paced' voluntary acts are lifting a finger, closing an eye etc.

How can we measure the *onset* of such a voluntary act?

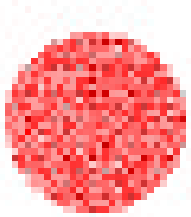
This question is the most important for performing serious experiments. Obviously, consciousness is private. It is a primary phenomenon. That means consciousness is only accessible to the subject that has the experience. (The only criterion for consciousness is consciousness itself). There is principally no way to reduce it to some measurable activities in he brain. Of course, there may be a correlation between consciousness and electrical activity in the brain. However, the primary phenomenon of consciousness is purely subjective.



Wund's clock

3 Benjamin Libet on consciousness and free will

Consider the following two description of the same situation, one time as our subjective report, the other time as from the perspective of modern neuroscience.



A Subjective report

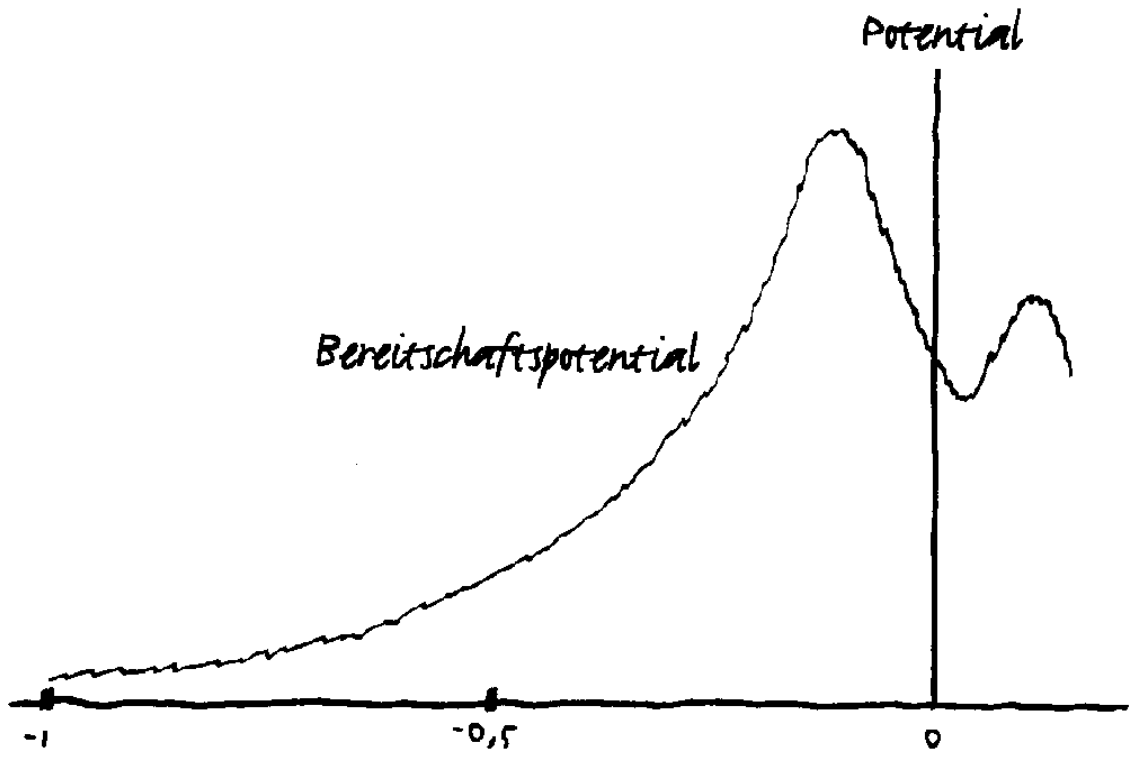
On the journey. We are driving three hours already, and we have to drive another four hours. We see a sign indicating a place to rest. We think 'time for a break'. On the other hand, we have to drive another 400 km and we want to arrive not too late. However, it is dangerous to drive lacking in concentration. Consequently, we decide to make a stop. We indicate, brake, and drive on the place to rest.

B Modern Neuroscience

On the journey. Unconsciously our brain has registered that we are tired. And unconsciously our brain registers this sign indicating a place to rest. from earlier experience our brain knows that we can rest there. And it gives a signal to our body to indicate and to brake. At the same time another bundle of neurons becomes active. Unconsciously it has checked the plan for our journey and has doubts whether we will arrive in time if we make a break. Our brain has to come to a decision. What's better, to stop or not to stop? Within milliseconds the brain decides to stop, and it gives order to register and to brake. All that happens unconscious. Only 200 milliseconds later this decision becomes conscious (and - being trained philosophers -

3.1 The readiness potential

In 1965, Hans H. Kornhuber and Lüder Deecke investigated the correlation between arbitrary movements of hand and foot and electrical activities in the brain (EEG). The general question was this: It is possible to demonstrate by EEG that a person performs a certain action (for example, she opens or closes her hand). Kornhuber & Deecke found a rather strange phenomenon: already 1 second before the hand (or foot) is moved an activity in the EEG appears. They called it "Bereitschaftspotential" (readiness potential). Surprising is that the readiness potential start so early.



Readiness Potential: Changes of the electrical field of a certain brain region already 1 second before an action begins.

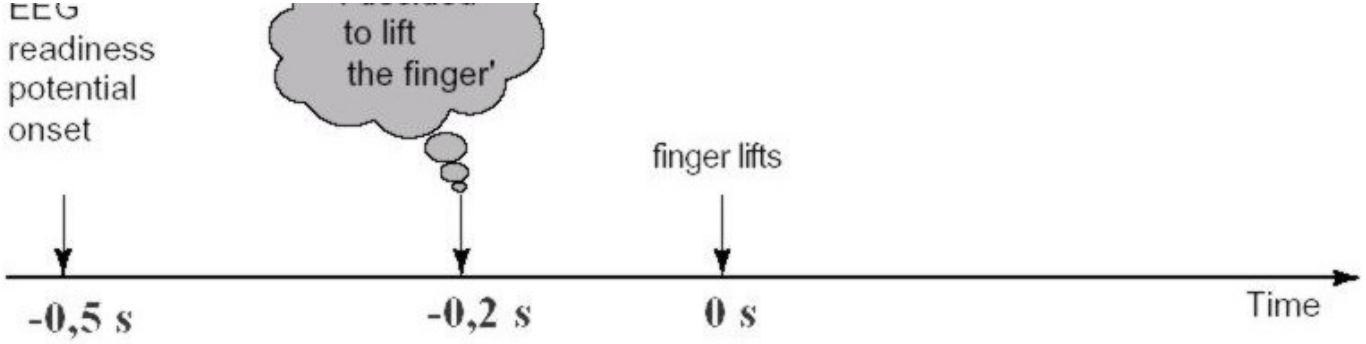
Benjamin Libet from the Medical center of the University of California (San Francisco) was fascinated by this finding and asked a very important question: If a simple action like moving our hand is prepared for more than a half second in our brain, at what moment do we consciously decide to perform this action? Intuitively, we feel it is much less that a half second. If this is right, and the preparation of an action begins much earlier as the conscious decision to perform this action, can we have a free will then. What about the freedom of our will?

3.2 Libet's 1983 experiment

The first experiments to address the timing of decisions directly were conducted by Benjamin Libet and his colleagues.

> Libet et al. (1983): Time of conscious intention to act in relation to onset of cerebral activity (readiness potential): the unconscious initiation of a freely voluntary act. *Brain* 106, 623–642.

Their experiments asked questions about when people believed they made a decision versus when the brain began to make the decision. In one form of their experiment, they measured EEG activity while subjects voluntarily chose to lift a finger. During the task, subjects watched a rapidly



moving clock hand and made a mental note of when they decided to lift their finger.

This yielded three types of data:

(1) when the subject lifted her finger [electromyogram of the muscles]

(2) when she believed she decided to lift her finger [Wund's clock]

(3) what her brain activity was during this time. [EEG]

The EEG results demonstrated that the cortex became active with a ‘readiness potential’ 350 ms before the reported awareness of a ‘wish to move’. These experiments suggested that our subjective awareness of decisions occurs measurably later than the actual events of deciding

Conclusion

Our brain initiates a 'voluntionary act' unconsciously. Not a conscious decision but unconscious processes are at the beginning. This conclusions directly contradicts our (conscious) common sense: Consciousness is unfaithful. It

swindles people. Furthermore, from the voluntionary act to the action (lifting a finger) it takes about 200 ms (myogram of the muscles). Is this enough time for a conscious stop of the action?

3.3 Libet's conclusions concerning free will

- Actually, only 100 ms is available in which the conscious function might affect the final outcome of the volotional process (the primary motor cortex needs some time to the spinal motor nerve cells).
- Libet argues that this is enough time for stopping or voting the final progress of the volutional process. "Conscious-will could thus affect the outcome of the

volational process even though the latter was initiated by unconscious cerebral processes."

- Indirect evidence of a veto possibility: Subjects in Libet's experiment reported that a conscious wish appeared but that they suppressed or vetoed that. Libet could show that in such cases a large readiness potential proceeded the veto, signifying that the subject was indeed preparing the act, even thought the action was aborted by the subject.

- Does the conscious veto have a preceding unconscious origin? In this case we cannot consider the veto as action of free will. Libet proposes, instead, that the conscious veto may not require preceding unconscious processes. The conscious veto is a *control function* different from a conscious wish

to act. At the moment there is no experimental evidence against this possibility.

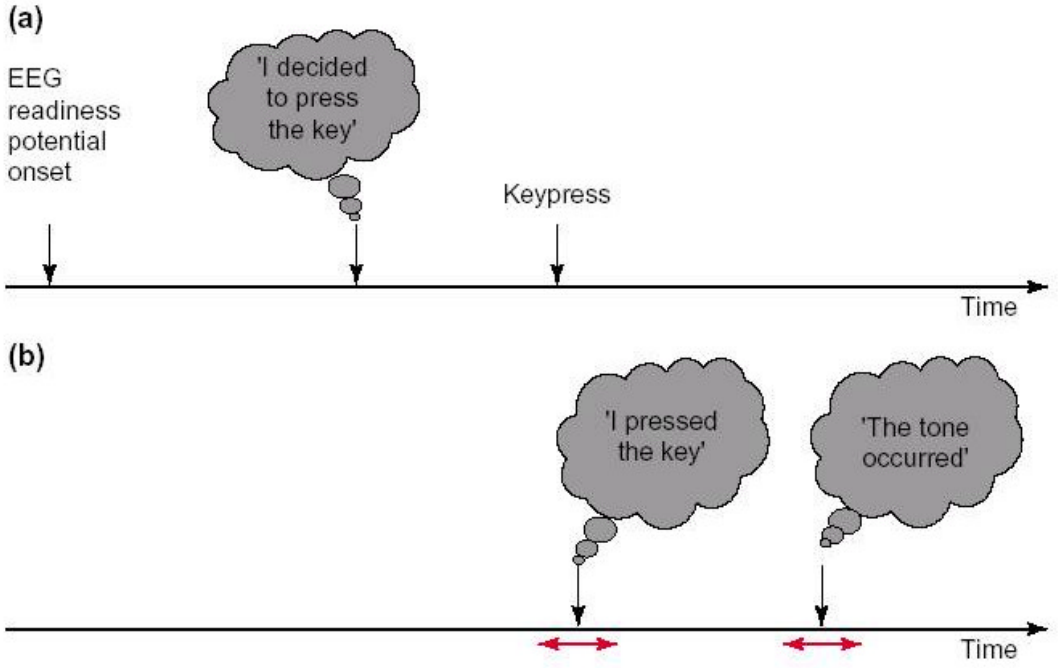
- Psychological implication: Consciousness is not a high level authority that gives orders to subordinated instances. Instead, its main role is a *selective* one: make a decision between the bulk of possibilities that are proposed by unconscious processes.

- Ethical implication: The role of conscious free will is not to initiate a voluntary act, but rather to control whether the act takes place. "This kind of role for free will is actually in accord with religious and ethical strictures. These commonly advocate that you 'control yourself'. Most of the Ten Commandments are 'do not' orders"

4 Causality and the perception of time

Libet investigated the relation between the felt time of conscious actions/events and the time course of brain activity (a). Another important question concerns the perception of events in time dependent on the real time course, for example the timing judgment of pressing a key and the (delayed) occurence of a tone (b).

An especially interesting question concerns the interaction of time and causality. What is the relation between time and causality?

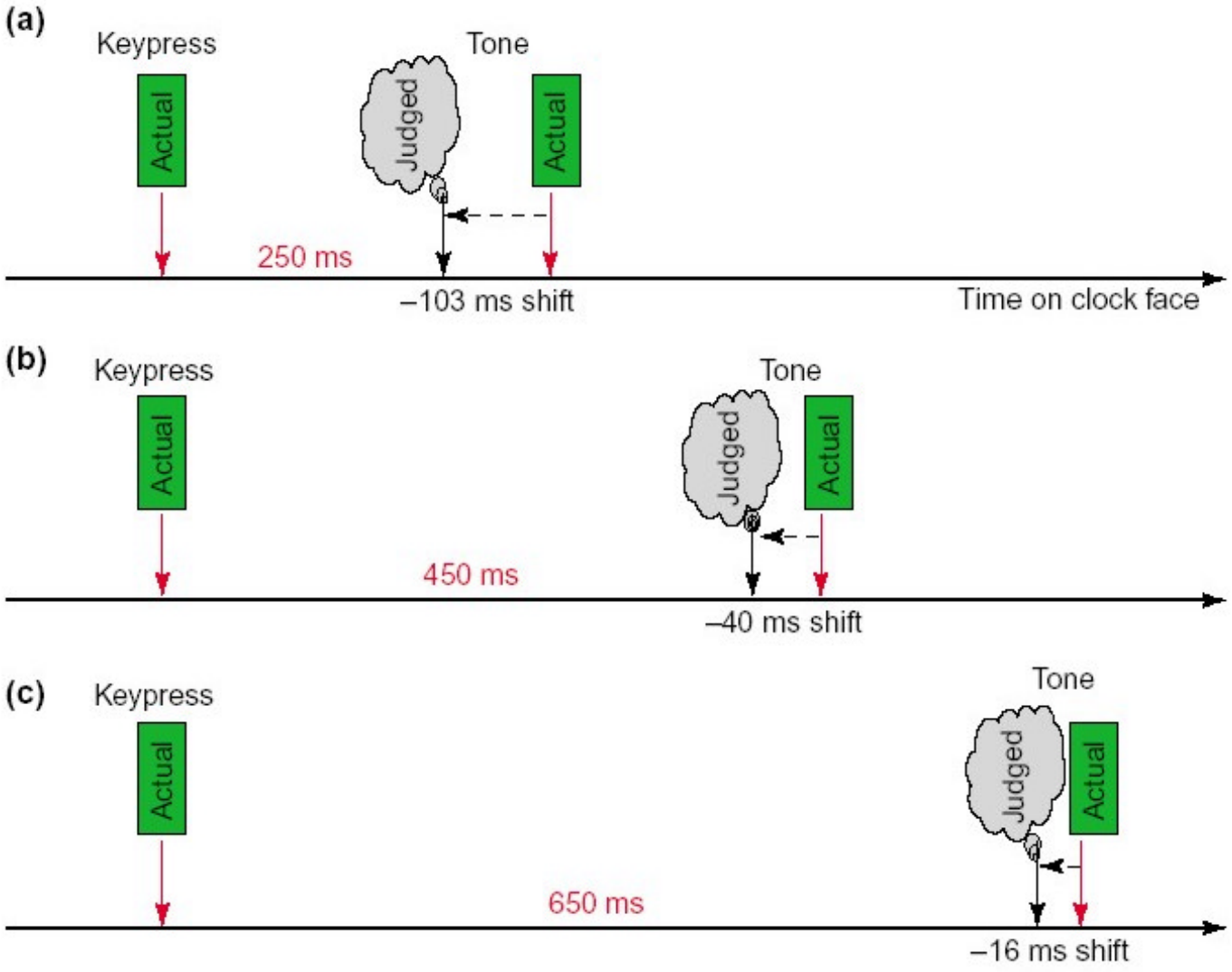


Does our perception of when an event occurs depend on whether we caused it? A recent study by Haggard, Clark and Kalogeras (2002) suggests that when we perceive our actions to cause an event, it seems to occur earlier than if we did not cause it (cf. David M. Eagleman and Alex O. Holcombe, in the reader)

In one condition, subjects judged the timing of an auditory tone by reporting the corresonding position of a rapidly moving clock hand. In the second, crucial condition, subjects pressed a key that caused a tone to follow 250 ms later. Again, subjects judged the time of the tone. Comparing the data across conditions, the perceived times of the tone when keypress and ton were causally linked were compared with the conditions in which the ton occurred by itself. Remarkably, when the tone was causally linked to the subjects' keypress, subjects judged the tone

to occur 46 ms earlier than if these events had occurred alone.

In a second experiment with different subjects, the delay between the keypress and subsequent tone was varied (to be 250, 450, or 650 ms), and subjects judged the time of the tone. Haggard et al. found that the further apart the keypress and tone, the more the temporal ‘attraction’ of the tone to the keypress was diminished (seeFigure).


(a)
Keypress
Tone
Actual
Judged
Actual
250 ms
–103 ms shift
Time on clock face
(b)
Keypress
Tone
Actual
Judged
Actual
450 ms
–40 ms shift
(c)
Keypress
Tone
Actual
Judged
Actual
650 ms
–16 ms shift

Conclusion

Tones perceived to be a consequence of one's actions seem to occur earlier in time than solitary tones. More generally, when we perceive our actions to cause an event, it seems to occur earlier than if we did not cause it.

Eagleman & Holcombe's explanation

The philosopher David Hume pointed out that events that are close together in space and time are more likely than spatiotemporally distant events to be perceived as causally related. With certain assumptions about the prior probabilities, it follows from ***Bayes' equation*** that events known to be causally related are more likely to be close in time and space than unrelated events.

P(Cause (e1, e2) | CloseTime(e1, e2)) >

P(Cause (e1, e2) | DistantTime(e1, e2))

==> (with certain assumptions about the prior probabilities)

P(CloseTime(e1, e2) | Cause (e1, e2)) >

P(DistantTime(e1, e2) | Cause (e1, e2))

5 The hard problem of consciousness (according to Chalmers)

- Against reductionism: The tools of neuroscience cannot provide a full account of conscious experience, although they have much to offer.

- Against mysterianism: Consciousness might be explained by a new kind of theory. The full details of such a theory are still out of reach, but careful reasoning and some educated inferences can reveal something of its general nature.

'Easy' problems

- How can a human subject discriminate sensory stimuli and react to them appropriately?
- How does the brain integrate information from many different sources and use this information to control behavior?
- How is it that subjects can verbalize their internal states?
- etc., etc.

"Although all these questions are associated with consciousness, they all concern the objective mechanisms of the cognitive system. Consequently, we have every reason to expect that continued work in cognitive psychology and neuroscience will answer them." (Chalmers 1995)

The 'hard' problem

How physical processes in the brain give rise to subjective experience? Subjective experience involves the inner aspect of thought and perception: the way things feel for the subject.

Chalmers discusses an isolated neuroscientist in a black-and-white room who knows everything about how the brain processes colors but does not know what it is like to see them. This scenario suggests that knowledge of the brain does not yield complete knowledge of conscious experience. Instead of calling it a *hard problem* others have called it an *explanatory gap*.

According to Francis Crick and Christof Koch the hard problem can be broken down into several subproblems, for instance:

- What leads to a particular conscious experience (such as the blueness of blue)?

- Why are some aspects of subjective experience impossible to convey to other people (in other words, why are they private)?

The explanatory gap

"For no matter how deeply we probe into the physical structure of neurons and the chemical transactions which occur when they fire, no matter how much objective information we come to acquire, we still seem to be left with something that we cannot explain, namely, why and how such-and-such objective, physical changes, whatever they might be, generate so-and-so subjective feeling, or any subjective feeling at all. This is the famous "explanatory gap" for qualia (Levine 1983)." (Tye 1997)

There are many different positions with regard to the explanatory gap / hard problem:

- There is a corresponding gap in the world. If existing fundamental theories cannot explain subjective experience, then something new is required. Experiences and feelings have irreducibly subjective, non-physical qualities. (e.g. Chalmers; see the Online Reader).

  "A complete theory will have two components: physical laws, telling us about the behavior of physical systems from the infinitesimal to the cosmological, and what we might call psychophysical laws, telling us how some of those systems are associated with conscious experience. These two components will constitute a true theory of everything." (Chalmers 1995)

- The existence of the gap does not detract from a purely physicalist view of experiences and feelings. Some physical qualities or states are irreducibly subjective entities (Searle 1992).

- The explanatory gap may one day be bridged but we currently lack the concepts to bring the subjective and objective perspectives together. On this view, it may turn out that qualia are physical, but we currently have no clear conception as to how they could be (Nagel 1974).

- The explanatory gap is, in principle, bridgeable but not by us or by any creatures like us. It is just that with the concepts we have and the concepts we are capable of forming, we are cognitively closed to a full, bridging explanation by the very structure of our minds (McGinn 1991).

- There is a real, unbridgeable gap, but it has no consequences for the nature of consciousness and physicalist or functionalist theories thereof. There is nothing in the gap that should lead us to any bifurcation in the world between experiences and feelings on the one hand and physical or functional phenomena on the other. There aren't two sorts of natural phenomena: the irreducibly subjective and the objective. The explanatory gap derives from the special character of *phenomenal* concepts. These

concepts mislead us into thinking that the gap is deeper and more troublesome than it really is. Phenomenal concepts are very special, first-person concepts different in kind from all others (Tye 1999, in the Reader)

==> There is no general agreement on how the gap is generated and what it shows.