Lord Byron in Albanian Dress
Thomas Phillips, 1813

Thought and Will

That man of loneliness and mystery,
Scarce seen to smile, and seldom heard to sigh—
Whose name appals the fiercest of his crew,
And tints each swarthy cheek with sallower hue;
Still sways their souls with that commanding art
That dazzles—leads—yet chills the vulgar heart.
What is that spell, that thus his lawless train
Confess and envy—yet oppose in vain?
What should it be, that thus their faith can bind?
The power of Thought—the magic of the Mind!

Lord Byron, *The Corsair*, 1814

This portrait shows Lord Byron – willful free thinker. In the words of Caroline Lamb, "mad, bad and dangerous to know." He is dressed in Albanian robes.

Later he travelled to Greece to fight for that country's freedom from the Ottoman Empire. He died there in 1824. The quotation is from a poem about a charismatic pirate leader:

> What should it be, that thus their faith can bind?
> The power of Thought—the magic of the Mind!

Brain and Mind: Course Outline

1. Introduction. Brain anatomy. Stroke. Neurons. Excitation. Action potentials. Synaptic transmission.. Body sensations. Braille.

2. Moving to the Music. Muscles. Stretch reflexes. Basal ganglia. Cerebellum. Parkinson's Disease. Balance. Hearing. Speech and music.

3. Sensation and Perception. Taste and smell. Hunger and satiety. Vision. Visual fields. Motion. Recognizing faces and objects. Illusions.

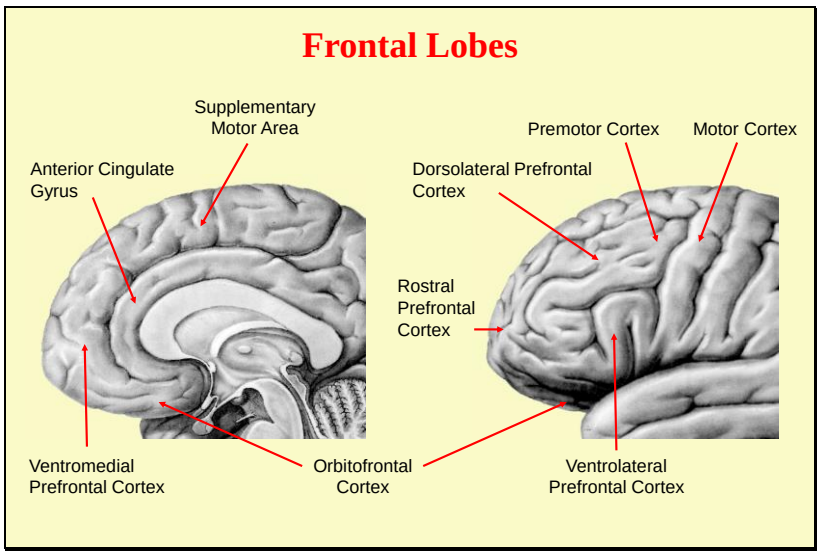
4. Consciousness. Sleep, meditation, coma, epilepsy. Locked-in syndrome. Attention. Consciousness. Theory of mind. Split-brain studies – interpreter.

5. Learning and Memory. Synaptic changes. Motor skills. Priming. Episodic vs semantic memory. Amnesia. Alzheimer's Disease.

6. Language and Emotion. Language. Humans vs chimps. Aphasia. Dyslexia. Basic emotions. Autonomic Nervous System. Love and Hate. Music.

7. Thought and Will. Executive functions. Psychopathy. Brain networks (attention and default). Determinism. Free will.

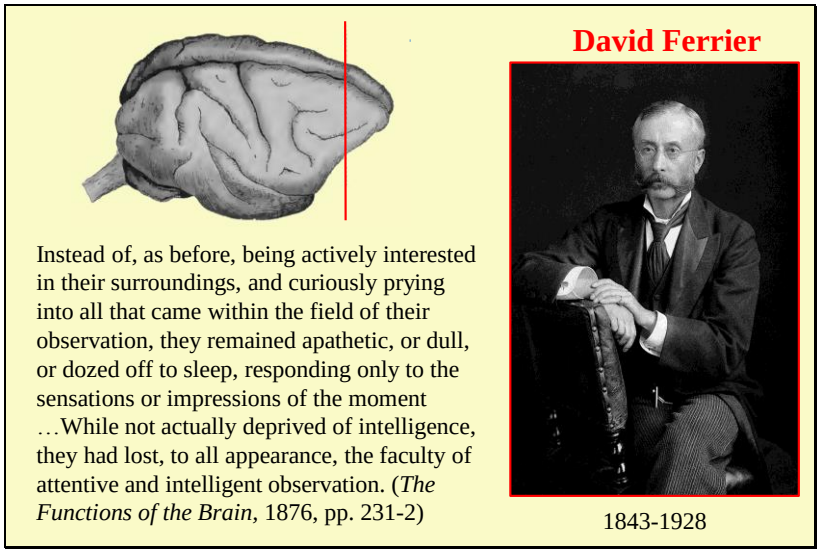
8. Madness and Wisdom. Psychiatric diagnosis. Anxiety. Schizophrenia. Depression. Addiction. Maturation of brain. Mental speed. Ageing. Wisdom.



The frontal lobes function as the drivers of our thought and initiators of our will.
There are many different regions in the frontal lobes and each controls its own set of processes:

The anterior cingulate, supplementary and premotor areas motivate, initiate and organize motor responses.
Medial and orbitofrontal cortex deal with emotions and morality.
Ventrolateral cortex is involved in accessing semantic memory.
The frontal pole is concerned with self and others.

They all act together to get things done. Without the frontal lobes we would just react – we would not initiate anything.

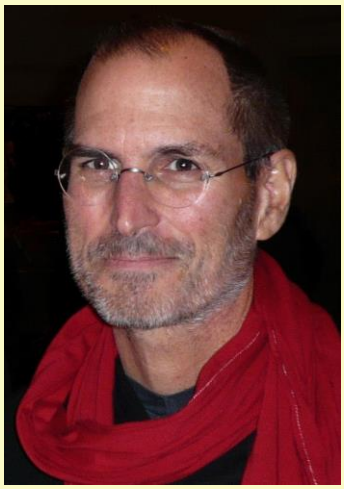


David Ferrier studied the effects of lesions to the anterior frontal lobes in dogs.

Frontal Lobe Functions

The prefrontal cortices, those regions of the brain anterior to the motor and premotor areas, are often considered the "executive" of the brain.

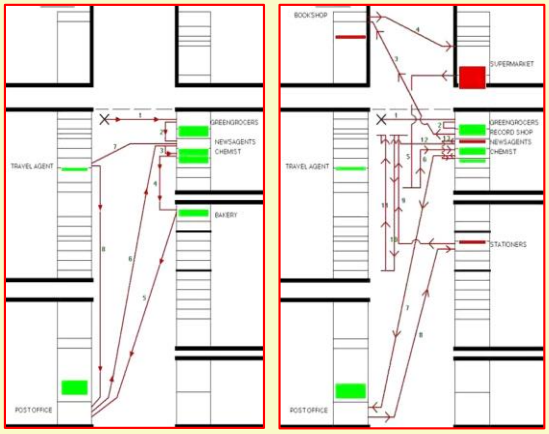
They are essential for ongoing **control** and **decision** processes. They channel our **motivations** into drives. They set **goals** and **monitor** whether these goals are being reached by present strategies. They make **inferences**, and **attend** to what is important. They consider the **future** implications of our actions. They maintain our **social** relations. They construct a **personality** and a life story.



Steve Jobs (1955-2011)

Without the anterior frontal regions we are like a business corporation without its CEO.
Lesions to these areas cause a loss of executive functions.
Steve Jobs was the quintessential CEO. Not someone to like but someone who could get things done.

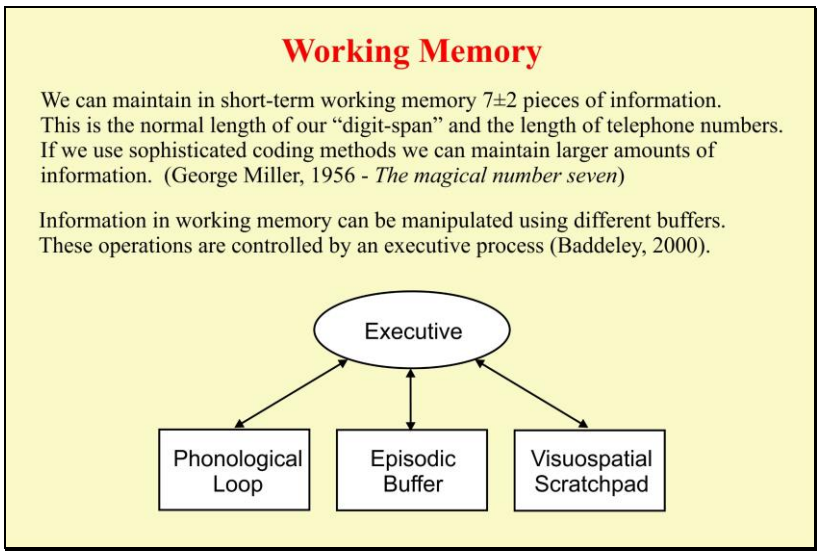
Planning/Strategy Deficits: Multiple Errands Test



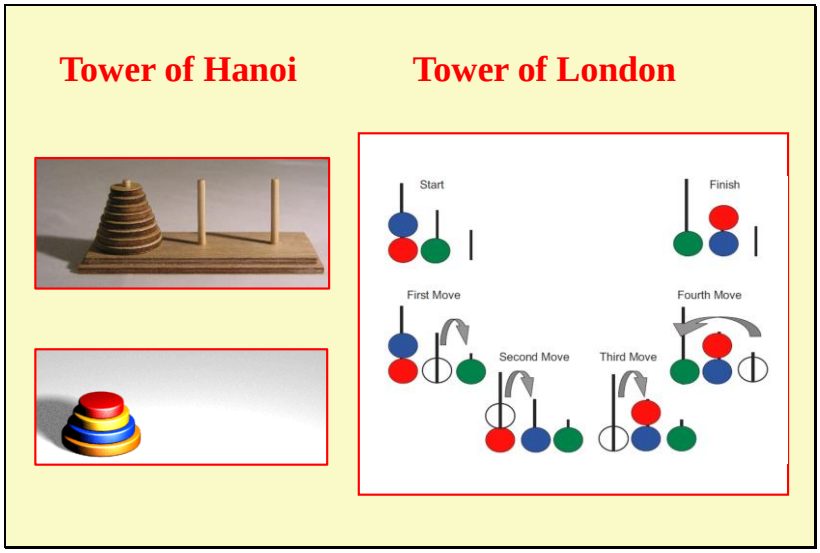
Normal Subject Frontal Damage

Patient must perform eleven tasks, such as buying a loaf of bread, buying a package of throat lozenges, finding out the exchange rate for the French franc, determining the price of a pound of tomatoes, etc., and then return to a particular place (e.g. post office) in 15 minutes.

Patients with lesions to the frontal lobes have difficulty setting up and following through on a strategy to get things done.
This can be tested in real life by giving the patient multiple errands to run. This was done by Tim Shallice and Paul Burgess in London. The maps shows an actual street in London where they sent the patients on their errands.
A patient with a frontal lesion forgets what he is supposed to be doing, back-tracks, goes to one place several times, etc.



This is a slide we have already seen – working memory.
Setting up strategies and figuring out what to do involves working memory. Although some of the buffers used to store information or programs are in sensory cortex, the executive that keeps them operating is mainly located in the dorsolateral frontal lobes.

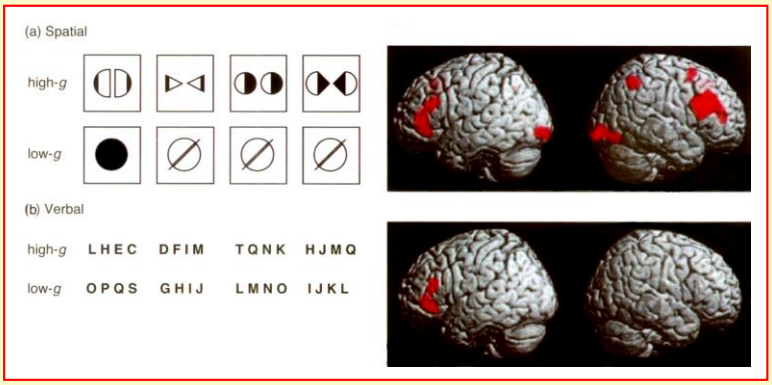


The Tower of Hanoi is a game that requires setting up strategies and keeping the goal in mind. The rules are that you must recreate the leftmost tower on the rightmost peg but you cannot put a larger disc on top of a smaller disc. Once you get more than 4 disks it becomes complicated.

Supposedly Indian priests in a faraway temple play out the game to make the universe conform to dharma.

Tim Shallice invented a variant – the Tower of London. The rules are simpler (you can only put so many beads on a rod) and the endpoint can be varied.

General Intelligence ('g' factor)



Blood flow in dorsolateral prefrontal cortex was higher during the difficult (high-g) task compared to the simple (low-g) task (Duncan, 2000).

The intelligence quotient can be examined using various tests. In these examples you have to choose the example that does not fit with the others.
In the spatial high g example the third diagram is odd – the two halves are not mirror images.
The verbal high-g is very difficult. The letters are separated by an increasing or decreasing number of other letters. Third is odd – separation is always 2.
One area of the brain that is active during all these tests is the dorsolateral prefrontal cortex. The activity increases as the test-question becomes harder.

Fractionation of Frontal Function

Rather than considering the prefrontal lobes as a general purpose computer that is used on demand for performing tasks, some scientists have proposed that different regions of the prefrontal cortex subserve different functions.

Don Stuss and his colleagues at the Baycrest Centre have identified three separate functions:

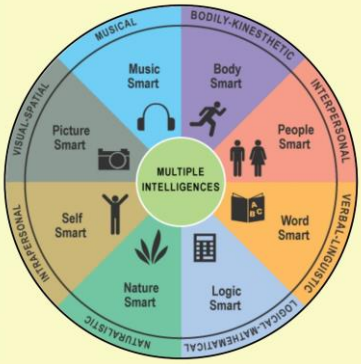
1. **Energization** – implemented by the medial frontal lobes
2. **Task setting** – disrupted by lesions to the left frontal cortex.
3. **Monitoring** – associated with the right inferior frontal lobe.

One simple task that can dissociate these function is **tapping** at a regular rate – once every 1.5 seconds.

Patients with medial lesions cannot maintain their timing – they start out well but then deteriorate. Patients with right frontal lesions are much more variable than either normal subjects or patients with other frontal lesions – they have difficulty monitoring their performance.

In the tapping task, you are given six timed tones to get you going.

Multiple Intelligences



In 1983, Howard Gardner in the book *Frames of Mind* argued for the existence of multiple intelligences, as opposed to a single general factor. He proposed that education should be adjusted to these innate abilities.

Most psychometricians and psychologists do not agree with this fractionation of intelligence, and it has no clear experimental support.

However, it has intuitive appeal – we all know people who are talented in one particular way. Whether these differences come from innate abilities or learning remains unknown.

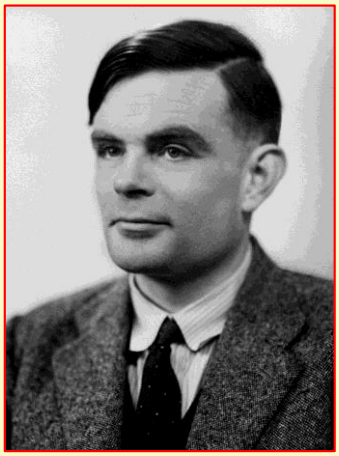
Howard Gardner has suggested that there are multiple intelligences.
The general factor may be related to the dorsolateral prefrontal cortex, and the different types of intelligence may be related to how that region interacts with other more specialized regions of cortex.

Artificial Intelligence

In 1950, Turing suggested that computers would soon intelligent behavior. He proposed a test: a human interrogator (or jury) would not be able to distinguish the computer from another human being, after a brief conversation.

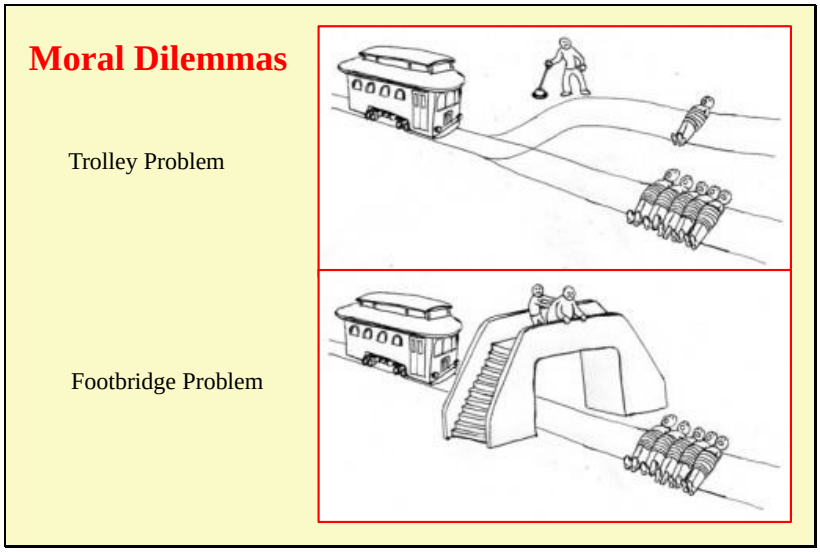
In 1991, Hugh Loebner, an American inventor, established prizes for the first computers to pass the Turing test. None has yet won the silver (text only) or gold (audio and visual) prize.

Many computers now use programs based on neural principles (neural nets) to perform intelligently.



Alan Turing (1912-1954)

Computers can do many things much better than human beings.
However, they cannot yet act sufficiently like a human being that we cannot recognize the difference.



One of the major difference between human beings and present-day computers is morality – human beings consider what they should or should not do. They evaluate what "ought" to be done as well as what "is."

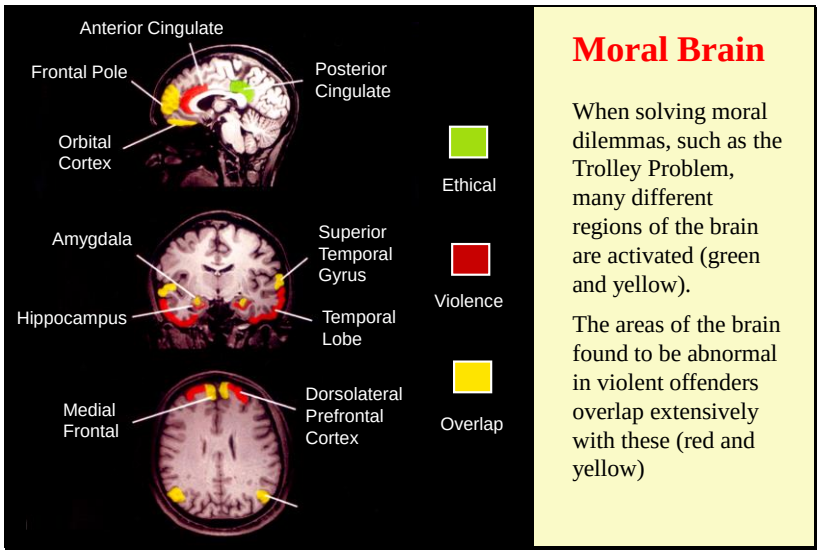
Several hypothetical problems have been used to evaluate what happens in the brain when one makes moral decisions:

In the trolley problem, most people would change the switch so that one person rather than five are killed by the runaway trolley.

However, most people would not push the fat man off the footbridge to derail the trolley and accomplish the same end-result.

And if the switch problem is recast as the transplant surgeon who wishes to take five different organs from a single healthy person to save the lives of five separate patients (each with a single-organ failure), no one would agree.

Figuring out what to do in these situations involves activity in many regions of the brain – particularly the anterior frontal lobes and the amygdala.



Moral Brain

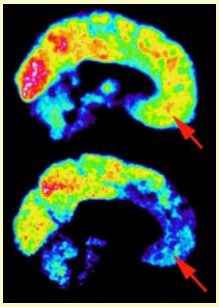
When solving moral dilemmas, such as the Trolley Problem, many different regions of the brain are activated (green and yellow).

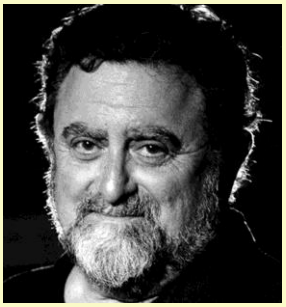
The areas of the brain found to be abnormal in violent offenders overlap extensively with these (red and yellow)

The areas used to figure out moral problems in normal brains overlap extensively with the areas that are abnormal in violent offenders.

Psychopathy

Superficial charm
Grandiosity
Pathological lying
Lack of remorse or guilt
Lack of empathy
Irresponsible
Impulsive, fearless
Sensation-seeking
Promiscuous





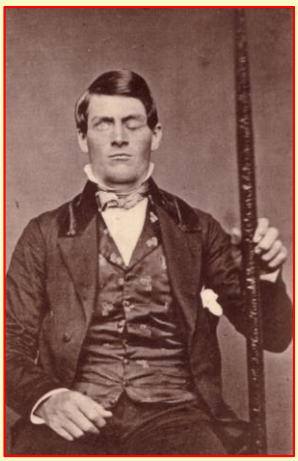
Most patients with Antisocial Personality Disorder show abnormalities in the **orbitofrontal cortex**, the **amygdala** and the **superior temporal gyrus**. There is also evidence that the brain's **serotonin** system is abnormal, perhaps because of a genetic defect in the enzyme that metabolizes this transmitter. Some normal people may show many of the syndrome's characteristics, and be quite successful – James Fallon is Professor of Anatomy at UC Irvine.

As we have seen, the orbitofrontal regions of the frontal cortex are involved in emotions and morality.
Psychopaths often show abnormalities in these areas.
The upper scan is from a normal subject and the lower scan is from James Fallon. He found out that his own scan was indistinguishable from scans of patients with antisocial personality disorder. He wrote a book about this in 2013 – *The Psychopath Inside.* He has also given TED talks on these ideas.
Several people have suggested that the psychopathic trait may help one succeed in competitive professions – running Apple, teaching anatomy. Provided it is properly controlled.

The Myth of Phineas Gage

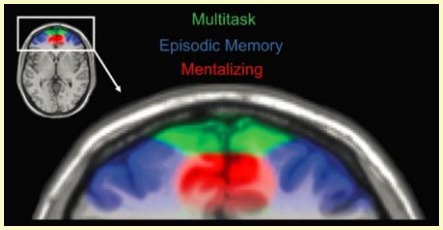
In 1848, Phineas Gage, a foreman on a railway construction gang, inserted gunpowder and fuse into a drill hole, probably forgot to use some covering sand, and then tamped the gunpowder with a metal rod. The powder exploded sending the tamping iron through his skull. After prolonged treatment by Dr. John Harlow, he appeared "quite recovered"

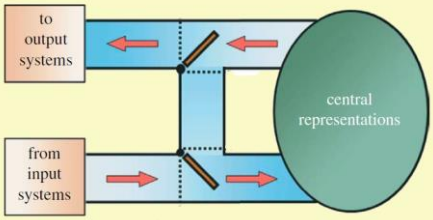
Harlow's 1868 report, suggested that the accident had drastically changed his personality – he was "no longer Gage." However, recent research has found that he was a conscientious worker until his death.



Phineas P. Gage (1823-1860)

Phineas Gage is probably the second most famous patient in the history of neuropsychology (HM being the most famous)
Most studies have suggested that his brain damage indicated how the frontal lobes were involved in personality.
However, recent evidence has suggested that he actually did not change that much. His history therefore indicates the resilience of the brain (or the person) rather than its weakness.





Frontal Poles

Paul Burgess has proposed that the rostral prefrontal cortex switches the focus of attention to either internal (stimulus-independent) or external (stimulus-oriented) information.

This area is active during multitasking, episodic memory, and mentalizing (theory of mind).

One important type of multitasking is prospective memory

Remember how we discussed the theory of mind in the session on consciousness. Areas of the anterior frontal lobe were involved when thinking about the self or about the minds of others ("mentalizing" in this diagram).
Thinking about the self is a stimulus-independent process.

Prospective memory is remembering to do something in the future. This is something that we have trouble with as we grow older.
It is probably similar to doing multiple tasks at the same time. While we are doing other things we must maintain in working memory an idea of what we have to do later.

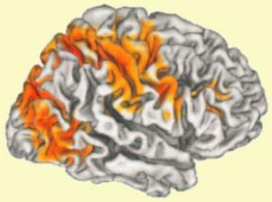
Attention Networks

Lesion studies have shown that

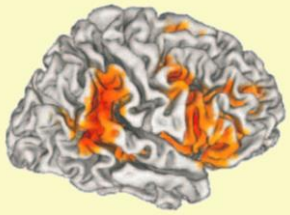
(i) the right parietal area is important for the spatial allocation of attention.
(ii) The anterior frontal lobes are essential to energization, task-setting and monitoring.

Blood flow studies (right) have identified two different networks that are active during attention – one goal-directed and one stimulus-oriented (Corbetta and Shulman, 2002)

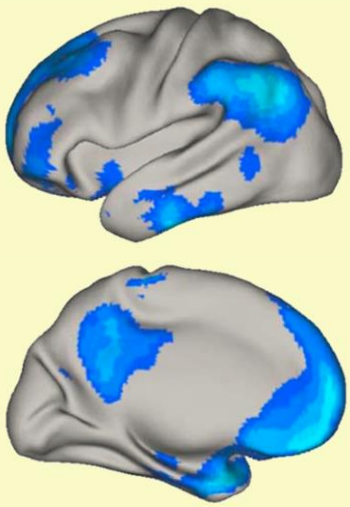
Dorsal Attention System (Goal-Driven)



Ventral Attention System (Stimulus Driven)



Attention is one of the major functions of the frontal lobe.
However attention is not localized in the frontal regions. Rather it involves interactions with other areas of the brain, most importantly the right parietal region which controls the spatial allocation of attention.
Two different attention-circuits occur – one directed to getting something done, and one directed to finding something out.



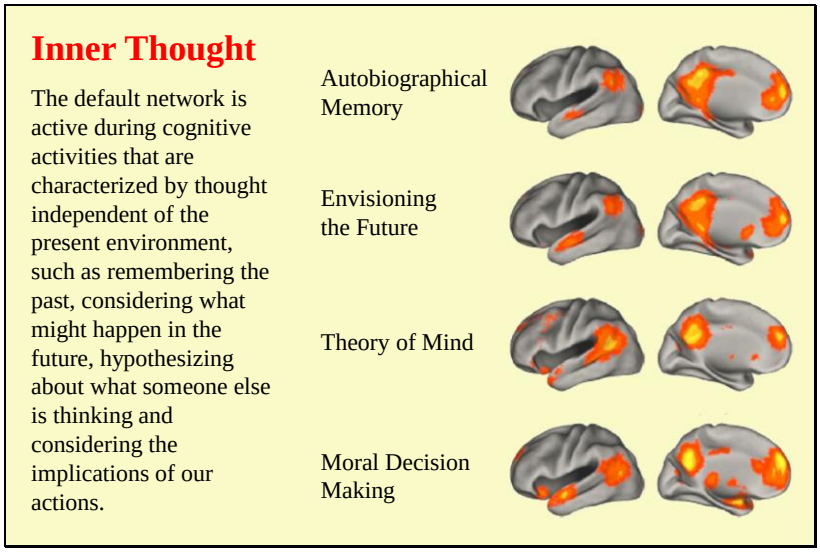
Default Network

Randy Buckner and his colleagues originally identified a set of brain regions that were active when the brain was at rest and deactivated during the performance of a specific task:

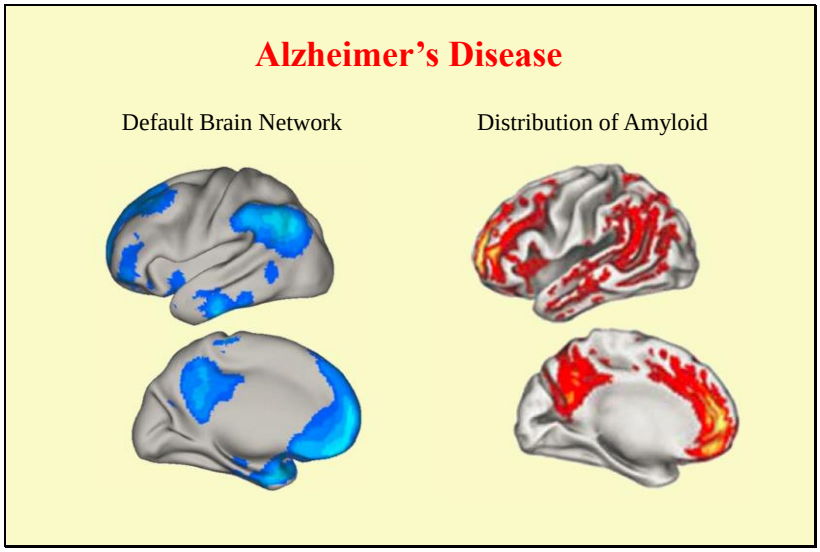
- Ventromedial prefrontal cortex
- Posterior cingulate
- Inferior parietal lobule
- Lateral temporal cortex
- Dorsomedial prefrontal cortex
- Hippocampus

These areas were also shown to be actively interconnected. They form one of the brains main networks.

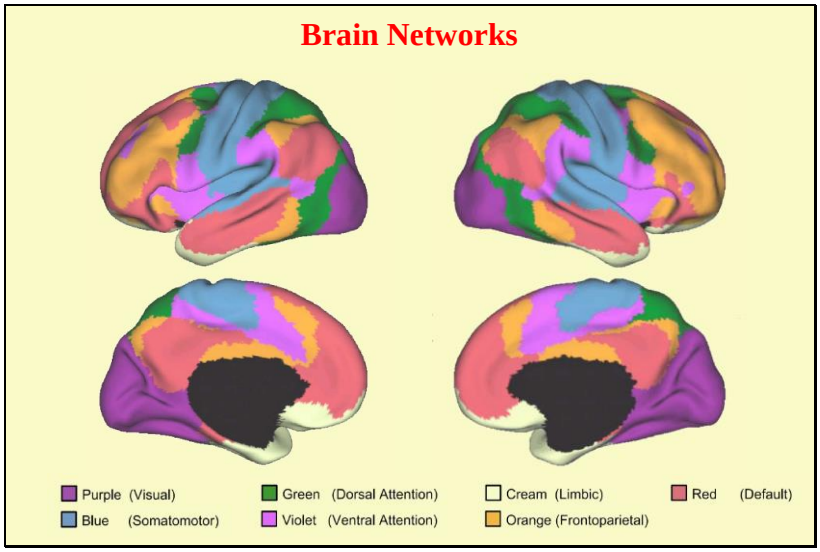
This is the brain during the state of mind that we often call “reverie” or daydreaming.



"Inner thought" of various kinds involves the default network – those areas of the brain that are active when we are not doing something else.



Interestingly, the distribution of amyloid deposits in Alzheimer's Disease is similar to the default network.
This is different from the distribution of neurofibrillary tangles, which are most prominent in the medial temporal regions.
Why is not known. Perhaps the default network is the most active of our brain networks.



Recent MRI studies of the brain have noted multiple different brain networks.
These may represent the different "modes" of thought. Sometimes we are seeing the world, sometimes operating our bodies, sometimes paying attention, sometimes remembering, sometimes planning, sometimes doing nothing.


Jackson Pollock, Convergence, 1952

This is one of Jackson Pollock's abstract paintings. Everything is related; everything overlaps; nothing is just in one place; nothing is simple. Like the networks of the human brain.

Paul-Émile Borduas, 1956,
Ouvertures Imprévues

Free Will

Physical Determinism
Neuro-Determinism
Imagined Future

What is thinking for if not for deciding what to do. And then doing it. The concept of such free will, however, is controversial. Some scientists have suggested that we do not really decide at all but that all our actions are determined by what has already occurred. They suggest that we have no free will.,

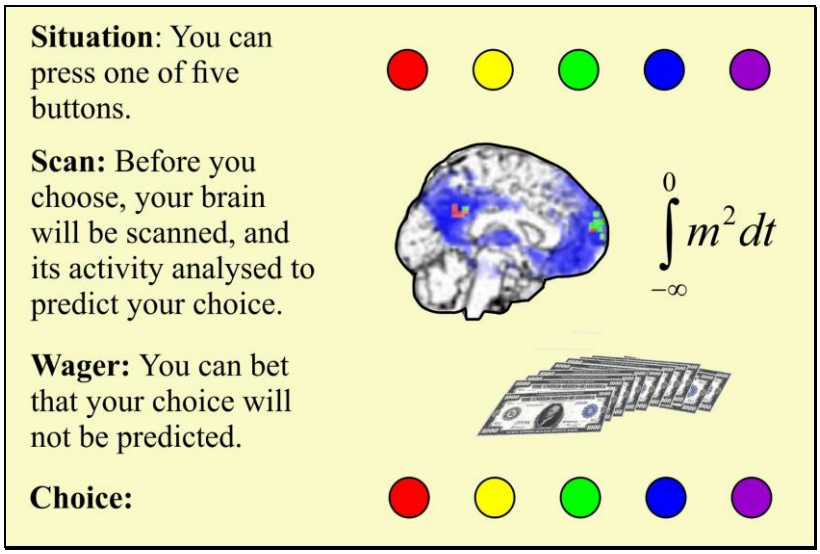
The painting is by the Québécois artist Paul-Emile Borduas. He was the author of a 1948 manifesto against the Quebec establishment called *Le Refus global* or *Total Refusal*. My talk will follow his cue. I refuse to accept the current view that everything we do is completely determined by the past, and that free will is therefore an illusion.

The painting is entitled *Unforeseen Openings*. Perhaps my presentation will show you some unexpected ways to look at free will.

A preview: I shall briefly review the idea of physical determinism and its limitations, discuss how complete determinism is incompatible with free will, consider some current ideas of how free will might be an illusion, and suggest how this is not the case

Since I am talking about a controversial subject, you should be aware of my conflicts of interest. Am I atheist or believer, optimist or pessimist, determinist or libertarian? I submit that "I am innocent."

Nevertheless, my presentation will be highly biased – it would not be interesting otherwise.



Imagine yourself 20 years from now. A brilliant cognitive neuroscientist claims to be able to read your brain and predict your future behavior. She studied with Sam Harris in Los Angeles and then completed her postdoctoral work with Chun Siong Soon and John-Dylan Haynes in Berlin. She knows her stuff and she uses the most advanced technology.

You will be able to press one of five buttons.

Before you do so, the neuroscientist will take a scan of your brain, analyse it and predict which button you will choose. She will pay particular attention to the posterior cingulate gyrus and the rostral prefrontal cortex. She is then willing to bet that her prediction will be correct.

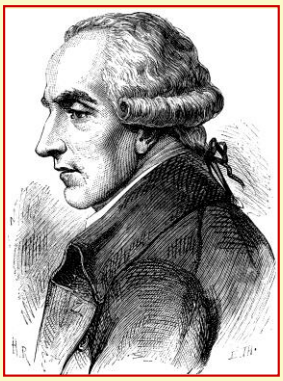
If you accept her bet and propose that she cannot predict your response, you believe in free will. If you do not, you are a determinist, or in this context a “neurodeterminist.” Neurodeterminists believe that their brain made them do it. – they are not responsible for their action

This is the wager. Faites vos jeux!

The Demon of Determinism

We ought then to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it – an intelligence sufficiently vast to submit these data to analysis – it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes.

A Philosophical Essay on Probabilities, 1812, translated by Truscott & Emory, 1902

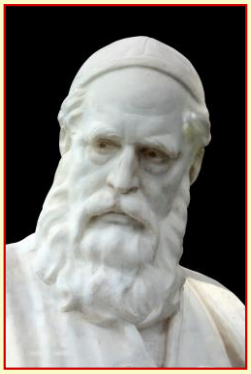


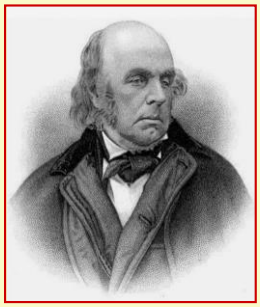
Pierre-Simon Laplace

Modern determinism was most clearly stated by Pierre-Simon Laplace. He proposed that an intelligence – whether God or Demon, whether real or hypothetical – could completely predict the future from the present if the intelligence knew all the "forces by which nature is animated" and could measure the exact "situation" of everything in the present universe.
Determinism is usually interpreted in terms of what will happen. However, it also casts its net backward: if we know everything about the present then we can tell exactly what happened in the past.
What is not always recognized is that Laplace wrote this definition of determinism in the introduction to his book on probability. Now, probability is what we use when we cannot predict exactly what will happen. A hypothetical vast intelligence might, but we cannot. We estimate the odds rather than predict the outcomes.

Fatalism

With earth′s first clay they did the last man knead,
And there of the last harvest sowed the seed.
And the first morning of creation wrote
What the last dawn of reckoning shall read.



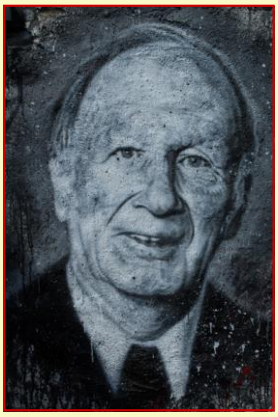


Rubaiyat of Omar Khayyam (1048-1131)
translated by Edward Fitzgerald (1859)
5th Version LXVIII

If the concept of determinism is taken seriously, then the present is determined by the immediate past, that past is itself determined by what preceded it, and so on. Ultimately, everything must

have been decided when the world began. All our present actions were determined 13.8 billion years ago at the moment of the Big Bang.

This idea is given poetic form in the Persian *Rubaiyat of Omar Khayyam,* translated by Edward Fitzgerald to become an essential part of the philosophy of Victorian England. We have two different ways to deal with this – we have no hope, or we must fulfil our destiny.



Edward Lorenz
by Thierry Ehrmann
Domaine de Chaos

Limits of Determinism

Determinism: If the present state and the laws governing how that state changes are known then the future is completely predictable.

Quantum Mechanics: The future is not precisely predictable from the present state but may be estimated in terms of probabilities.

Adequate Determinism: At macroscopic levels, quantum uncertainty plays no significant role in the prediction of the future.

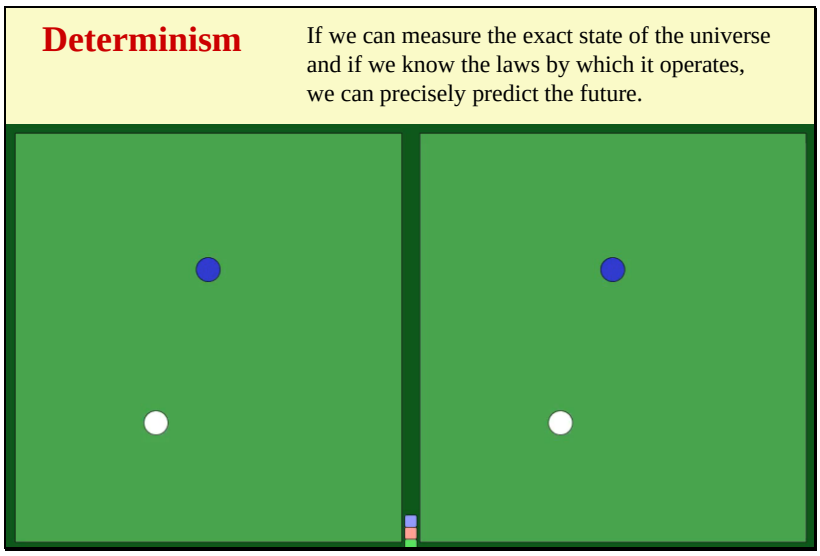
Chaos: When the present determines the future, but the approximate present does not approximately determine the future.

Determinism is a powerful working hypothesis but it may not be universally applicable. In the early 20th century, we became aware that atomic and sub-atomic processes are not deterministic. They follow rules, but these are expressed in terms of probabilities rather than certainties. Several recent formulations have attempted to explain free will in terms of this quantum uncertainty. Yet, chance is not the same as choice. If we make our decisions on the basis of random quantum events, we are just subject to the tyranny of the atom rather than the will of God.

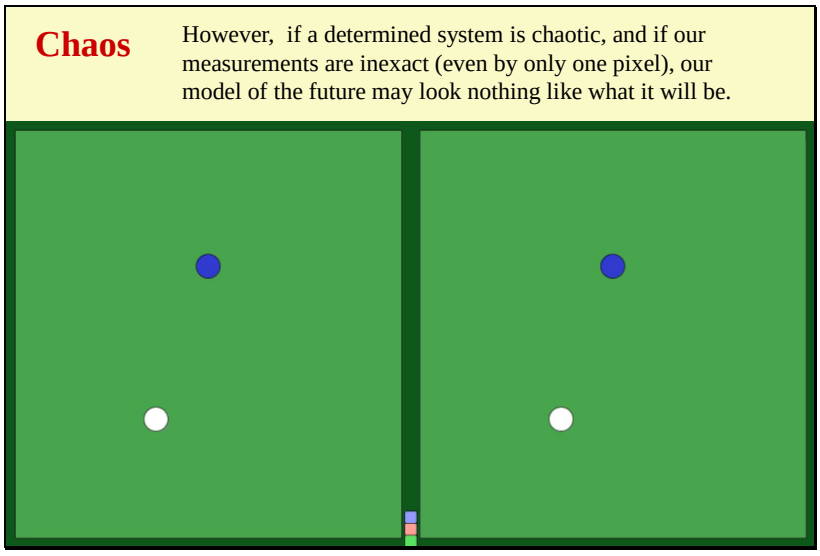
Most biologists consider that at the levels of chemistry and physiology, quantum uncertainty averages out and we are “for all intents and purposes” fully determined. [Physicists are sometimes less confident, recognizing that they know little about most of the universe – dark matter and dark energy.]

My suggestion is that the universe veers away from strict determinism at levels of extreme simplicity – quantum uncertainty – and also at levels of extreme complexity – conscious choice.

Sometimes, as Edward Lorenz, has shown, fully determined systems are liable to chaos. Chaos occurs when the present completely determines the future, but the approximate present does not approximately determine the future.



This slide provides an example of a typical deterministic system – billiard balls on a billiard table. If the rules by which the system operates and the positions and velocities of the balls are exactly known, the future of the system can be precisely predicted.
On the left is the actual system. It is not perfect – the table is frictionless and the balls are inelastic – there is only so much an old man can program – but it does follow deterministic laws. On the right is the modeled system. If we initiate movement in the white ball, our prediction fits exactly with what happens.



Some systems, however, are chaotic as well as being determined. In a chaotic system our predictions can be wildly off the mark if our measurement of the initial state of the system is not exact. Chaos is usually considered in terms of complex systems such as the weather. However, chaos also occurs in very simple systems, even in billiards.

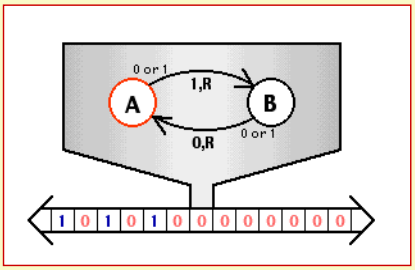
This example shows the same deterministic system on the left as in the previous slide. On the right is the prediction. This time the measurement of the initial position of the white ball was out by one pixel. The measurement of the velocity vector was exact.
At the very beginning the prediction will be approximately correct. After the first few seconds, however, the model will show no relationship whatsoever to the actual.
Chaos is an inherent part of physical determinism. It is therefore often impossible to measure the state of the world with sufficient accuracy to give meaningful predictions of what will actually occur.

Both movies are available at
http://creatureandcreator.ca/?p=806

Prediction and Computability

Predicting everything that will occur before it occurs would require a computer that is larger and/or faster than the universe.

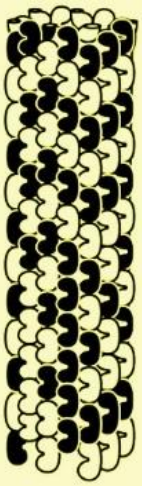
"Laplace was wrong to claim that even in a classical, non-chaotic universe the future can be unerringly predicted, given sufficient knowledge of the present." (Wolpert 2008: *Physical limits of inference*)



Prediction and Free Will:
Key factors in any test for free will would be the use of recursive reasoning (rather than flipping a coin) in coming to a decision, and the inability of the subject to predict what she or he will finally decide.

Even without chaos, complete predictability is impossible. The universe contains neither time nor space enough to map its own future. Laplace was wrong. The proof is related to Turing's Halting Problem.
A Turing machine reads an infinite tape one symbol at a time. According to its internal state at the time of reading, the machine then changes the symbol written on the tape, moves the tape, and changes its state. The Turing machine is a model of a computer. We cannot predict when the machine will stop. This is similar to our inability to know if a problem is soluble before it is solved.
David Wolpert's work means that "No matter what laws of physics govern a universe, there are inevitably facts about the universe that its inhabitants cannot learn by experiment or predict with a computation." (Collins, 2009). The most we can hope for is a "theory of almost everything" (Binder, 2008).
However, even though we cannot prove determinism, we cannot disprove it. It continues to be a reasonable working hypothesis for most situations
Lack of predictability is a characteristic of free will:
If you are in the process of deciding how to act and if you cannot predict how you will decide, you are in a state of free will.

Freedom and Chance



Indeterminism of quantum mechanics may just be a matter of our not yet knowing the actual deterministic rules that underlie sub-atomic processes – "superdeterminism."

Quantum uncertainty may provide a way for our behavior not to be fully determined by antecedent causes. We would need to imagine some way for unpredictable quantum events to change brain activity. The "Orchestrated Objective Reduction of Quantum States" in neuronal microtubules is one such hypothesis (Penrose and Hameroff, 2011).

Chance occurrences are by definition ones for which I can claim no responsibility. And if certain of my behaviors are truly the result of chance, they should be surprising *even to me* (Harris, 2012).

One way out of the problem that quantum uncertainty poses for determinism is to claim that yet-unknown deterministic laws underlie quantum events. Once we discover these laws we will be able to re-cast quantum mechanics so that all events are exactly rather than stochastically determined. The problem with such a "superdeterminism" is that we would have to observe the events at subquantal levels, and that would require using subquantal measuring devices, and that would run into Heisenberg's Uncertainty Principle. I think indeterminism is here to stay. However, I do not think that quantum uncertainty can explain free will, as proposed, for example, by Penrose and Hameroff. They suggested that quantum events in the neuronal microtubules could underlie our choices of one action over another. Making free will depend on quantum uncertainty is unsatisfying in that it reduces free will to chance rather than choice. Random is not the same as free. Even Sam Harris agrees.

Logical Problems of Free Will

Free will means that we are sometimes in the position with respect to a contemplated future act: that we are able either to perform the act or to do otherwise. The claim that we can choose between these two futures is incompatible with the idea that the past and the laws of nature together determine, at every moment, a unique future.

If our actions do not necessarily follow from our mental/cerebral states, i.e. our intentions, then we cannot decide to do one thing or another. Unless the world is deterministic, we cannot exercise free will.

Peter van Inwagen
by Francis Hills

Peter van Inwagen is one of the finest modern philosophers to consider free will. This slide summarizes two of his conclusions.

Freedom of the will is not possible if the world is completely determined. Free will occurs when we choose to act in one way when we could have acted otherwise. If we can indeed do otherwise – if two different futures can equally follow from the same present – then the future is not determined.

However, free will cannot exist without determinism. If we make a decision, we can only carry it out if our behavior is determined by that decision – if action potentials travel down the nerves to the muscles, if the muscles move the limbs, and if the limbs perform the intended physical acts. So we cannot have free will if the universe is completely determined, and free will is meaningless if the universe is not determined. The only way out in a completely determined universe is for free will to be an illusion.

However, van Inwagen concludes that free will is true and the world is not completely determined.

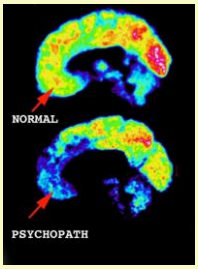
Absence of Free Will

If our actions are completely determined:

(i) There is no reason to spend any time deliberating how to act

(ii) We have no moral responsibility for our actions

(iii) Concepts of justice, reward, punishment and rehabilitation become irrational.



The less someone believes in free will, the more likely he or she will cheat if the opportunity presents, and the more likely she or he will indulge in anti-social acts if they will not be discovered (Vohs & Schooler, 2008; Baumeister et al., 2009).

Even if we are not free, should we act as if we were?

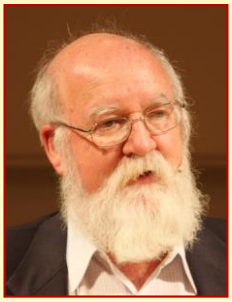
Van Inwagen believes in free will because he cannot imagine human life without personal responsibility. If there is no free will, everything we do is determined before we have anything to do with it. We need not think; we are never responsible for our actions; any idea of justice is meaningless. All evil will be exculpated by fMRI evidence that the brain was just unable to be good.

The world where people do not believe in free will is not pleasant. Simply suggesting to subjects that there is no free will encourages dishonesty and mischief.

So, even if we are not free, should we act as if we were? This is a strange way to live our lives.

Free Will and Determinism

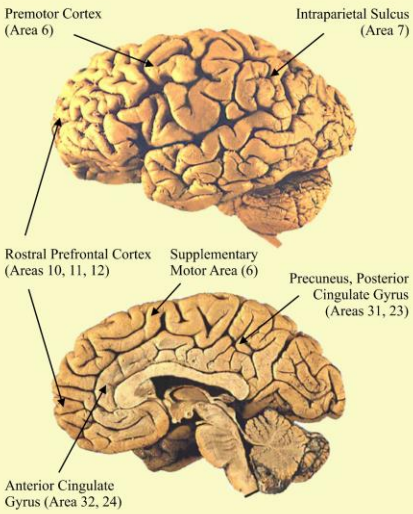
	Free Will Impossible	Free Will Possible
Determinism True	Determinism	Compatibilism
Determinism False	Nihilism	Libertarianism



Most of us are compatibilists: 75% of normal folk (Nahmias et al, 2005), 80% of biologists (Graffin & Provine, 2007), and 60% of philosophers (Bourget & Chalmers, 2014)

Our autonomy does not depend on anything like the miraculous suspension of causation but rather on the integrity of the processes of education and mutual sharing of knowledge. (**Dennett**, 2003).

We can take various positions in relation to the problem of free will and determinism. Van Inwagen's position is one of philosophical "libertarianism." This is not the same as political libertarianism, which disputes the laws of society rather than the laws of science.
Most of us believe that we have free will, but we are also convinced that the universe is determined. We are "compatibilists" – determinism is true but so is free will. We do not know how the two co-occur, but somehow they must.
Dan Dennett is the most prominent of our present compatibilists. But he is unclear about exactly how free will can exist in a world of causes.



Initiating an Act

Stimulus-evoked acts involve parietal cortex and the premotor and motor areas. The supplementary motor area (SMA) and the pre-SMA may be involved when there is a choice between responses.

Self-initiated acts involve the rostral prefrontal cortex, anterior cingulate, SMA, premotor and motor regions. Activity in medial parietal lobe and rostral prefrontal cortex may precede consciousness of volition.

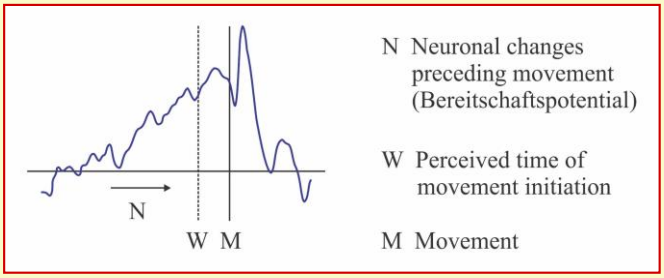
Multiple regions of the brain are involved in initiating an act. Every act involves a complex interaction between regions. The decision is not localized.

When the actions are in response to external stimuli the main areas involved are the Intraparietal Sulcus and the premotor areas of the frontal cortex. The supplementary motor area (SMA) and the pre-SMA may be involved when there is a choice between responses.

Self-initiated acts involve interactions between the rostral prefrontal cortex, anterior cingulate, SMA, premotor and motor regions. The anterior prefrontal region and its connections may be needed to consider plans of actions and to relate them to remembered information – what worked or did not work before. The anterior cingulate region and its connections may be necessary for motivation.

Activity in medial parietal lobe and rostral prefrontal cortex may precede consciousness of volition. Activity in these circuits may represent the subconscious biases that affect our behavior. The neuro-determinist proposes that these activities control how we respond. The neuro-compatiblist replies that these activities contribute to but do not necessarily control how we respond.

Neurodeterminism: Libet Experiments



Libet's EEG experiments (1982-85) have been replicated by Fried et al (2011) with frontal neurons, and by Soon et al (2008, 2013) with fMRI patterns

Problems of Libetarianism: what does the physiological activity preceding the action represent? and how is this related to the decision to act?

Neuroscience entered the philosophical arena in the early 1980s when Benjamin Libet evaluated the relations between volition and the readiness potential (or *Bereitschaftspotentia*l) recorded from the scalp. The readiness potential began up to a second before the movement but the subject consciously perceived the time of movement initiation at about 200 ms before the movement. Similar experiments have recorded unit activity in the human frontal cortex beginning about 2 seconds before the act (Fried et al.) and fMRI activation patterns (Haynes et al., Soon et al.) some 4-10 seconds prior to the act

These experiments have led to a theory of volition that has been called "neuro-determinism." Perhaps a better term might be "Libetarianism." Our actions are determined by cerebral processes of which we are unaware. We only become conscious of what we are doing just before we do it. We do not control our actions, we just watch them taking place.

The 200 ms between the awareness of response-initiation and its occurrence could make it possible to inhibit or "veto" a response in process. Thus we might be consoled with the idea that even if we don't have free will, we might have "free won't." Yet recent experiments have shown that even this might be unconsciously driven (Filevich et al., 2013).

One problem with the neural measurements is that we do not know what they represent. Many different cerebral processes contribute to the readiness potential – estimating time, preparing to respond, monitoring performance, etc. Some of these can be unconscious and can correlate significantly with later acts. Yet such processes do not necessarily cause the act – the mind can always change at the last minute (or millisecond).

Free Will as Illusion ("Willusionism")

Free will is an illusion. Our wills are simply not of our own making. Thoughts and intentions emerge from background causes of which we are unaware and over which we exert no conscious control. We do not have the freedom we think we have. (Harris, 2012)

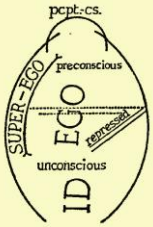
Farewell to the purpose-driven life. Whatever is in our brain driving our lives from cradle to grave, it is not purposes. But it does produce the powerful illusion of purposes (Rosenberg, 2011).

Because of these findings many scientists and philosophers have suggested that our idea of free will is illusory. Eddy Nahmias has suggested that we call this position "willusionism."
I submit that this idea is wrong – free will is not an illusion. Now, this is an illusion!

The argument that a particular experience is illusionary presupposes that other experiences are veridical. Indeed we only know that something is illusory if we can prove by some other experience that reality has been distorted.

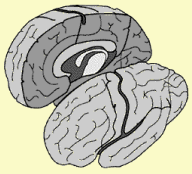
Despite the illusion of the tilting tiles in Richard Gregory's café-wall, we can prove with a sprit level that they are actually all horizontal.

The Rationalization of the Interpreter



… the large majority of mental processes in a normal person arise from sources unsuspected by him. … No one will admit that he ever deliberately performed an irrational act, and any act that might appear so is immediately justified by distorting the mental processes concerned and providing a false explanation that has a plausible ring of rationality (Jones, 1908).

It is the left hemisphere that engages in the human tendency to find order in chaos, that tries to fit everything into a story and put it into a context … even when it is sometimes detrimental to performance (Gazzaniga, 2011).



Those who have proposed that free will is an illusion point to clear evidence that we often do not know why we behave in a particular way. Psychoanalysis has long shown that we invent plausible but false reasons for how we act. This quotation is from Ernest Jones, one of Freud's early disciples. The psychoanalytic idea of rationalization has been supported by numerous recent psychological studies showing the effects of subliminal stimulation and the extent of our unconscious prejudices.

Michael Gazzaniga's studies of split-brain patients showed how the left hemisphere can invent plausible but totally inaccurate explanations for our actions. He suggests that the left-hemisphere language-system interprets our experience so that it makes sense. It tries to find order in chaos and to fit our experience into a meaningful story. Sometimes, however, the story is false.
So perhaps we are always wrong? I think not. Just like the argument from illusion, the argument from rationalization only works if we are sometimes right. We have to know the real explanation in order to show that our rationalization is false.

Nature of Free Will

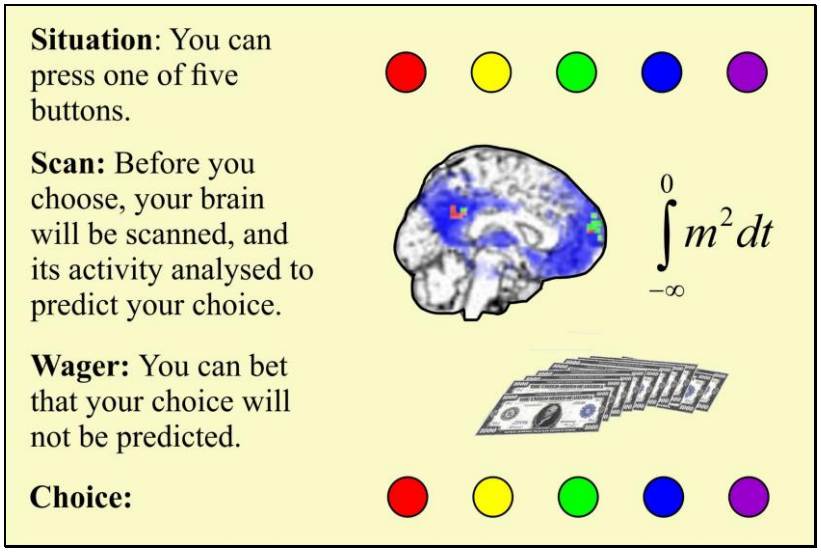
Only some of what we do is under conscious or controlled processing. Most of what we do occurs automatically. We are therefore often mistaken about why we acted in a particular way.

Nevertheless, we sometimes come to a decision about how to act by deliberately weighing the future consequences of several possible actions.

Such future-directed thought can have a top-down effect on the present. In particular, acts of free will can form a "self" that will then continue to act in a characteristic way, sometimes automatically and sometimes deliberately.

"Every undetermined self-forming choice is the initiation of a novel pathway into the future, whose justification lies in that future and is not fully explained by the past." (Kane, 2011)

Only a small part of what we do is under conscious or controlled processing. Most of what we do occurs automatically.
We are therefore often mistaken about why we acted in a particular way. We are not aware of causes outside of ourselves or hidden from conscious scrutiny, and we may invent reasons that are unrelated to what actually occurred, so that we can make sense of ourselves and our actions.
Nevertheless, we sometimes come to a decision about how to act by deliberately weighing the future consequences of several possible actions and choosing the most appropriate.
The future does not determine the present. That is not the way time flows. But the imagined future can determine the present.
Once a feedback loop is created, time and causality become complicated. In causal circles, causes need not precede their effects. Once we conceive of consequences, the future becomes part of the present and we can base our actions on how the future will (or should) be.
Such future-directed thought can have a top-down effect on the present. In particular, acts of free will can form a "self" – a set of predispositions to act in a characteristic way, sometimes automatically and sometimes deliberately.



And so we return to our hypothetical wager. Should we bet that our actions cannot be predicted? Will it be possible 20 years from now for a brilliant neuroscientist to predict our actions before they occur?
In the experiments of Eddy Nahmias and colleagues, subjects were asked about just such a scenario: a future neuroscientist reads the brain activity of a person called Jill and predicts what Jill will do. More than 80 % of subjects accepted that this will be possible, but still claimed that Jill has free will if she is acting according to her own reasons. They believe that "the brain scanner is simply detecting how free will works in the brain" (Nahmias, 2015).
The astute among you may wonder whether during the scan you could fervently and honestly intend to press the red button.
But then, once you have made your bet, on second thought you might wilfully decide to press one of the other buttons. After all, even at the last millisecond you can change your mind.

The concluding slide shows Borduas' *Black Star*. It was painted almost ten years after the *Total Refusal* manifesto and three years before Quebec's Quiet Revolution. Quebec society then became no longer determined by its past and began to look to the future.

I have considered physical determinism and pointed out its limitations in quantum uncertainty, chaos and incomputability. I have shown that complete determinism is in logical conflict with free will. I have reviewed some of the evidence that suggests that our unconscious brain determines what we might falsely believe to be our free choices. And I have refused to accept that evidence, arguing that we are still free when we base our actions on an evaluation of their consequences.

Determinism rules except at its limits. At the level of the atom there is quantum uncertainty. At the level of the brain there is conscious choice.

In our brains, most of what happens follows the laws of determinism, with the past causing the present and the present causing the future. Most of what we do is unconscious. Yet some acts are deliberately chosen after consideration of what will happen. These are as much determined by the imagined future as by the actual past. As such they are both determined and free.

The topic of free will is discussed in a posting on my website:
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