

**Determined
To Be Free**

Terence Picton

**Physical Determinism
Free Will
Neuro-Determinism
Imagined Future**

Paul-Émile Borduas, 1956,
Ouvertures Imprévues

Rotman Research
Institute Conference
March 11, 2015

Good afternoon. The meeting is winding down. Soon you will be free. A word or two before you go.

The painting is by the Québécois artist Paul-Émile **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 currently popular 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 talk might 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."

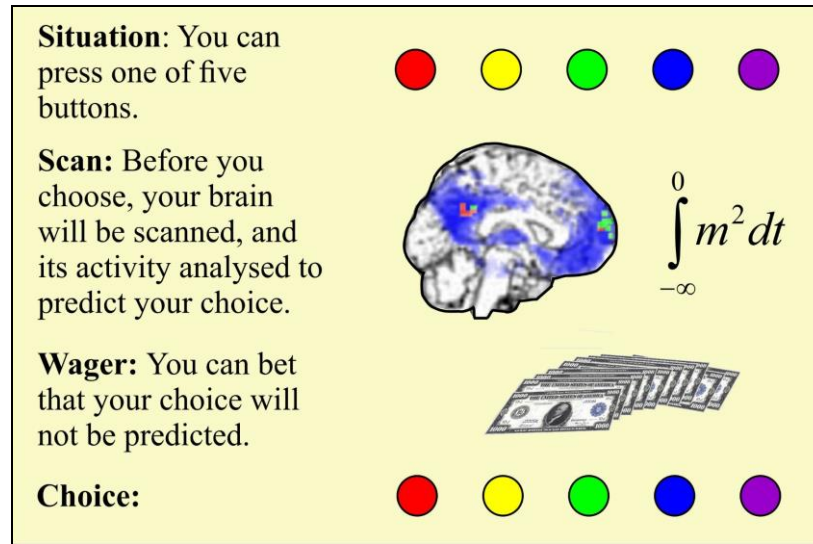
Nevertheless, my presentation will be highly **biased**. It would not be interesting otherwise.

Situation: You can press one of five buttons.

Scan: Before you choose, your brain will be scanned, and its activity analysed to predict your choice.

Wager: You can bet that your choice will not be predicted.

Choice:



The diagram illustrates a game with four stages: Situation, Scan, Wager, and Choice. At the top and bottom are two rows of five colored buttons: red, yellow, green, blue, and purple. In the center, a brain scan shows activity in the posterior cingulate gyrus and rostral prefrontal cortex. To the right of the brain is the mathematical expression $\int_{-\infty}^0 m^2 dt$. Below the brain is a stack of US dollar bills.

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 willing to bet that her prediction will be correct.

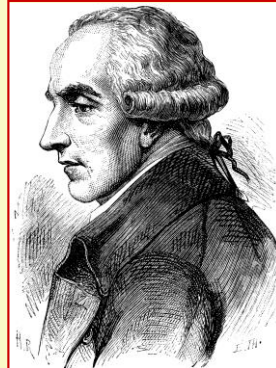
If you take the bet, you believe in free will. If you do not, you are a determinist – or in this context a **“neuro-determinist.”**

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.

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 actions determined 13.8 billion years ago at the moment of the **Big Bang**.



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.

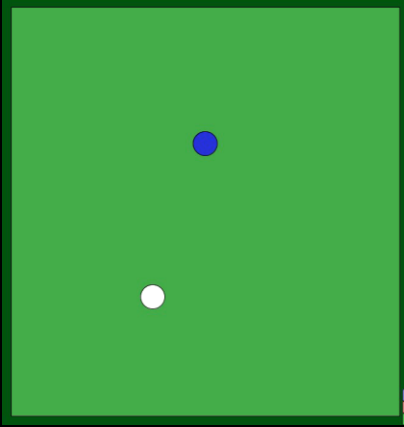
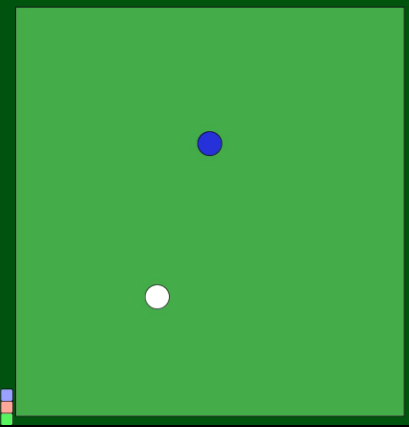
Determinism is a powerful **working hypothesis** but it may not be universally applicable. In the early 20th century, we became aware that atomic and sub-atomic processes are not deterministic. They follow rules, but these are expressed in terms of probabilities rather than certainties.

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.

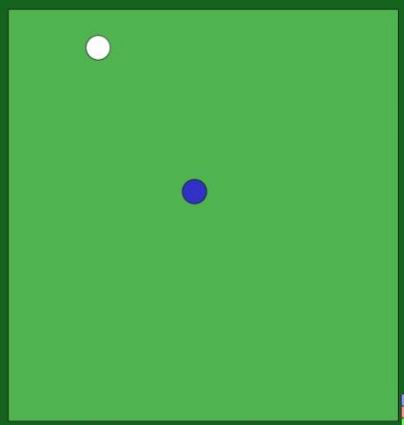
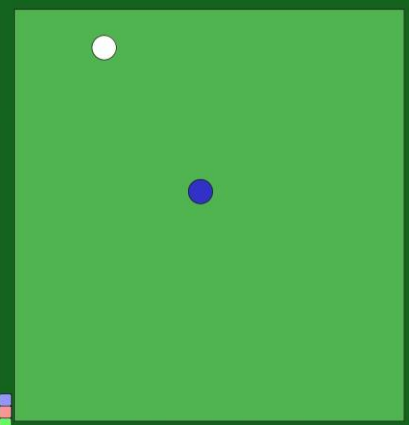
My suggestion, however, is that the universe veers away from strict determinism both at levels of extreme **simplicity** – quantum uncertainty – and at levels of extreme **complexity** – conscious choice.

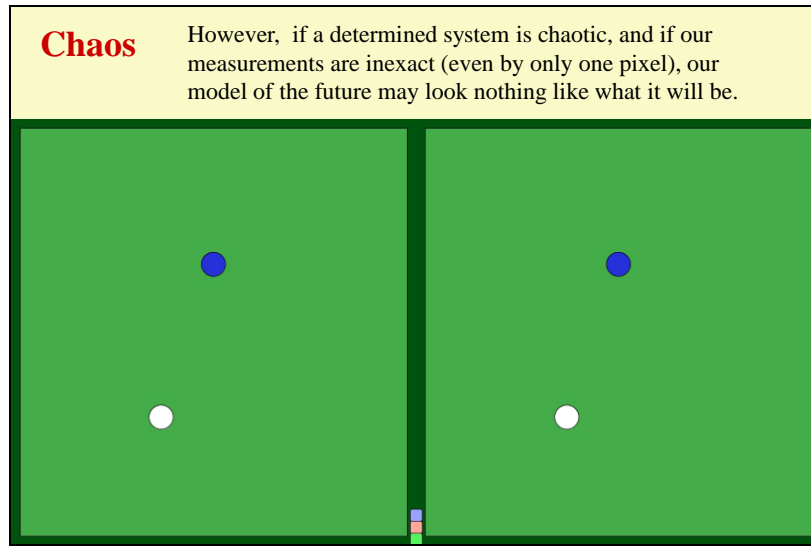
Sometimes, as Edward Lorenz has shown, fully determined systems are liable to **chaos**. Chaos occurs when the present completely determines the future, but the approximate present does not approximately determine the future.

Determinism	If we can measure the exact state of the universe and if we know the laws by which it operates, we can precisely predict 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.

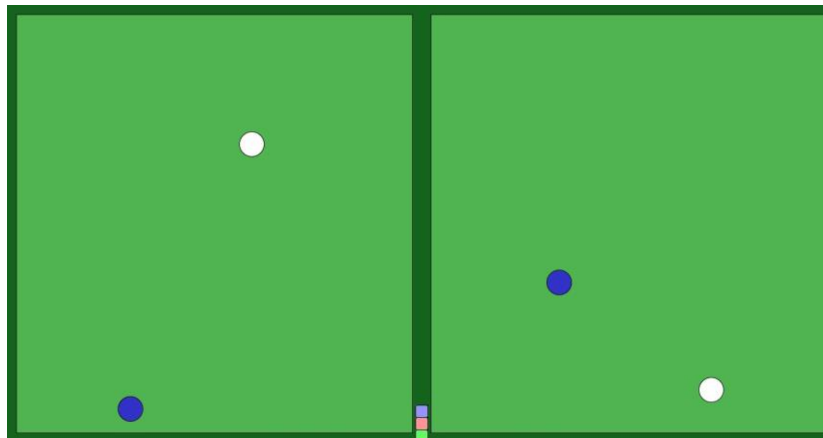
	
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Some determined systems, however, are **chaotic**. In a chaotic system our predictions can be wildly off the mark if our measurement of the initial state of the system is not exact. Chaos is usually considered in terms of complex systems such as the 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.

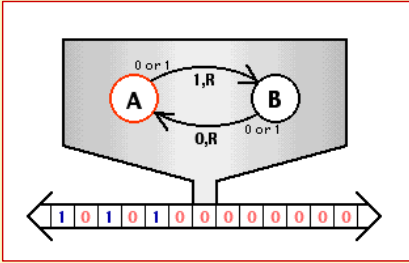


Chaos is an inherent part of physical determinism. It is therefore often impossible to measure the state of the world with sufficient accuracy to give **meaningful predictions** of what will actually occur. Our model of the future may look nothing like what it will be.

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*)



The diagram shows a Turing machine with two states, A and B, represented by circles. State A is on the left and state B is on the right. Transitions are labeled: from A to A (0 or 1), from A to B (1, R), from B to A (0, R), and from B to B (0 or 1). Below the machine is a tape with a sequence of symbols: 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0. The tape is bounded by arrows at both ends.

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 [Gödel's Incompleteness Theorem and] 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

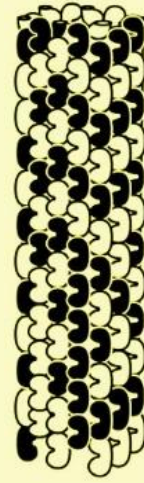
Lack of predictability is a characteristic of free will. If you are in the **process of deciding** how to act and if you cannot predict how you will decide, you are in a state of free will.

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 presents two of his conclusions, each as definite as his portrait.

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 can do 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.

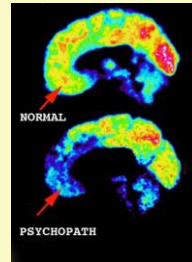
So we cannot have free will if the universe is completely determined, and free will is meaningless if the universe is not determined. The only way out in a completely determined universe is for free will to be an **illusion**.

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?

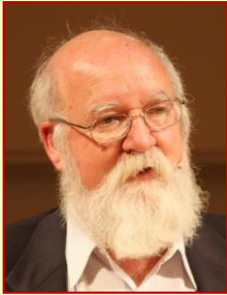
Van Inwagen believes in free will because he cannot imagine human life without **personal responsibility**. If there is no free will, everything we do is determined before we have anything to do with it. We need not think; we are never responsible for our actions; any idea of justice is meaningless.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

A 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



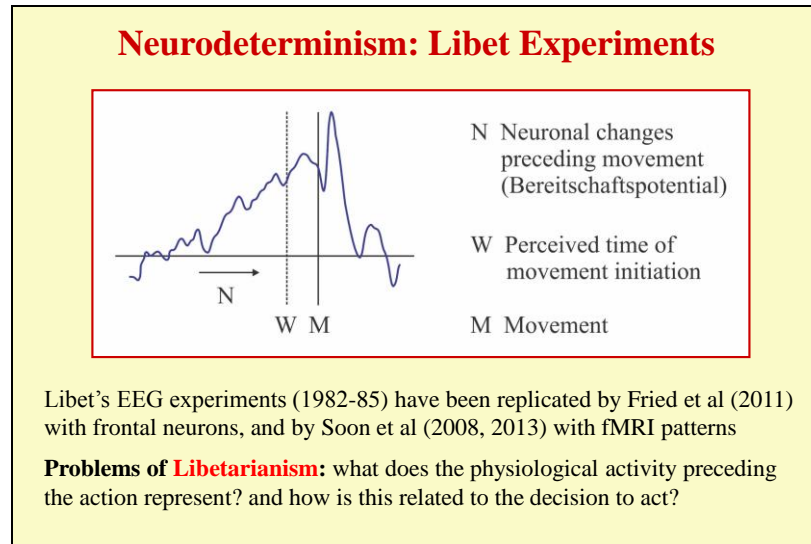
Most of us are compatibilists: 75% of normal folk (Nahmias et al, 2005), 80% of biologists (Graffin & Provine, 2007), and 60% of philosophers (Bourget & Chalmers, 2014)

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).

However, we can take positions other than that of full determinism in relation to the problem of free will. 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. [Something to do with human knowledge and communication.]



Neuroscience entered the philosophical arena in the early 1980s when Benjamin Libet evaluated the relations between volition and the readiness potential (or *Bereitschaftspotential*) 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. The brain decides unconsciously; awareness follows after.

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.) between 4 and 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 willy-nilly determined by cerebral processes about 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.

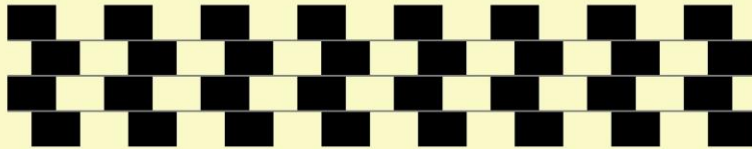
The 200 ms between the awareness of response-initiation and its occurrence could make it possible to inhibit or “veto” a response in process. Thus we can be consoled with the idea that even if we don’t have free will, we have “free won’t.” Yet recent experiments have shown that even this might be unconsciously 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 illusory 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 spirit level that they are actually all horizontal.

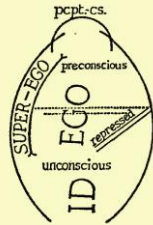
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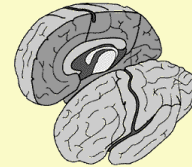


The Rationalization of the Interpreter



... 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 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.

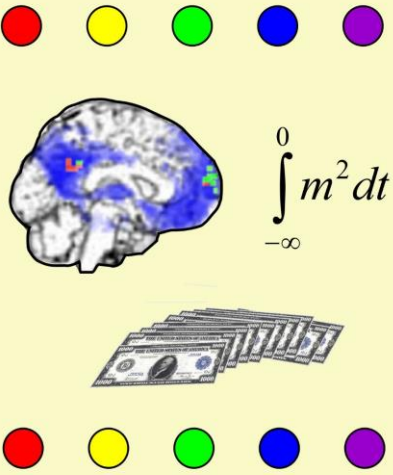
Such future-directed thought can have a top-down effect on the present. In particular, acts of free will can **form a “self”** – a set of predispositions to act in a characteristic way, sometimes automatically and sometimes deliberately.

Situation: You can press one of five buttons.

Scan: Before you choose, your brain will be scanned, and its activity analysed to predict your choice.

Wager: You can bet that your choice will not be predicted.

Choice:



The diagram features five colored circles (red, yellow, green, blue, purple) at the top and bottom. In the center, there is a brain scan with colored regions, a stack of money, and the mathematical expression $\int_{-\infty}^0 m^2 dt$.

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 whenever we base our actions on an **evaluation of their consequences**.

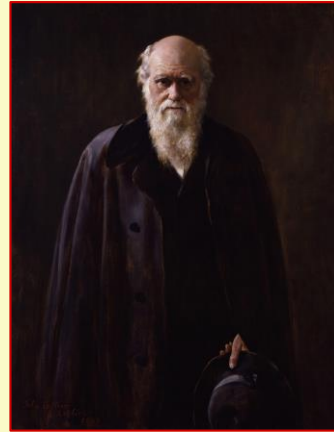
Determinism rules but only within **limits**. At the level of the atom there is quantum uncertainty. At the level of the brain there is conscious choice.

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 a conscious evaluation 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**.

Evolution and Free Will

“The general **delusion** about free will obvious – because man has power of action, & he can seldom analyse his motives (originally mostly **INSTINCTIVE**, & therefore now great effort of reason to discover them: this is important explanation) he thinks they have none.”
(from Darwin’s *Notebooks*).

Yet, evolution depends on two processes: the production of **offspring with variable characteristics** and the **selection** of those offspring that survive in a world of limited resources. The variation is largely a result of genetic mutations and these are caused by indeterministic quantum events.



Charles Darwin
by John Collier (1883)

Darwin thought that free will was a delusion. Since we are not conscious of the instincts that actually drive our actions, we only think that we freely choose. In fact we do not. Our behavior derives from an interaction between our genetic predispositions and the environment we live in.

Evolution is often considered as part of a general determinism. Selection occurs willy-nilly according to hard and fast rules. Yet indeterminism rests at the very heart of Darwin’s theory. Evolution depends on ...

Some people have likened **cognitive processing** to Darwinian evolution (e.g., Edelman, 1987). In evolution, various species are created and only the most adaptive are selected. In cognition, various possible actions are considered and only the most appropriate are selected.

A major problem is why evolution determined that consciousness occur. Human kind is certainly the most successful of all earth’s species. This would suggest that consciousness and free will are **highly adaptive traits** that have been selected to facilitate our survival. Evolution is a deterministic process. Yet by selecting out the fittest, evolution has led to consciousness. We have been **determined to be free**.