Free will unleashed

For decades science has told us that free will is an illusion. But now neuroscientist **Peter Ulric Tse** thinks he has identified the brain mechanism that lets us act of our own volition

FREE will. Philosophers tell us it is logically impossible. Neuroscientists argue that it is an illusion because they can predict which finger you will move before you are aware of willing to move. But I am convinced that a new understanding of how neurons "realise" information can reveal how free will works in the brain.

We have been thinking in the wrong way about how neurons encode and transmit information. The conventional view is that this neural code is based on neural firings called spikes. According to this view, the ability to turn thoughts into subsequent thinking and actions is the result of spikes cascading through neural circuits. This is not wrong. It just neglects half the story.

The missing piece is that neurons can rewire each other. Spikes don't just trigger subsequent spikes in other neurons. Within milliseconds, they can temporarily change the degree to which synapses – the nerve structures that pass signals to other neurons – trigger future spikes. This reweighting of a synapse is like changing the combination on a padlock without opening it, and can happen without necessarily triggering spikes immediately. I base this claim on research from the past decade showing that rapid bursts of spikes trigger the opening of specialised synaptic receptors, altering the responsiveness of neurons to subsequent spikes.

This means that a neuron could now be driven by an input that, moments before, might have contributed nothing to its firing. For example, a nerve cell that has just responded to a touch to your forehead could now respond to someone stroking your hand.

This rapid synaptic reweighting could potentially alter the connectivity of an entire circuit, defining new neuronal paths that signals can traverse. Just as railway switches must be flipped to allow trains to pass, synaptic weights must be reset before brain signals can follow one path through a neural circuit instead other possible paths. And if information is realised in the brain at the level of circuits, not just neurons, it is no wonder that listening to spikes in single neurons has not allowed us to crack the neural code.

What does this have to do with free will? Determinists argue that because all particles follow predetermined trajectories, all events, including our lives, unfold as inevitably as a movie. Indeterminists, supported by quantum mechanics, argue the opposite – that all events are random. In either case, whether predetermined or random, there is no room for free will to make events turn out otherwise.

PROFILE

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Future firing

There is, however, a middle path to freedom between these unfree extremes. If the brain sets up criteria for future firing, and if spike timing is made random by the amplification of quantum-level events in the synapse, it is down to chance how these criteria are met. The inputs that meet criteria cannot be predicted – the outcome depends on which spikes coincidentally arrive first.

How does chance interplay with these internal criteria in real life? If I ask you to think of a politician, your brain sets the appropriate criterion in neurons involved in retrieval of information held in your memory. Perhaps Margaret Thatcher comes to mind. If it were possible to rewind the universe, you might think of Barack Obama this time, because he also meets the criterion. This process is not utterly random, because the answer had to be a politician. However, it is also not deterministic, because it could have turned out otherwise.

Similarly, think about why you dated your partner rather than many possible other people. Because they met your criteria for a good mate first. Had you by chance turned left rather than right that day, you might now be with someone else who also met your criteria.

Factoring in rapid synaptic reweighting also gets around the argument that free will can't exist because of the impossibility of self-causation. The argument goes as follows: we act as we do at each moment because of how our brain is physically organised at that time. So because we are not ultimately responsible for the way we are organised then, we are not responsible for the consequences of that action. It had to happen as it did, otherwise a thought could change its own neuronal basis, which is impossible. But with synaptic reweighting, mental events don't change their present physical basis. They change the neuronal basis of possible future events.

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Has your choice of path already been determined by previous events?

But this alone is not enough for free will. The brain of a zombie who lacked consciousness could use this mechanism too, but we would not say it had free will. To have free will requires that our self – that which we feel directs our attention around our conscious experience – has some say in the matter of what we do or think.

If consciousness plays no part in the synaptic reweighting process, there is hardly a free will worth having. (There are many definitions for consciousness, but I define it as all the information that presently is, or could be, voluntarily attended to.)

Fortunately, the neural activity associated with consciousness does play a necessary role. One way to demonstrate this is using a thought experiment. Let's say you are planning a dinner party and play out various possibilities in your mind's eye. You imagine serving a steak, then realise that one guest is vegetarian, so set criteria "delicious; not meat" among synapses associated with memory retrieval. As described before, whatever comes to mind will meet these criteria yet could have turned out otherwise.

"We are not mere automata or unfree characters in a deterministic movie"

Let's say spinach lasagne is the first appropriate solution that comes to mind. This solution could only have been reached through intentional manipulation of conscious thoughts, so the neural activity that gives rise to consciousness is necessary for the subsequent act of shopping for spinach. Your brain freely willed the outcome of spinach by setting up specific criteria in advance, then playing things out. Such internal deliberation is where the action is in free will, not in repetitive or automated motor acts.

This way of understanding the neural code has deep implications. It means that our thoughts and actions are neither utterly random nor predetermined. This counters arguments that free will is an illusion. It shows that the conclusion derived from the dogma of determinism – that mental events, including volitional ones, cannot cause subsequent events – is wrong.

We are not mere automata or unfree characters in a deterministic movie. We can change the physical universe with our minds. For example, it was not predetermined at the big bang when and where aeroplanes would be invented. They were brought into existence by brains that could harness chance to creatively envision a different future.

This does not mean that we require a soul for free will. We don't. My account is entirely physicalist. But our brains can set criteria, play events out internally, choose the best option, then make things happen. And it could always have turned out otherwise. ■