

Cover Page:

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Title: (Re?)Defining Freedom of Choice: Scientific Terminology for Free Will

Abstract:

A concept for freedom of choice is defined in terms of the flexibility of learning control systems, including animal brains, to learn from their experiences and change their future chosen actions. This definition gets away from the mind/body dualism concept so often criticized by scientists and, starting from the introspective experience of voluntary actions, defines the freedom of choices in a way that is both suitable for modeling by the scientific method and fits with common human experiences.

Word count: 2,794

(Re?)Defining Freedom of Choice: Scientific Terminology for Free Will

From the time we awake until we again sleep, we humans are choosing actions to take. We think of ourselves as having volition (freedom of choice) for our actions. Even our simplest sentences express this foundational viewpoint of volition:

I took the cookie.

Is there any sort of choice concept for such actions that makes scientific sense with a notion of “freedom” to choose? What is the “I” above that is choosing to take the cookie? For at least the last 100 years there’s been a growing conflict between the scientific community and the public over the concept of volition. Scientists argue that there is no freedom of choice, whether by arguing that any such freedom is meaningless¹, an illusion², or doesn’t exist³.

This conflict isn’t helpful for science (no improvements to understanding) or the public (what are those scientists on about?). Let’s fix it. To quote Albert Einstein, “We cannot solve our problems with the same thinking we used when we created them.”⁴ If the concept that these scientists describe is a meaningless illusion that doesn’t exist, maybe we need a different way of thinking about whatever it is that they imagine they are denying (more on this later). In this context we (both here and the scientists) are not referring to the external, Free speech, “Give me liberty”, or avoidance of physical constraints (e.g. incarceration) sort of freedom. We are referring to an internal freedom that arises within people and gives us a freedom to voluntarily chose, at least some of, our actions. In effect to ‘deal’ with our external environment. To solve this problem, we need to understand where we are, where we need to be, and then get there:

1. Where we are: The most common notion of volition rests on the idea of mind-body dualism⁵: The concept that we people (at least) have something apart from our bodies, often referred to as a mind or soul, that exists in an immaterial (non-physical, noncorporeal, mental, spiritual...) plane or dimension, but is still able to provide direction for our chosen actions. The choices directed by our minds are those which we consider to be freely chosen by ourselves, choices that aren’t constrained by the past history of the Universe – in this sense “freely” chosen. It should come as no surprise that such a noncorporeal “mind” would be frustrating to scientists. There’s nothing to observe, measure, or test for a noncorporeal mind. No potential value for better understanding to add by the processes of the scientific method.
2. We need to get to a concept/definition for “free will” that’s BOTH:
 - a. Observable and testable by the scientific method, AND

¹ Dr. B.F. Skinner interview: https://www.youtube.com/watch?v=l_ctJqjlrHA&t=2m55s

² Harris, Sam (2012). Free Will, page 5. Free Press. ISBN 978-1451683400.

³ Sapolsky, Robert M. Determined: A Science of Life without Free Will. Penguin Press, 2023.

⁴ Einstein quote reference: https://www.brainyquote.com/quotes/albert_einstein_121993

⁵ Mind-body dualism: https://en.wikipedia.org/wiki/Mind%E2%80%93body_dualism

- b. Makes sense in terms of providing direction for the actions that we humans consider to be freely (or voluntarily) chosen.

Voluntary:

We're going to pry the words free and will apart to distinguish between the concept of chosen actions and the concept of "freedom" for such actions by starting with the word voluntary:

English: **Voluntary** -> translates in German to: "Freiwillig" – literally: freely willed

This English word, "voluntary", is particularly helpful as a starting point because we humans have an introspective appreciation for which actions of our bodies we consider to be voluntary (in that sense 'freely' chosen) and which involuntary (not freely chosen):

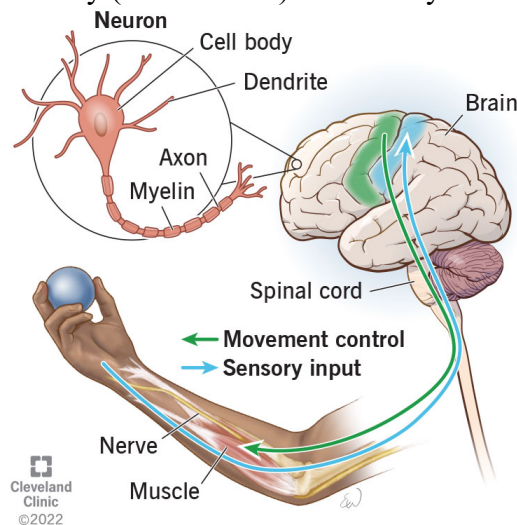
A. **Involuntary:** Strictly 'biological' actions: **tissue healing, hair/nail growth, blood chemical exchanges, blood flow, ...**

B. **Involuntary:** actions of our autonomic nervous system⁶: **gut churning, heart beating, gland secretions such as sweating, ...**

C. **Involuntary:** reflex⁷ actions, skeletal muscle contractions that bypass the brain: **sneezing, hiccups, patellar and withdrawal reflexes, ...**

D. **Voluntary:** contractions of our skeletal muscles directed via motor neurons of our voluntary nervous system⁸ from the brain: **Say "yes", squeeze a ball, ride a bicycle, take the cookie, ...**

The Voluntary (aka Somatic) Nervous system⁹ (Figure 1):



⁶ Autonomic nervous system: https://en.wikipedia.org/wiki/Autonomic_nervous_system

⁷ Reflexes: <https://en.wikipedia.org/wiki/Reflex>

⁸ Somatic (aka "Voluntary") nervous system: https://en.wikipedia.org/wiki/Somatic_nervous_system

⁹ Somatic (aka "Voluntary") nervous system: https://en.wikipedia.org/wiki/Somatic_nervous_system

I don't believe there will be much dispute about which categories of bodily actions noted above are considered voluntary vs. involuntary. A good test to distinguish between voluntary versus involuntary actions is to consider how you would respond if a trusted professional such as a doctor asked you to take an action. "Please clench your fist." Sure, I can do that, voluntary. "Please contract your stomach." – I can't directly do that → involuntary. The concepts of responsibility and blame also tie in. Can you blame me if my stomach growls or if I can't stop hiccupping when asked to do so? If we can agree on these categories, then we can tease apart the concept of "freedom" for "voluntary" choices by referring to their underlying biology:

I choose my voluntary actions freely. ← has the same meaning as → I have free will.

After all, we don't choose our involuntarily actions "freely", right? So, what is it that's unique to our voluntary actions that makes them "freely" chosen vs those involuntary actions? Here is where we can use well understood biological science about the signaling processes shown in figure 1 to physically (scientifically) characterize what distinguishes voluntary from involuntary actions. As seen in Figure 1, control signals travel from the brain via motor neurons to the skeletal muscles (over 600 of them).

- Signaling (direction) for actions considered "voluntary" comes from the brain as shown.
- Signaling for actions considered "involuntary" comes from ... elsewhere – **A.** locally for biological functions, **B.** from the autonomic nervous system for autonomic functions, and **C.** bypassing the brain – short circuiting through the spinal system – for reflexes.

Now we're in a position to define:

Freedom for voluntary choices: is the *flexibility* of the learning capability/capacity of the brain to direct voluntarily chosen actions (as above) based on learning from past experiences.

Lest we be accused of defining one unknown term with another, by "learning capacity" we simply mean that the brain can store internal state, which can generally be referred to as memory, which can build up from past experiences and can influence (help direct, select) the choices of voluntary actions such as:

Language skills, motor skills, social skills, vocational skills, tastes, artistic skills, etc., etc.

Our brains (those of animals generally) have uniquely evolved to be capable of storing massive amounts of internal memory state to influence future choices. At this point I'll describe how this definition differs from other philosophical and scientific positions on "free will":

Firstly, this is not a "compatibilism"¹⁰ position. Compatibilism is roughly the idea that people don't actually have any 'freedom' for their willed choices (which are constrained by Physics), but it's OK to speak as if we do. With the definition for the freedom of will defined here, this

¹⁰ Compatibilism: <https://en.wikipedia.org/wiki/Compatibilism>

freedom can be observed and tested and is generally subject to the processes of the scientific method. For example, I estimate (more details elsewhere¹¹) that the freedom for willed human choices is on the order of 10^{15} bits (1,000,000,000,000,000). This estimate derives from 100,000,000,000 brain neurons, each connected, on average, to 1,000 others, via an analog connection that can be estimated to vary by some 10 bits. There's lots of 'room' for those learned language skills, motor skills, social skills, vocational skills, visualization and artistic skills, etc.

With this definition and model our 'self' ("I") is our brain – with all its current memories. Our "minds", including our experiences (by the nominally favored neuron model for brain function), while awake (medically "conscious"), are the active processes of our waking brains, recirculating firing patterns of neurons internal to our brains, with input from sensory neurons and output via motor neurons. Long term memory is stored (e.g. per the Nobel Prize winning work of Dr. Eric Kandel¹² and others) in strengthened or weakened connections between axons and dendrites of brain neurons, connections developed by the "fired together → wires together" paradigm.

I think it worthwhile to contrast this definition and model with the sorts of arguments against the "free will" concept frequent among other ("free will denying") scientists to make better sense of those arguments. For example:

Dr. Sam Harris writes¹³ that one of the assumptions for the popular 'free will' concept is:

- Each of us could have behaved differently than we did in the past.

Related to this past tense temporal confusion is a future tense idea from Dr. Sabine Hossenfelder¹⁴:

- Free will is the idea that in this present moment several futures are possible and your 'free will' plays a role in selecting which of these possible futures becomes reality.

The past is, well, past. Fixed. The concept from Dr. Harris of, "could have behaved differently" I consider to be a strange one. What people do often think is, "Oh, if only I knew ...". This much makes sense and fits with the model presented here. Different past experiences could have led to different memories (internal state) and consequentially different actions. In terms of the future, that hasn't happened yet and so is only theoretical or predicted. From the model presented here the idea that our "free will" (our learned memory state) can 'select' (at least influence) which possible future becomes reality is straight forward science, with memories from past learning influencing current and future chosen actions.

Dr. Hossenfelder is driving at an imagined conflict between the cause-and-effect laws of Physics and any sort of a 'freedom' to make choices that could be considered unconstrained (in that sense free) from such laws in the sense of mind/body dualism. Everything presented here fits with the cause-and-effect laws of Physics, whether deterministic or nondeterministic (stochastic). It is

¹¹ Upper bound on brain state storage: <http://www.webstart.com/projects/choice/harris-share.pdf#page=13>

¹² Kandel E. R. (2007). In search of memory: The emergence of a new science of mind (1st ed.). W. W. Norton.

¹³ Harris, Sam (2012). Free Will, page 6. Free Press. ISBN 978-1451683400.

¹⁴ Dr. Sabine Hossenfelder Youtube post: https://www.youtube.com/watch?v=zpU_e3jh_FY&t=50s

our definition of “free” that differs – here flexibility from learning, there unconstrained (directed, influenced) by the laws of Physics.

In my opinion there’s good reason to believe that nondeterministic effects from quantum mechanics are significant at the neuron firing level in human brains. Quantum Physicist Dr. Henry Stapp even estimates how significant such effects are likely to be given the dimensions of axon-dendrite connections¹⁵. However, as Dr. Harris points out, no such effect would provide any sort of a “freedom” to direct chosen actions, but rather would serve to reduce the fidelity for directed actions. In this regard I tend to think of the human aphorisms:

“To err is human”: suggesting that actions that depend on very few neurons can have a nondeterministic character that can result in ‘error’s, and:

“Practice makes perfect”: suggesting that with adequate practice enough neurons will become involved in any activity that, by the law of large numbers, the action will become “adequately determined¹⁶”.

Regardless of the above, however, the model presented here is independent of any relevance of determinism or nondeterminism. In fact, attentive readers will notice that with this model fully deterministic systems such as computer systems, can have any amount of “freedom” of choice, depending on their internal state (programming, learning, ...). For example, a simulation of an animal brain (even a human brain) on a computer can have all the “freedom” to make choices that a biological brain has. In my writing elsewhere I give an example of a very simple deterministic system with only one bit of internal state¹⁷ that does, by the model described here, have “free will” – just very, very little such freedom of choice. What matters the most isn’t whether a ‘self’ has some freedom to learn and make voluntary choices, but how much and what types of learning are possible. Humans have a hugely larger capacity for learning and directing our voluntarily chosen actions than, say, a c-elegans nematode¹⁸. In this case size matters.

Sam Harris suggests that another ‘illusion’ about freedom of choice is that:

- We are the conscious source of most of our thoughts and actions in the present.

This statement is difficult to test because of its ambiguity. After all, if by “we” the reference is to our brains, can there be any doubt about the above? Is it suggesting that we are (must be?) fully (by what measure?) “aware” of all our chosen actions? Of course that isn’t possible. We may have thoughts like, “I think I’ll...” or “I shouldn’t...”, or even “I plan to...” (e.g. take the cookie), but until *after* a chosen action is taken, we can’t be fully “aware” of the choice made. I suggest that readers consider these variations on the above sentence:

¹⁵ Stapp, Henry (2011). *Mindful Universe: Quantum Mechanics and the Participating Observer*. Springer. ISBN 978-3-642-18075-0, pp. 30.

¹⁶ Bob Doyle, “Free Will, The Scandal in Philosophy”, 2011, i-Phi Press, BJ1461.D69 2011, pp. 56.

¹⁷ Learning control system with one bit of internal state: <http://www.webstart.com/projects/choice/harris-share.pdf#page=26>

¹⁸ *Caenorhabditis elegans*: https://en.wikipedia.org/wiki/Caenorhabditis_elegans

i. We are the *waking* source of most of our thoughts and actions in the present.

or alternatively:

ii. We are the *deliberative* (or even *consciously aware*) source of most of our thoughts and actions in the present.

I argue that #i above isn't controversial. Rather it is obvious. Naturally (biologically) we only take voluntary actions when we are awake (in the clinical sense "conscious"). That's the only time when our brains are processing our memories and directing our actions accordingly.

On the other hand, if we were to clarify Dr. Harris' meaning as per #ii, then we would clearly understand that his statement is simply false. We realize that even if we may, at times, deliberate or plan or think about or ... potential actions, such deliberative actions are rather rare and, in any case, are also strongly separated (at least in time) from the actions themselves. The only sense in which we can imagine an 'illusion' that we are 'consciously aware' of all our freely chosen thoughts and actions is in the sense that we can 'consider' (have internal thoughts processes related to) any such actions before and/or after having a thought or taking an action.

Most people aren't consciously aware of the fact that to turn a bicycle to the right we first turn the handlebars slightly to the *left*, initiating a fall to the right that we can then turn the handlebars toward the right "into", effecting a coordinated right turn. By the definition here, turning a bicycle is still a freely chosen action even though aspects of the action are "un(sub?)conscious". I'm a foot tapper. I'm often not aware of my tapping foot until somebody near me points it out. Is my foot tapping freely chosen? I find that with feedback from others I can learn to tap my foot less in their presence – so I'd say freely chosen. If a doctor asks, "Please tap your foot." or "Please stop tapping your foot." I can directly comply. Some actions such as eye blinking/closing can be signaled by all three sorts of active signaling mechanisms: autonomic, reflexive, and voluntary. We can even voluntarily choose (freely) NOT to blink our eyes – blocking otherwise autonomic or reflexive blinking. If a doctor asks us to blink, or close our eyes, or even to hold our eyes open, we can voluntarily, in the sense defined here 'freely', choose to do so.

We humans are constantly "Living and learning" about our environment (including other people) and 'jostling' with others to influence their chosen actions – whether informally as with social interactions or more formally as with crime and punishment. We raise our children to live their best lives by crafting their early learning environments to prepare them for the environments we anticipate they will live in. Throughout our lives we are having experiences (day-to-day "practical life" experiences, education, training, trials and traumas, etc.) that leave memories in our brains that influence our future choices. The "free will deniers" such as Harris and Sapolsky and Hossenfelder argue that even such simple aspects of life as matters of taste illustrate how people have **no** 'freedom' of choice. After all, actions dictated by our tastes are at least influenced by our past experiences and so directed by the laws of Physics and not by "us". By the model presented here, however, our 'selves' (our waking brains), acting based on such influences from past experiences, are simply *exercising* our freedom to choose, not denying it. New learning, new choices. That, now here redefined, is the freedom we (our learning and controlling brains) have to influence (direct, select) our voluntarily chosen actions.