Neer Singhal

How Does Quantum Physics Affect the Free Will Debate?

The free will debate is one of the most fundamental and unrelenting arguments from pre-Socratic philosophy. It is frustrating in that the rate at which new questions and ideas emerge seems to outweigh the rate at which questions are answered. Certainly, as ideas surrounding modern and social science have developed – neuroscience, quantum physics, religion etc. – the variety of factors which must be considered in answering the free will question has expanded rapidly. While this essay focusses only on the relation between quantum physics (QP) and free will, it is essential to realise that this is just one factor within the multi-faceted complex of the debate. Within the free will debate, there are 2 ideas that come into contention, namely *free will* and *determinism.* The ambiguity surrounding the precise definitions of these terms is partly responsible for this contention; certainly, philosophers are notorious for defining these terms in the way that best fits their argument. For the purpose of this essay, 'free will' will be defined as 'the deliberative choosing on the basis of desires and values[1].' This seems the most appropriate definition as it emphasis the centrality of *deliberativeness*, thus highlighting the significance of *the self* in choosing an action. Crucially, this definition alludes to the possibility that *either* action could have been undertaken (action X *or* action Y (see figure 1)). Determinism is slightly clearer: for the purpose of this essay, determinism will be defined as that which considers 'our thoughts, decisions, choices and actions as mere *effects* in a causal chain'[2]. In contrast to the definition of free will, determinism reasons that nothing can happen other than that which does happen.

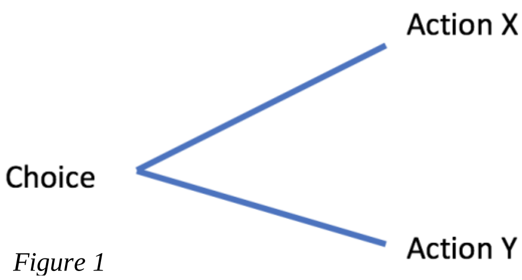

Figure 1

Within the free will debate lies the question of compatibility between free will and determinism. On the surface, however, conventional debate surrounding compatibilism and incompatibilism is fundamentally mistaken as it presumes the truth of either free will and/or determinism. It seems that QP renders both propositions false. Randomness and unpredictability of elementary particles lies central to quantum physics, which intuitively seems to undermine the truth of determinism. Moreover, the notion of randomness seems to weaken arguments for free will as it retracts from the act of deliberation in choosing a certain action. *When this essay refers to 'the base assertion,' it refers to the notion of universal randomness as the product of quantum unpredictability.* A deeper exploration of this topic shows that various interpretations of quantum physics lead to different conclusions regarding free will and determinism. Ultimately, quantum physics is a relatively new scientific idea about which very little is known. This ambiguity is the cause of debate regarding the relation between quantum physics and free will. On a side note, while this essay incorporates elements of philosophy *and* physics, it is essentially one that focusses on philosophy. While scientific ideas are central to the topic, complex and mathematical analyses of quantum physics will be omitted with the intention of conciseness.

Prior to an understanding of quantum physics, most scientists adhered to principles developed by Isaac Newton. In his book, *Philosophiæ Naturalis Principia Mathematica*, Newton declares

[1] O'Connor, Timothy. "Free Will." Stanford Encyclopaedia of Philosophy. January 7, 2002. Plato.stanford.edu/entries/freewill/

[2] Honderich, Ted. *How Free Are You?* (New York: Oxford University Press, 2002), pg. 155

his intention of 'demonstrating the frame of the System of the World[3].'[4] In doing so, he succeeded in forming a scientific framework so rigid and predictable that its very nature was deterministic. Indeed, Newtonian mechanics seems to be a testament to events as mere products of causation. For example, we can determine where a projectile will land given its velocity and angle. Once Newtonian mechanics is incorporated into the framework of events in our brain (on a micro-scale), it is apparent that the behaviour of neurones is merely the product of causal circumstance[5], whose causal chain regresses to at least the Big Bang. Once Planck developed theories of QP, this clockwork nature of science could no longer justify determinism. At the very core of QP lies uncertainty, formalised through Heisenberg's uncertainty principle, which shows that we can never know the exact position and speed of a particle because all particles exhibit both particle properties and wave properties (wave-particle duality). This unknowingness results in uncertainty as to the position of an elementary particle. The most common argument made by physicists, therefore, is that uncertainty and randomness undermine determinism (and strengthen indeterminism). We cannot use standard ideas of cause and effect to exhibit causal chains that neatly explain the behaviour of systems. Quantum uncertainty weakens our idea of conventional causation and shows that both action X and action Y *could have* occurred.

Some philosophers would argue that the real possibility of both paths occurring is *sufficient* for free will, and would thus encourage libertarianism (incompatibilist free will). However, this mode of utilising quantum physics to justify libertarianism seems primitive and far-fetched. Our human desire for freedom is certainly one of the reasons that philosophers tend to *force* free will into existence with little justification. It is nonsensical to equate the real possibility of both action X and action Y from occurring to some conception of 'free will'. This randomness/uncertainty seems to be the very opposite of freedom. If neurones in the brain act randomly and uncertainly, how do humans have any *freedom* in *willing* desired actions. It is a lottery. This form of randomness directly opposes this essay's definition of free will which incorporates *deliberativeness* as a key element. So, while the majority of physicists and philosophers try to force some notion of free will from QP, it seems more intuitive to argue that QP inherently opposes our free will – at the very least, any free will worth having. This is a profoundly perturbing concept as it suggests there is no free will *or* determinism. In essence, the universe is uncontrolled and random. This sort of reasoning seems valid and sound, and supports the *base assertion.*

It is essential to consider QP and quantum randomness within the brain or any other action-choosing faculty as it is of very little use to examine quantum effects in a far-off galaxy. As such, it is apt to first marry QP and neuroscience and discuss the conclusions of these studies. John Searle at the University of California Berkeley formulated a theory that supports the aforementioned *base assertion* and postulated quantum indeterminism in the brain[6]. As an introduction to Searle's philosophy of mind, it is essential to realise the three forms of

---

[3] Newton, Isaac. *Philosophiæ Naturalis Principia Mathematica.* (England: Benjamin Motte, 1687)

[4] Dolnick, Edward. *The Clockwork Universe.* (New York: HarperCollins Publishing, Reprint Edition in 2011), pg. 313.

[5] Honderich, "Mind and Brain" in *How Free Are You?*

[6] Searle, John R. "Free Will as a Problem in Neurobiology." *Philosophy* 76, no. 298 (2001): 491-514. http://www.jstor.org/stable/3751903.

consciousness/mental states: perpetual consciousness, which is seeing and otherwise being aware of things, reflective consciousness, which is thinking of various kinds, and affective consciousness, which has to do with decisions, actions and desiring in general[7]. Moreover, most philosophers including Honderich and Searle believe in a simultaneous, nomic connection between the brain (neural events) and the mind (consciousness). This connection is known as down-up causation. Left-right causation, on the other hand, is the idea that a previous neural event is a *cause* for the next. Searle argues that the first two neural events in figure 2 come about by standard left-right causation. However, he finds it difficult to believe that affective neural events come about by similar forms of causality[8]. Herein lies a neurological 'gap.' Searle adds that this gap is bridged by the chance-relation supposed by the indeterminist interpretation of quantum theory – to which, at a conscious level, something as obscure as a 'self' is added. See figure 2 for a diagrammatic representation of the mind-brain connection.

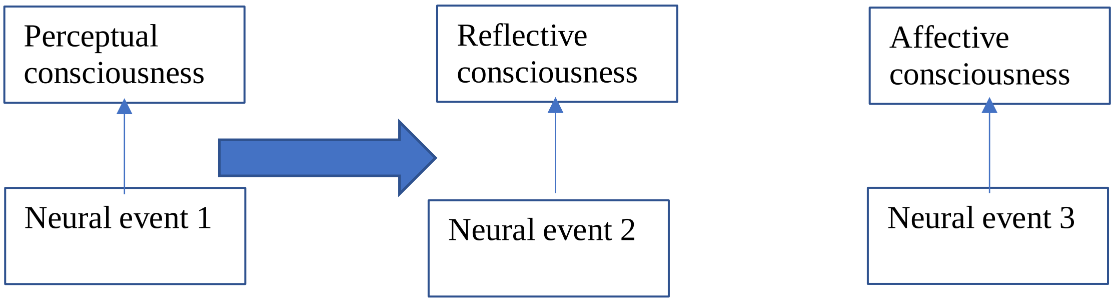

Figure 2

Searle's justification for quantum indeterminism in the brain is terrible. He seems to arbitrarily claim that down-up causation holds true everywhere while *some* left-right connections are just luck or chance. In such a way, he defines the brain and mind as a consistently down-up machine which doesn't exhibit consistent left-right causation. It seems almost mystical that our brains and minds jump back and forth between QP and standard causation, depending on whether we are deciding something or, alternatively, seeing or thinking something. On a final note, Searle, a philosopher, seems to gravitate towards neuroscientific details instead of the philosophy of mind. As such, he formulates a neuroscientific theory with a very weak scientific foundation. Although this account of indeterminism is almost certainly false, by no means does it credit *quantum determinism*. Indeed, the essay will continue by highlighting the absurdity of arguments supporting quantum determinism and/or quantum free will.

One such example stems from Robert Kane and his notion of parallel processing. Kane asks us to imagine two crossing recurrent neural networks, each of which represents a person's conflicting motivations[9]. Let choice A be the moral choice and choice B be the selfish one. Kane explains that the neural networks are connected in such a way that the undetermined, quantum *noise*, which opposes the person's desire to make a choice arises from the desire to make the ulterior choice. He continues by arguing that when either neural network/'pathway' 'wins' (in that some form of arbitrary activation threshold is exceeded), the person will be making *their own – free – choice* despite the undetermined noise from the other option. Kane attempts to show that the choice is not random (hence free), but he never actually addresses the arbitrariness problem. The choice is 'willed' either way (whether the person chooses option A

[7] Honderich, *How Free Are You?* Pg.77
[8] Dardis, Anthony. "Why Mental Causation?" In *Mental Causation: The Mind-Body Problem*, 1-9. Columbia University Press, 2008. http://www.jstor.org/stable/10.7312/dard14416.5.
[9] Kane, Robert. *A Contemporary Introduction to Free Will.* (New York: Oxford University Press), pg. 137-139

or B), but there was nothing determining which of the two occurred. Even with justifications for both actions, the choice still seems inescapably arbitrary. As a result, the person ends up willing whichever action is chosen. Kane gives no reason *why* the person may have willed option A over B or vice versa. It's arbitrary. It is blatant that Kane attempts to disguise these poor arguments for free will under complex scientific and philosophical waffle and terminology. Therefore, Kane's marriage of QP and neuroscience achieves very little in the free will debate as it fails to satisfy its aim of justifying the existence of free will.

Perhaps the main dispute to the *base assertion* is that while quantum uncertainty operates on a micro/particle level, its effects are negligible in larger systems. This is labelled 'near-determinism' or 'naturalism'. Ultimately, its effects are insignificant when considering human action, whose scale of magnitude is several degrees greater. This view is supported by scientific philosophers such as Robert L. Klee[10] and Ted Honderich[11]. Honderich distinguishes the micro-world and the macro-world. He labels the micro-level as 'the level of small particles theorised about in physics, as distinct from the macro-level, which includes everything from larger than the particles, including neurones and neural events.'[12] A truer analysis of the effects of quantum physics in the brain would require greater study into neuroscience beyond the scope of this essay but it is vital to consider the philosophical claims of near-determinism. Instantly, there seem to be certain dilemmas that arise from this definition of near-determinism.

It is curious that Honderich draws the line between micro-level and macro-level events such that neurones are included within the macro-world. While neurones are larger than atoms by a factor of around 10000, humans are also larger than neurones by a factor of 10000. Although drawing the distinction at the point between small particles and neurones is not necessarily wrong, it does seem ambiguous and designed in a way as to support Honderich's argument for determinism. Indeed, it is very difficult to draw an exact line where some vague idea of a micro-world develops into some vague idea of a macro-world. Moreover, it is the very building blocks of these neurones that determine its actions. If the building blocks (elementary particles) are subject to random and unpredictable behaviour, then does it not follow that the larger systems which these building blocks comprise are equally subject to this behaviour? Certainly, if neurones were subject to random behaviour, we would concede that human behaviour was equally random. As the ratio of magnitude between neurones and humans is similar to that between elementary particles and neurones, is it not at least conceivable to argue that neurone behaviour is equally subject to quantum randomness, and hence undetermined. Honderich's division between the micro and macro worlds seems to be a false dichotomy. No such division exists.

The other argument against the truth of near-determinism owes itself to chaos theory, another relatively new scientific idea[13]. In 'chaotic' physical systems, very small changes in initial conditions lead to large and unpredictable changes in the system's subsequent behaviour[14]. While the commonly held narrative that a butterfly flapping its wings in South America initiates a chain of events that ultimately affects weather patterns in North America (The

---

[10] Klee, Robert L. "Micro-Determinism and Concepts of Emergence." *Philosophy of Science* 51, no. 1 (1984): 44-63. http://www.jstor.org/stable/187730.

[11] Honderich, *How free are you?* Pg. 71-75

[12] Honderich, *How free are you?* Pg. 157

[13] Kane, *A Contemporary Introduction*, pg. 134

[14] Baker, Gregory and Gollub, Jerry. *Chaotic Dynamics: An Introduction* (Melbourne: Cambridge university press, 1990).

Butterfly Effect) is a slight exaggeration, there is growing evidence that chaos theory plays a significant role in information processing in the brain. While determinists may respond that chaotic systems are indisputably deterministic, it does not retract from the idea that chaos theory suffices in *amplifying* the effects of micro-indeterminism and quantum jumps on a 'micro-level' (even if this amplification occurs in a deterministic way), thus translating the randomness of quantum effects to randomness of mental processes. As a result, arguments for near-determinism are inadequate in undermining indeterminism.

There is, however, one fatal assumption that has hitherto not been addressed, namely the false equivalence between 'quantum *unpredictability'* and '*randomness'*. Any line of reasoning that attempts to prove or indeed disprove this equivalence is futile due to the lack of knowledge scientists have with regards to quantum jumps. It is beyond the scope of this essay to delve too deeply into the specifics of QP yet necessary to briefly consider them. Consider the fact that many of the predictions made in practice are incorrect because there is not sufficient prior information. For example, weather predictions are tentative as humans have not yet developed truly accurate means of measuring climatic conditions. In theory, weather predictions *could be* 100% accurate. Similarly, determining the result of a dice throw is theoretically predictable if enough information (e.g. force of throw, weight of dice etc.) were gathered prior to the action.[15] In contrast, in quantum mechanics, even if all the information is available, the outcomes of certain experiments generally can't be predicted perfectly beforehand [16]. As a result, events such as quantum jumps and quantum locality can never be predicted by humans. Many physicists/philosophers seem quite content to jump to the conclusion that quantum events are completely random and arbitrary. While this isn't necessary wrong, there must be some evidence to bridge this assumption. Does the fact of unpredictability necessarily lead to randomness? Is there some underlying deterministic mechanism which *causes* this apparent quantum unpredictability? At present, there is no conclusive, univocal answer given by the scientific community. Most classical physicists postulate there must be some undiscovered, hidden variable in the framework of QP that neatly encompasses *apparent* quantum randomness. If this were the case, the scientific community could once again comfort themselves with Newtonian determinism. Impulsively, it seems deeply unnatural and unsatisfying to have scientific principles that concede to unpredictability/randomness. This concession opposes the very purpose of scientific study. Whether to trust this impulse is a separate matter – ultimately, we do not yet know whether quantum unpredictability is a product of *randomness* or the lack of scientific progress. Either way, it is imperative to consider quantum randomness with a grain of salt in this essay.

John Stewart Bell (1928-1990) was an Irish physicist who used experimentation to attempt to prove the super-determinism of the universe (and thus disprove the *base assertion* that the universe essentially consists of random quantum effects) by showing that quantum effects travel faster than light[17]. To comprehend Bell's experiment, imagine the following scenario: two experimenters are space-like separated (their laboratories are separated by such a distance

[15] Allen, David. *How Mechanics Shaped the World.* (Switzerland: Springer International Publishing, 2014)

[16] University of Calgary. "A roll of the dice: quantum mechanics researchers show that nature is unpredictable." ScienceDaily. [accessed August 17, 2018] www.sciencedaily.com/releases/2012/07/120709162715.htm

[17] Bhatia, Aatish. 'The Experiment That Forever Changed How We Think About Reality.' *Wired.* Published on January 14, 2014. https://www.wired.com/2014/01/bells-theorem/ [accessed on August 19, 2018]

that any information travelling from one to another in a pre-stipulated period of time would transfer faster than the speed of light). Each experimenter is assumed to be *free* to choose, at the last second, which experiment to conduct (let the choice consist of either experiment A or experiment B). QP already hypothesises that the outcome of one laboratory would actually be interconnected with the choice made by the experimenter in the other laboratory. It would instantaneously affect the outcome of the other laboratory, which, in theory, could be located in another galaxy. Bell showed this hypothesis to be true, thus violating the principle of local causality, the notion that causal influences can only occur locally. This instantaneous interconnection seems to occur completely external to the fabric of space-time, therefore rendering the conventional notion of causality meaningless[18]. Again, Bell (amongst other philosophers) makes the fatal error of jumping hastily to conclusions about determinism. Philosophers argue that this retraction of free will results in determinism, as one event *causes* (though not in our conventional notion of local, space-time causality) another through *quantum connectedness*. Moreover, while these conclusions are not necessarily wrong, Bell's theorem requires metaphysical concepts to explain its results. By definition, humans, who are bound by space-time, cannot viably explore realities that go beyond space-time, and must subsequently accept the possibility that there may exist some alternative reality that is ultimately unprovable; we cannot conclusively use Bell's theorem as proof for quantum determinism as it requires concepts beyond our experience. Certainly, there lies one theoretical paradox – if QP is random, how can QP experimentation (which, as a result, is also random and unreliable) prove quantum determinism. Therein lies the contradiction in using Bell's theorem to disprove the *base assertion* of universal randomness.

Scientists have identified several loopholes with Bell's theorem. These loopholes suggest that while the conclusions of Bell's experiment (and indeed subsequent experiments) *seem* to verify the predictions of QP, they actually serve as reflections of the previously mentioned 'hidden variables' that simply give the illusion of QP. The most prominent loophole is named the 'free will loophole.' This loophole proposes that the operations of the apparatus used in the experiment may 'conspire' with events in the shared causal past of the apparatus themselves to determine the characteristics of measured elementary particles/electrons etc. If this scenario were true, it would suggest that the axiom upon which Bell's theorem lies – that both experimenters have complete freedom of choice – is false. As a result, the apparatus would conspire in such a way as to suggest that two space-like separated particles had a much stronger correlation than in reality, thus exhibiting bias towards QP over classical Newtonian physics.

To close this third loophole, an experiment would need conducting by determining apparatus' settings using some of the oldest light in the universe: distant quasars, or galactic nuclei, which formed billions of years ago[19]. This experiment would utilise the fact that if two galactically-separated objects are sufficiently distant from each other, they would have been out of causal contact since the Big Bang some 14 billion years ago, with no possible means of any third-party communication with *both* of them since the beginning of the universe — an ideal scenario for determining each particle detector's settings[20]. However, such an experiment is completely

---

[18] Vandegrift, Guy. "Bell's Theorem and Psychic Phenomena." *The Philosophical Quarterly (1950-)* 45, no. 181 (1995): 471-76. doi:10.2307/2220310.

[19] Hansen, Kaj B. "An Inverse of Bell's Theorem." *Journal for General Philosophy of Science / Zeitschrift Für Allgemeine Wissenschaftstheorie* 26, no. 1 (1995): 63-74. http://www.jstor.org/stable/25171013.

[20] Chu, Jeniffer. 'Closing the Free Will Loophole.' MIT News. Posted on February 20, 2014. [accessed August 17, 2018] http://news.mit.edu/2014/closing-the-free-will-loophole-0220

infeasible as it would require scientists to travel to (or at least in some way connect to) galactic objects located billions of light years away. Moreover, doesn't the fact that the experimenters are eventually connected by causality to both galactic objects retract from the nature of any complete independence of the measurements of particles? Isn't bias inserted by the very act of choosing two such objects that the experimenters can see only because of their causal connections to the objects? The objects will be independent of *each other*, but the experimenters will not be independent of the objects. Therefore, the very essence of experimenting on causally separate objects would in some way form causal links that undermine the purpose of the experiment. To tie this back to the free will debate, while Bell's theorem (to some extent) reconciles QP with super-determinism, and undermines the assertion of universal randomness, the, albeit far-fetched, 'free will loophole' seems to question the validity of this theorem. However, it is very unlikely that this loophole can be remedied in the near future due to its inherently complex nature. As such, problems with Bell's experiment itself and loopholes opened by responding scientists are ultimately inconclusive. While they are interesting in that they highlight the multi-faceted nature of QP-free will, they achieve very little in forming any absolute proofs for either side of the debate.

To conclude, it is important to recall that while this essay focusses only on the implications of quantum physics to the free will debate, quantum physics is just one variable within the entire complex of the debate. Similar essays could have been written on the implications of religion, neuroscience etc. Indeed, the explanation for the differences in conclusions is twofold. On the one hand, definitions of key terms such as free will and determinism are not absolute. Although this essay fixates on specific definitions, these are in no way definitively true or universal and it is arrogant to claim the definitions used in this essay as the most accurate. Secondly, and perhaps more significantly, quantum mechanics is a relatively new and complex means of viewing the world. As such, physicists have not yet come to univocal conclusions as to the specifics. One example of how this impacts discussion with free will is the question of hidden, undiscovered variables that may undermine the apparent randomness of perceived quantum physics. The *base assertion* postulated by the essay is the notion that quantum randomness not only leads to indeterminism, but also retracts from the very foundation of free will by undermining the act of human *deliberation*. This line of reasoning seems to imply complete universal randomness – chaos. The essay assumed the burden of proof to lie with philosophers who disagreed with universal chaos. However, it seems that any argument attempting to weaken this base assumption has one of two flaws: either arguments are logically/scientifically unsound (consider Kane's idea of neural networks and quantum noise as a justification for free will) or experiments to prove them are unfeasible (consider the proposed loopholes of Bell's theorem). Ultimately, therefore, until proven otherwise, quantum physics has disastrous impacts for free will as its unpredictability translates to randomness and *chaos* in the world. Nonetheless, it is expected that as knowledge of quantum physics develops, the understanding of links between quantum physics and the free will debate will strengthen. It is reasonable to acknowledge that human understanding of quantum physics is not quite at a sufficient level where discussion regarding its impacts on free will are in any way conclusive or definitive. On a final note, it is necessary to consider the *impacts* of the *base assertion*. Does universal chaos necessarily lead to fatalism? It seems very difficult to escape nihilistic and fatalist tendencies if human experience is perpetually subject to random quantum effects. Scientists and philosophers must collaborate to find a way of disproving universal quantum chaos.

Neer Singhal

Bibliography

[1] O'Connor, Timothy. "Free Will." Stanford Encyclopaedia of Philosophy. January 7, 2002. Plato.stanford.edu/entries/freewill/
[2] Honderich, Ted. *How Free Are You?* (New York: Oxford University Press, 2002), pg. 155
[3] Newton, Isaac. *Philosophiæ Naturalis Principia Mathematica.* (England: Benjamin Motte, 1687)
[4] Dolnick, Edward. *The Clockwork Universe.* (New York: HarperCollins Publishing, Reprint Edition in 2011), pg. 313.
[5] Honderich, "Mind and Brain" in *How Free Are You?*
[6] Searle, John R. "Free Will as a Problem in Neurobiology." *Philosophy* 76, no. 298 (2001): 491-514. http://www.jstor.org/stable/3751903.
[7] Honderich, *How Free Are You?* Pg.77
[8] Dardis, Anthony. "Why Mental Causation?" In *Mental Causation: The Mind-Body Problem*, 1-9. Columbia University Press, 2008. http://www.jstor.org/stable/10.7312/dard14416.5.
[9] Kane, Robert. *A Contemporary Introduction to Free Will.* (New York: Oxford University Press), pg. 137-139
[10] Klee, Robert L. "Micro-Determinism and Concepts of Emergence." *Philosophy of Science* 51, no. 1 (1984): 44-63. http://www.jstor.org/stable/187730.
[11] Honderich, *How free are you?* Pg. 71-75
[12] Honderich, *How free are you?* Pg. 157
[13] Kane, *A Contemporary Introduction*, pg. 134
[14] Baker, Gregory and Gollub, Jerry. *Chaotic Dynamics: An Introduction* (Melbourne: Cambridge university press, 1990).
[15] Allen, David. *How Mechanics Shaped the World.* (Switzerland: Springer International Publishing, 2014)
[16] University of Calgary. "A roll of the dice: quantum mechanics researchers show that nature is unpredictable." ScienceDaily. [accessed August 17, 2018] www.sciencedaily.com/releases/2012/07/120709162715.htm
[17] Bhatia, Aatish. 'The Experiment That Forever Changed How We Think About Reality.' *Wired.* Published on January 14, 2014. https://www.wired.com/2014/01/bells-theorem/ [accessed on August 19, 2018]
[18] Vandegrift, Guy. "Bell's Theorem and Psychic Phenomena." *The Philosophical Quarterly (1950-)* 45, no. 181 (1995): 471-76. doi:10.2307/2220310.
[19] Hansen, Kaj B. "An Inverse of Bell's Theorem." *Journal for General Philosophy of Science / Zeitschrift Für Allgemeine Wissenschaftstheorie* 26, no. 1 (1995): 63-74. http://www.jstor.org/stable/25171013.
[20] Chu, Jeniffer. 'Closing the Free Will Loophole.' MIT News. Posted on February 20, 2014. [accessed August 17, 2018] http://news.mit.edu/2014/closing-the-free-will-loophole-0220