EVIDENCE OF MACROSCOPIC QUANTUM PHENOMENA AND CONSCIOUS REALITY SELECTION

Cynthia Sue Larson

ABSTRACT: The purpose of this paper is to present an overview of emergent examples of macroscopic quantum phenomena. While quantum theory asserts that such quantum behaviors as superposition, entanglement, and coherence are possible for all objects, assumptions that quantum processes operate exclusively within the quantum realm have contributed to on-going bias toward presumed primacy of classical physics in the macroscopic realm. Non-trivial quantum macroscopic effects are now recognized in the fields of biology, quantum physics, quantum computing, quantum astronomy, and neuroscience, with implications for medicine, psychology and sociology. Robust examples of macroscopic quantum coherence and entanglement contain unmistakable biological advantages, such as are observed in the green sulphur bacteria photosynthesis transfer mechanism, and in the navigational system of the European Robin. Macroscopic quantum processes in the form of an olfactory electron tunneling mechanism best account for the otherwise inexplicable difference observed in the odor of identically-shaped molecules. Evidence of reverse-direction causality is apparent in experiments with large numbers of photons and human subjects. Entanglement, retrocausality, and superposition of states are suggested as causal factors to account for increases in efficacy of the placebo effect. Alternate histories of "flashbulb memories" and embodied cognition are considered as possible examples of superposition of states in a holographic multiverse in which the many worlds of the multiverse and the many worlds of quantum mechanics might just be one and the same thing.

KEYWORDS: macroscopic quantum phenomena; quantum biology; retrocausality; placebo effect; embodied cognition; holographic multiverse; alternate histories.

PRODUCING QUANTUM PHENOMENA ON A MACROSCOPIC SCALE

In much the same way that the "British Invasion" introduced popular music by the Beatles to the United States, a new "Quantum Invasion" is poised to leave no branch of science untouched. A good deal of credit for this new quantum perspective goes to researchers involved in developing quantum computing technologies, as new breakthroughs in macroscopic quantum processing are being introduced at a rapid rate. Some recent non-trivial examples of laboratory-produced macro-scale quantum effects include: evidence of superposition with superconductors, entanglement of hundreds of photons, and entanglement of diamonds at room temperature.

Quantum superposition of macroscopically distinct states has been developed for use in quantum computers with use of the Superconducting Quantum Interference Device (SQUID). SQUIDs operate with one magnetic flux state corresponding to a few microamperes of current flowing clockwise and the other corresponding to the same amount of current flowing anticlockwise, so they can be in two states simultaneously. Quantum computing thus represents a shift from the binary world of classical computing with its bits, bytes, and two-fold logic to probabilistic quantum computing which is capable of analyzing and assessing vast ranges of possibilities. [1]

Gisin *et al* demonstrated entanglement at the macroscopic level by entangling two fiber-optics populated by 500 photons. The phenomenon was confirmed by reconverting back to the microscopic level in order to determine that entanglement indeed persisted on the macroscopic scale. Gisin and colleagues intend to entangle increasingly large objects in future projects. [2]

Lee *et al* succeeded in entangling millimeter-sized diamonds at room temperature with ultra-short optical pulses, noting, *"Without a specially engineered system, measurements on time scales shorter than the characteristically fast times of a real-world system."* [3]

CONSCIOUSNESS AND MACROSCOPIC QUANTUM PHENOMENA IN NATURE

It's worth noting when considering the role of consciousness in quantum reality selection that organisms with no brains, such as bacteria and plants, meet the criteria for being conscious, since *"In the simplest sense, consciousness is an awareness ... of the outside world."* Plants select mating partners, communicate with other plants, and act cooperatively or competitively with others after first differentiating between kin and strangers. Bacteria communicate with one another, anticipate predictable environmental changes, and make informed decisions. Indeed, *"It is puzzling that primitive organisms that lack any kind of nervous system show sophisticated behaviours that we assume require a nervous system."* [4]

As scientists find confirmation of non-trivial macroscopic quantum processes, we may well wonder whether nature has succeeded in leveraging a profusion of macro

quantum effects in places we've yet to look. Momentarily setting aside the matter of consciousness existing just fine without brains or nervous systems, one of the biggest challenges confronting scientists attempting to study macroscopic systems demonstrating quantum superposition has been decoherence. Recently, this situation has improved, as scientists find that while it may be difficult to prove the quantumness of macroscopic states, it is not impossible.

Physicists have conducted a number of ground-breaking experiments in which large-scale superpositions in solid state and quantum-optical systems have been attained and the accompanying decoherence mechanisms examined. Sekatski, Gisin and Sangouard demonstrated that the amount of entanglement surviving experimental defects (noise identified with a weak measurement) is upper bounded by an expression involving solely the probability to distinguish the two components with inaccurate measurements. Thus, the observation of entanglement becomes progressively more difficult as the distinctiveness of the components increases, and this task of distinguishing between two states becomes more difficult for quantum superposition. They found that, *"by establishing a relationship between the stability requirement and the 'macroscopic distinguishability' of two superposed states, we demonstrate that indeed, the more distinguishable the states are, the more demanding the stability requirements."* In other words, Sekatski *et al* conclude that an extreme control is required in order to observe the quantum nature of either macro superposition states or macro entangled states. [5]

Recent discoveries in quantum biology indicate evidence for non-trivial quantum processes that provide plants and animals with evolutionary advantages. Such processes go beyond the fundamental involvement of quantum physics intrinsic to all chemical systems, demonstrating clear cases of quantum coherence at room temperature in photosynthetic systems, and the magnetic sensing in some species of birds. [6]

QUANTUM COHERENCE PLAYS A STRONG ROLE IN PHOTOSYNTHESIS

An exciting breakthrough in understanding photosynthesis arose through the study of green sulphur bacteria when biologists made a discovery challenging the historical classical models of photosynthesis transfer mechanisms. Direct evidence of long-lived quantum coherence was obtained by studying the Fenna-Matthews-Olson (FMO) bacteriochlorophyll complex, that acts as an energy 'wire' capable of connecting the chlorosome light-harvesting antenna to the reaction center where the plant converts photons to usable energy. [7]

Researchers were amazed to find evidence of quantum processes at work in such a wet, warm, noisy environment. Further investigation by quantum computer scientists,

Lloyd *et al* revealed further insights. Lloyd recognized evidence for quantum coherence, and was *"... able to show right away that the bacteria were not performing a quantum search algorithm. To our surprise, however, the bacteria were in fact performing a different type of quantum algorithm, called a quantum walk."* [8]

A quantum walk is a transport mechanism in which a walker takes steps in random directions through a quantum superposition of paths through a network of possible paths, which can exhibit either constructive or destructive quantum interferences. Quantum walkers can get stuck or 'localized' within the network when experiencing destructive quantum interference, but gain considerable boosts in speed compared with classical random walkers when experiencing constructive quantum interference. Lloyd found that the variable of environmental temperature provided interference that could either reduce or improve efficiency of FMO transport. Lloyd's team noted highest transport efficiency occurring at 290K, the average temperature of the water in which the bacteria live, with nearly 100% efficiency around a robust range of many tens of degrees K above or below 290K.

An exciting auxiliary finding by Lloyd's team is that highest efficiencies of transport occur where time scales converge. Biologists have puzzled for decades about why evolutionary preference is given to photosynthesis in which many time scales in the excitonic transport process--coupling constants, energy differences, decoherence rates and environmental correlation times--converge within a scale of about one picosecond. Computer modeling of the FMO photosynthesis demonstrates that a kind of 'quantum Goldilocks effect' is in place where natural selection has pushed time scales together to ensure photosynthetic systems attain optimal quantum complexity to be both robust and functional.

Coherence of the FMO complex is remarkably long-lived, with timescales up to one picosecond in a transport process lasting less than five picoseconds. Scientists were amazed to find long-lasting coherence in such wet, warm, noisy biological environments--and further surprised to learn that noisy environments produce sizable gains in transport efficiency. Tunings of excitonic couplings in the transport mechanisms can be made in such a way to preserve coherences, thereby allowing lifetimes and coherence times to exist on the same order of magnitude as one another and the transport time (that is regulated by the lifetimes). [9]

BIRDS UTILIZE QUANTUM COHERENCE AND ENTANGLEMENT FOR NAVIGATION

Many species of animals, including migratory birds, employ magnetoreception to navigate via Earth's geomagnetic field, though the exact mechanics for this process are

mysterious. Although the European Robin utilizes magnetic sensation, their directional sense was found to operate inexplicably better by day than at night. Studies show that the essential navigational process occurs in the bird's eye, based on geomagnetic-dependent dynamics of the spins of unpaired electrons. According to a quantum biology perspective, energy deposited by each incoming photon creates pairs of free radicals--highly reactive molecules--that each have an unpaired electron. These unpaired electrons are influenced by magnetic fields in such a way that as the free radicals separate and move apart, one is more influenced by the pull of the Earth's magnetic field than the other, thus shifting the pair of free radicals between two quantum states with different chemical reactivity. Researchers estimated the lifetime and coherence time to be on the order of several microseconds, and found that sensitivity of the avian compass is enhanced by environmental noise, with long coherence times not required for navigation. [10]

SMELLING WITH ELECTRON TUNNELING

If smell is determined by matching molecules to scent receptors, why do identically shaped molecules smell noticeably different from one another? Twin-shaped molecules of pure acetophenone and its fully deuterated analogue acetophenone-dg are easily distinguished by smell, despite having identical structures, rendering the classical "lock and key" olfactory model outdated. Luca Turin proposed a quantum mechanism of inelastic electron tunneling to explain why molecules of similar shape but different vibrations smell different. The proposed mechanism works like this: an electron in the nasal receptor finds its way to the receptor's donor compartment, where a scent molecule arrives. The scent molecule's vibrational frequency enables the electron to tunnel to a different energy state. The electron then travels to the acceptor unit and the scent molecule leaves. [11] Brookes *et al* tested this proposed electron tunneling mechanism with a simple model, finding this quantum "swipe card" mechanism is consistent with underlying physics and observed features of smell, provided the receptor has low reorganization energy within ranges known from other biomolecular systems. [12]

RECEIVING INFORMATION FROM THE FUTURE

Cramer's Transactional Interpretation of quantum physics posits "handshakes" between emitter and absorber participants of quantum events in which advanced and retarded waves are exchanged.[13] Intriguingly, observable macroscopic quantum phenomena is evidenced by retroaction, ie: receiving information from the future. Hosten and Kwiat established evidence of reverse-direction causality when they detected a shift in a beam of polarized light moving between air and glass that was

influenced by a future decision. This effect was determined to be the photonic version of the spin Hall effect in electronic systems, indicating the universality of this effect for particles of different nature. [14] Howell reported similar success in observing retroactive effects in weak, less obtrusive measurements showing that light traveling through an observed gate was amplified by a factor of more than 100 when influenced by a future choice. [15]

Bem observed apparent evidence of information coming from the future when he noted a 53% majority of subjects correctly selected the concealed screen showing an erotic image *before* a random number generator made a choice of whether or not to project such an image. [16] A 3% edge corresponds to the house edge for some casino games, and matches the odds by which natural variances in species arise providing biological advantages.

ENTANGLEMENT, RETROCAUSALITY AND SUPERPOSITION IN THE PLACEBO EFFECT

Though placebos administered in randomized controlled trials were originally presumed inert and thus incapable of producing effects, a conceptual shift has been made to an awareness that some kind of psychosocial therapy occurs once placebo administration has begun. Serious investigation into what makes placebos produce improvement in ever-increasing numbers is now underway at Harvard-affiliated Program in Placebo Studies and the Therapeutic Encounter (PiPS). [17] Barsky reports, *"The placebo response was about twice as powerful than it was in the 1980s."* [18]

Some placebo effect experiments indicate subjects can improve multiple choice test scores. Weger and Loughnan administered a general knowledge multiple choice test in which participants were informed that correct answers would flash onscreen for a moment so as to be subconsciously received, and were given the verbal guidance, *"On some level, you already know the answer."* Though gibberish was all that flashed on their screens, this academic placebo boosted students' scores significantly higher than participants who received neither assurances nor gibberish. [19]

Langer's experiments suggest that mindset improves visual acuity. Research participants who wore pilot's uniforms and operated flight simulators scored a whopping 40% better on vision tests than control group members placed in similar conditions with a "broken" simulator, who only pretended to fly a plane. [20]

Price *et al*'s review of the placebo effect recognizes contextual factors influencing placebo effects including: conditioning, verbal suggestion, and experimenter behavior. Meta-analyses indicate that while placebo effect sizes are small on average, placebo effects tend to be larger in studies focusing on analyzing placebo mechanisms. This suggests that when researchers seek to enhance the placebo effect, they often

successfully enhance it. Verbal suggestions inducing certain expectations have been noted to induce larger placebo responses than those with uncertain expectations. [21]

Walach postulates a "Weak Quantum Theory" in which macroscopic entanglements exist among various conditions in blinded studies, noting the possibility that quantum entanglement occurs in the experiments themselves, and that experimenter bias and expectations can influence results. [22] Manek and Tiller agree with Walach that entanglement between experimenters, subjects, expectations, and other experimental factors must be considered in order to "untangle the entanglement" occurring in randomized controlled trials and all types of experiments. [23]

Radin and Lobach suggest another aspect of quantum mechanics may play a pivotal role in the placebo effect: retrocausality. Radin and Lobach demonstrate presentience in their study, stating, *"A passive perceptual interpretation of the presentiment effect proposes that some aspect of the mind-brain is sensitive to events that are yet to unfold."* Radin and Lobach assert this indicates that future events exist in some form, either probabilistic or determined, since their subjects were responding in advance of anything physically occurring. [24]

SUPERPOSITION OF STATES IN ALTERNATE HISTORIES

Regularly experiencing superpositions of states, we would expect to occasionally encounter conflicting memories of past events, as Hawking and Hertog proposed in their top down cosmology in which *"histories of the universe thus depend on what is being observed,"* [25] and as researchers confirm can be found in "false recollections." We would also expect to see occasional inconsistencies in "flashbulb memories"--long-lasting detailed memories related to surprising, important, emotionally arousing events such as President Kennedy's assassination or the *Challenger* space shuttle explosion--as have in fact been observed. [26]

Neisser and Harsch conducted studies of students' recollections of events following the *Challenger* space shuttle explosion, collecting first-hand accounts one day after the disaster describing how students heard about the explosion and what they were doing, where they were, and how they felt at the time. When the same students answered these questions two years later, fewer than 10% of the students' recollections matched their original descriptions of events. Some students persisted in claiming their current memories of events were accurate, even when confronted with their own hand-written journal reports. One student commented, *"That's my handwriting, but that's not what happened."* [27]

In a holographic multiverse with multiple histories, we might expect to witness greatest inconsistencies in memories of past events when there has been a longer timespan between events and first reports. Indeed, longer delays between first experiencing a memorable event and initial documentation of such "flashbulb memories" have been found to produce improved consistency between participants' subsequent reports. [28]

CONSCIOUS REALITY SELECTION IN EMBODIED COGNITION

William James said, *"If you want a quality, act as if you already have it."* In the field of Embodied Cognition, sociologists and psychologists are finding that by taking actions in keeping with a new reality, we embody the qualities we associate with those actions. Hung and Labroo report that the act of making a fist increases willpower. Participants completed five studies designed to evaluate the effects of fist-clenching on: making charitable donations, withstanding discomforting ice water, drinking vinegar for better health, and choosing healthier snacks. Muscle-firming exercises profoundly improved peoples' ability to do what they felt was right despite pain, discomfort, or temptation. [29]

Studies show that when we act powerfully, we think powerfully, with benefits extending to improved performance in interviews, stressful situations, and making good impressions. Cuddy reports that people adopting "power poses" such as standing over a desk with both hands leaning forward experienced 25% decreases in cortisol levels and 19% increases in testosterone, whereas control group participants adopting "low power" poses experienced a 17% increase in cortisol and a 10% decrease in testosterone. [30] Cuddy *et al* conducted another experiment in which participants holding power poses prior to interviews demonstrated notable improvements in presentation quality (enthusiasm, confidence, captivating) compared to the control group, and felt more empowered and were more often selected to be hired than control group members. [31]

Epstein has found that relationships are improved when people act close by participating in "soul gazing" exercises in which they looked into each others' eyes. Participants reported a 7% increase in loving, an 11% increase in liking, and a 45% increase in closeness, with 89% of the participants reporting notably improved feelings of intimacy. [32]

IMPROVING HEALTH AND LONGEVITY WITH POSITIVE STEREOTYPES

Our answer to the question, *"What are the first words that come to mind when you think of old people?"* is correlated with health and longevity. Levy's research shows that seniors with

positive biases toward aging are 44% more likely to fully recovery from disability than those without such positive biases. [33] Levy finds that people demonstrating positive age stereotypes when asked to respond to statements such as *"Things keep getting worse as I get older,"* and *"as you get older, you get less useful"* live 7.5 years longer on average than those harboring negative stereotypes about the elderly. This remarkable gap persists even when Levy factors out covariates of age, gender, socioeconomic status, loneliness and functional health. [34]

INCREASING EVIDENCE OUR MULTIVERSE IS MANY WORLDS

At this time when more than two-thirds of physicists surveyed agreed there is no fundamental limit to quantum theory, and everything exists in a superposition of states [35], there is growing evidence from several areas of physics--including discovery of the Higgs boson, mysteriously vanishing neutrinos, and observation of cosmic radiation at the time of the Big Bang--suggesting we exist in a multiverse. With the discovery of the Higgs boson, a symmetrical universe now seems less likely than the possibility that we exist in an eternally inflating multiverse. Anthropic arguments arise when considering that only those universes capable of supporting conscious entities could be observed, since the universe we observe can support our form of life, and is not expected to be typical. [36]

Some of the first hard evidence of other universes outside our own was discovered by scientists analyzing cosmic background radiation data collected by the European Space Agency's Planck telescope. The very anomalies Mersini-Houghton and Holman predicted years earlier had finally been observed. As Mersini-Houghton explained, *"These anomalies were caused by other universes pulling on our universe as it formed during the Big Bang. They are the first hard evidence for the existence of other universes that we have seen."* [37][38]

Bousso and Susskind propose that an eternally inflating multiverse is necessary to provide exact operational meaning for the probabilistic types of predictions that quantum mechanics makes. As Bousso and Susskind explain, decoherence--the current version of wave-function collapse--is dependent on environmental factors, specifically the choice of a set of unmonitored degrees of freedom. [39]

Bousso and Susskind ask, *"According to an older view of quantum mechanics, objective phenomena only occur when an observation is made and, as a result, the wave function collapses. A more modern view called decoherence considers the effects of an inaccessible environment that becomes entangled with the system of interest (including the observer). But at what point, precisely, do the virtual realities described by a quantum mechanical wave function turn into objective realities?"*

A key to answering this question and appreciating how the many-worlds interpretation of quantum mechanics and the multiverse might be the same thing is found in decoherence. Because macroscopic entities become quickly entangled with

environmental degrees of freedom, observers do not experience superpositions of macroscopically distinct quantum states, such as seeing a simultaneously alive and dead cat. Decoherence is subjective and reversible, presenting challenges any time we depend upon decoherence when attempting precise tests of quantum mechanical predictions. Bousso and Susskind propose a view of the global expanding multiverse as a patchwork of decoherent causal diamonds, postulating a requirement for irreversible entanglement and infinite repetition, with "hat" regions of the multiverse consisting of supersymmetric multiverse regions with vanishing cosmological constant.

If we exist within a holographic multiverse of interconnected parallel universes, can we move between them? Within the context of a holographic multiverse, wormholes, also known as Einstein-Rosen bridges, have been proposed as pathways connecting parallel universes. Susskind and Maldacena suggest wormholes be viewed as entanglement between black holes. [40] Though wormholes have not yet been physically observed, they've been envisioned as intra or inter-universe connections since Einstein and Rosen first proposed the Einstein-Rosen bridge. [41]

Considering how entanglement can construct space-time suggests a role quantum physics plays with respect to gravity. Physicists have recently proposed that two entangled black holes, when pulled apart, form a wormhole "shortcut" between the two of them. Building upon earlier research by Jensen and Karch, [42] Sonner has shown that the creation of a pair of entangled quarks gives rise to a wormhole connecting the two of them. Sonner mapped the pairs of created quarks he created onto four-dimensional space, utilizing holographic duality to derive a more complex dimension from a lower dimension. In this way, Sonner witnessed that what emerges together with two entangled quarks is a wormhole. [43]

SUMMARY

Macroscopic quantum processes including coherence, entanglement, superposition, and teleportation provide living organisms with competitive advantages, improving efficiencies and environmental adaptability beyond what reductionist classical systems can achieve. Evidence has been found for non-trivial macroscopic quantum behavior in the fields of biology, quantum physics, quantum computing, quantum astronomy, and neuroscience, with fascinating implications for possible macroscopic quantum effects in the fields of medicine, psychology and sociology. Further exploration of macroscopic quantum processes holds great promise, as quantum macro phenomena offer such exotic gifts as gleaning knowledge of future decisions and intuiting optimal decision paths.

One of the biggest surprises of reviewing macroscopic quantum processes is noting that they appear to play an active role in establishing fine-tuning in the manner

required to support life. Macroscopic quantum processes are seemingly responsible for pushing together salient time scales in the FMO transport mechanism, allowing green sulphur bacteria to readily adapt to and thrive within a broad adaptive range of environmental variables, such as temperature.

Recognition that macro quantum phenomena can unexpectedly appear in the form of inexplicable increases in the efficacy of inert placebo treatments in rigorous scientific experiments warrants an overhaul of long-standing assumptions regarding objectivity. It seems likely that the scientific method will benefit from including consideration of entanglement between researchers, subjects, expectations, and other experimental variables.

cynthia@realityshifters.com
Reality Shifters
http://www.realityshifters.com

REFERENCES

[1] Friedman, Jonathan R., *et al.* "Quantum superposition of distinct macroscopic states." *Nature* 406.6791 (2000): 43-46.

[2] Bruno, Natalia, *et al.* "Displacement of entanglement back and forth between the micro and macro domains." *Nature Physics* 9.9 (2013): 545-548.

[3] Lee, K. C., *et al.* "Entangling macroscopic diamonds at room temperature." *Science* 334.6060 (2011): 1253-1256.

[4] Trewavas, Anthony J., and František Baluška. "The ubiquity of consciousness." *EMBO reports* 12.12 (2011): 1221-1225.

[5] Sekatski, Pavel, Nicolas Gisin, and Nicolas Sangouard. "How difficult it is to prove the quantumness of macroscropic states?." arXiv preprint arXiv:1402.2542 (2014).

[6] Lambert, Neill, *et al.* "Quantum biology." *Nature Physics* 9.1 (2013): 10-18.

[7] Engel, Gregory S., *et al.* "Evidence for wavelike energy transfer through quantum coherence in photosynthetic systems." *Nature* 446.7137 (2007): 782-786.

[8] Lloyd, Seth. "Quantum coherence in biological systems." *Journal of Physics: Conference Series*. Vol. 302. No. 1. IOP Publishing, 2011.

[9] Chin, A. W., S. F. Huelga, and M. B. Plenio. "Coherence and decoherence in biological systems: principles of noise-assisted transport and the origin of long-lived coherences." *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 370.1972 (2012): 3638-3657.

[10] Bandyopadhyay, Jayendra N., Tomasz Paterek, and Dagomir Kaszlikowski. "Quantum coherence and sensitivity of avian magnetoreception." *Physical review letters* 109.11 (2012): 110502.

[11] Turin, Luca. "A spectroscopic mechanism for primary olfactory reception." *Chemical Senses* 21.6 (1996): 773-791.

[12] Brookes, Jennifer C., *et al.* "Could humans recognize odor by phonon assisted tunneling?." *Physical review letters* 98.3 (2007): 038101.

[13] Cramer, John G. "The transactional interpretation of quantum mechanics." *Reviews of Modern Physics* 58.3 (1986): 647.

[14] Hosten, Onur, and Paul Kwiat. "Observation of the spin Hall effect of light via weak measurements." *Science* 319.5864 (2008): 787-790.

[15] Dixon, P. Ben, *et al.* "Ultrasensitive beam deflection measurement via interferometric weak value amplification." *Physical review letters* 102.17 (2009): 173601.

[16] Bem, Daryl J. "Feeling the future: experimental evidence for anomalous retroactive influences on cognition and affect." *Journal of personality and social psychology* 100.3 (2011): 407.

[17] Feinbert, Cara. "The Placebo Phenomenon: An Ingenious Researcher Finds the Real Ingredients of 'Fake' Medicine." *Harvard Magazine* Jan-Feb (2013)

[18] Spiegel, Alix. "The Growing Power of the Sugar Pill." *National Public Radio* (NPR) March 8 (2010).

[19] Weger, Ulrich W., and Stephen Loughnan. "Mobilizing unused resources: Using the placebo concept to enhance cognitive performance." *The Quarterly Journal of Experimental Psychology* 66.1 (2013): 23-28.

[20] Langer, Ellen, *et al.* "Believing Is Seeing Using Mindlessness (Mindfully) to Improve Visual Acuity." *Psychological Science* 21.5 (2010): 661-666.

[21] Price, Donald D., Damien G. Finniss, and Fabrizio Benedetti. "A comprehensive review of the placebo effect: recent advances and current thought." *Annual Review of Psychology* 59 (2008): 565-590.

[22] Walach, Harold. "Generalized entanglement: a new theoretical model for understanding the effects of complementary and alternative medicine." *Journal of Alternative & Complementary Medicine* 11.3 (2005): 549-559.

[23] Manek, Nisha J., and William A. Tiller. "A new perspective on "the placebo effect": Untangling the entanglement." Medical hypotheses 77.4 (2011): 614-619.

[24] Radin, Dean, and Eva Lobach. "Toward understanding the placebo effect: investigating a possible retrocausal factor." *The Journal of Alternative and Complementary Medicine* 13.7 (2007): 733-740.

[25] Hawking, Stephen W., and Thomas Hertog. "Populating the landscape: A top-down approach." *Physical Review D* 73.12 (2006): 123527.

[26] Larson, Cynthia Sue. Quantum Jumps: An Extraordinary Science of Happiness and Prosperity (2013): 56.

[27] Neisser, Ulric, and Nicole Harsch. "Phantom flashbulbs: False recollections of hearing the news about Challenger." (1992): 9-31.

[28] Winningham, Robert G., Ira E. Hyman, and Dale L. Dinnel. "Flashbulb memories? The effects of when the initial memory report was obtained." M*emory* 8.4 (2000): 209-216.

[29] Hung, Iris W., and Aparna A. Labroo. "From firm muscles to firm willpower: Understanding the role of embodied cognition in self-regulation." *Journal of Consumer Research* 37.6 (2011): 1046-1064.

[30] Carney, Dana R., Amy JC Cuddy, and Andy J. Yap. "Power posing brief nonverbal displays affect neuroendocrine levels and risk tolerance." *Psychological Science* 21.10 (2010): 1363-1368.

[31] Cuddy, Amy JC, Caroline Ashley Wilmuth, and Dana R. Carney. "The benefit of power posing before a high-stakes social evaluation." (2012).

[32] Epstein, Robert. "How science can help you fall in love." *Scientific American Mind* 20.7 (2010): 26-33.

[33] Levy, Becca R., *et al.* "Association between positive age stereotypes and recovery from disability in older persons." JAMA 308.19 (2012): 1972-1973.

[34] Levy, Becca R., *et al.* "Longevity increased by positive self-perceptions of aging." *Journal of Personality and Social Psychology* 83.2 (2002): 261.

[35] Ball, Philip. "Experts still split about what quantum theory means. Poll reveals diverse views about foundational questions in physics." *Nature* (2013)

[36] Schellekens, A. N. "Life at the interface of particle physics and string theory." *Reviews of Modern Physics* 85.4 (2013): 1491.

[37] Mersini-Houghton, Laura, and Richard Holman. "``Tilting" the universe with the landscape multiverse: the dark flow." *Journal of Cosmology and Astroparticle Physics* 2009.02 (2009): 006.

[38] Taylor, Rosie. "Is Our Universe Merely One of Billions? Evidence of the Existence of 'Multiverse' Revealed for the First Time by Cosmic Map." *Mail Online*. 19 May 2013.

[39] Bousso, Raphael, and Leonard Susskind. "Multiverse interpretation of quantum mechanics." *Physical Review D* 85.4 (2012): 045007.

[40] Maldacena, Juan, and Leonard Susskind. "Cool horizons for entangled black holes." *Fortschritte der Physik* 61.9 (2013): 781-811.

[41] Einstein, Albert, and Nathan Rosen. "The particle problem in the general theory of relativity." *Physical Review* 48.1 (1935): 73.

[42] Jensen, Kristan, and Andreas Karch. "Holographic Dual of an Einstein-Podolsky-Rosen Pair has a Wormhole." *Physical review letters* 111.21 (2013): 211602.

[43] Sonner, Julian. "Holographic Schwinger Effect and the Geometry of Entanglement." *Physical review letters* 111.21 (2013): 211603.