Examining the nature of retrocausal effects in biology and psychology

Julia Mossbridge

Citation: AIP Conference Proceedings **1841**, 030004 (2017); doi: 10.1063/1.4982775
View online: http://dx.doi.org/10.1063/1.4982775
View Table of Contents: http://aip.scitation.org/toc/apc/1841/1
Published by the American Institute of Physics

Examining the Nature of Retrocausal Effects in Biology and Psychology

Julia Mossbridge[1,2,a)]

[1]*Visiting Scholar, Department of Psychology, Northwestern University, Evanston, IL 60208, USA*
[2]*Scientist, Institute of Noetic Sciences, Petaluma, CA, 94952, USA*

[a)]Corresponding author: jmossbridge@gmail.com

Abstract. Multiple laboratories have reported physiological and psychological changes associated with future events that are designed to be unpredictable by normal sensory means. Such phenomena seem to be examples of retrocausality at the macroscopic level. Here I will discuss the characteristics of seemingly retrocausal effects in biology and psychology, specifically examining a biological and a psychological form of precognition, *predictive anticipatory activity* (PAA) and *implicit precognition*. The aim of this examination is to offer an analysis of the constraints posed by the characteristics of macroscopic retrocausal effects. Such constraints are critical to assessing any physical theory that purports to explain these effects. Following a brief introduction to recent research on PAA and implicit precognition, I will describe what I believe we have learned so far about the nature of these effects, and conclude with a testable, yet embryonic, model of macroscopic retrocausal phenomena.

BACKGROUND

I will be discussing two forms of *precognition*, which I will define here as the ability to gain accurate information about upcoming events that are not predictable by using any of the five senses or inference. To my knowledge, getting information about the future cannot currently be distinguished from the case in which a future event is correlated to a person's mental state in the present, precognition can be considered to be a macroscopic manifestation of retrocausality. However, "causality" may be a misnomer in this particular case (and perhaps in general), as thus far there is no need to suppose that an event that is precognized *changes* an individual's mental state, just that there is a correlation between them (e.g., [1]).

Before diving into this attempt to describe the nature of macroscopic retrocausal effects, it is worth going over two psychological concepts: *consciousness* and *nonconscious processes*. I'm going to use as my definition of consciousness the one offered by Chief Scientific Officer of the Allen Institute for Brain Science, Christof Koch. To wit, "By consciousness I mean the ability to feel something, anything -- whether it's the sensation of an azure-blue sky, a tooth ache, being sad, or worrying about the deadline two weeks from now" [2]. In other words, in the present discussion, consciousness is equated with waking experience. My working definition of *nonconscious processes* is that they are the complement of consciousness – they comprise all processes that we do not experience. Note that I try not to refer to "nonconsciousness." This is because the suffix "–ness" suggests something that can be experienced. To give an example of the difference between these two terms, I am conscious of writing these words and I presume you are conscious of reading them, but neither of us is conscious of all the physical processes that are being used to support the feats of reading and writing. Those physical processes are nonconscious, in the sense that the real-time internal intricacies of these processes do not inhabit our daily waking experience. Whether these physical processes are conscious of themselves is an interesting question that I will not attempt to address here.

Quantum Retrocausation III
AIP Conf. Proc. 1841, 030004-1–030004-8; doi: 10.1063/1.4982775
Published by AIP Publishing. 978-0-7354-1511-9/$30.00

There are two reasons why we must define consciousness and nonconscious processes in order to understand precognition. First, as we will shortly see, nonconscious processes seem to be much more involved in precognition than consciousness is, at least for the forms of precognition to be examined here. Second, by reminding ourselves that nonconscious processes have access to information that is not always shared with consciousness, we can begin to feel not so strange about the idea that some kind of process can predict future events. In other words, once we place ourselves in the psychological stance of humility vis-à-vis the folk belief that consciousness reveals the world to us as the world really is, we may find the idea of reverse-time phenomenon at the macroscopic level easier to swallow (e.g., [3]). Please consider a few arguments to illustrate this fundamental point, then we will get on with discovering what the precognition data tell us.

If consciousness presented to us the world as it actually is, there would be no visual illusions, because appearances would be equivalent with reality. We would find Einstein's theory of relativity unsurprising, as it would completely mesh with our phenomenal experience. Quantum mechanics? Easy! Every schoolchild would understand complementarity and entanglement, as from a young age we would experience everything in the physical world exactly as it is. Clearly, none of these musings hold. The main reason we have jobs as scientists is that we do not experience the world exactly as it is. We experience it, instead, exactly as our brains present it to consciousness. Nonconscious processes prepare information for us, sometimes presenting it to us in a way that does not match physical reality – either because of limitations in our nervous systems, or because life is actually more efficient the less information our perceptual systems try to represent [4].

Once you see that your consciousness is not always an accurate predictor of how physical processes actually work, it is not a great leap to suggest that perhaps your conscious sense of the forward-only movement time is another re-presentation that may not perfectly match physical reality. Essentially, this idea is just extending Plato's allegory of the shadows on the cave wall to include the timing of those shadows; that is to say, their timing may not represent the timing of the events that cause them. For instance, the events that caused them could be light-years away, so that there is a delay between the physical events and our experience of it that we cannot sense inside the cave. Or the events that caused the shadows could be unordered, all occurring at once, but the shadows on the cave wall are organized in a temporal order through a process of which we are not aware. More generally, our forward-only sense of temporal flow might be a useful fiction produced by our nonconscious processes. The flow of physical time may actually be symmetric, as suggested by many physical equations. If this is the case, then you might expect that there could be physiological and psychological states in which the useful fiction of asymmetric time breaks down and the underlying physical reality of a symmetric temporal flow is revealed and can be monitored in the laboratory. My sense is that this is what precognition represents, but it is worth reviewing the data that have led me to this conclusion.

WHAT HAVE WE LEARNED ABOUT NONCONSCIOUS PRECOGNITION?

While not aiming to recreate a summary of precognition research in general (for this, please see [5]), here instead I will briefly describe a distillation of what we have thus far learned about two types of precognition, *predictive anticipatory activity* (PAA; also called presentiment) and *implicit precognition*. I select these types because this is where my expertise lies and these two types of precognition seem to have similar characteristics. But it is worth mentioning that other types of precognition such as anomalous cognition (i.e. remote viewing) are also important to understand, and to that end, Marwaha and May have described anomalous cognition with an intriguing multimodal model [1]. However, anomalous cognition/remote viewing requires conscious access to future events and has a time scale on the order of hours, days, weeks, or years. Thus, my suspicion is that it has a different, or at least largely different, mechanism from PAA and implicit precognition, which are largely nonconscious phenomena with a briefer time scale.

Predictive Anticipatory Activity (PAA)

In one of the first PAA experiments, Dean Radin used heart rate, blood volume, and electrodermal activity as measures of generally nonconscious physiological arousal [6]. He recorded these variables as participants viewed a randomized series of images, each showing an event that was either calm or emotional (e.g., a picture of a sunset versus a picture of a house on fire). The dependent variables were the physiological measures in a pre-defined period prior to each different trial type (i.e., calm versus emotional), and the results revealed significantly different physiological changes prior to calm events as compared to emotional events, with the difference emerging on the order of seconds before an event. This basic result has been replicated multiple times across at least 12 laboratories since the original study. A recent statistical meta-analysis of PAA experiments indicates that the overall effect is between 5 and 6 sigma [7]. Potential problems with these data have been examined, including multiple analyses (*p*-hacking), fraud, and publication bias, though little evidence has been obtained to suggest that these problems produce the PAA phenomenon [7-8]. Of course, this conclusion has evoked debate (e.g., [9-10]). It is my opinion that barring methodological errors that might be discovered in the future, the data point in the direction of PAA being a physiologically real phenomenon.

Any model of macroscopic retrocausality should be informed by what we know about PAA to date. In my opinion, we can be fairly sure of four characteristics of PAA. *First*, the pre-responses that comprise PAA have features similar to the responses following emotional events. In other words, PAA can be seen as a mirror-in-time of post-event responses [11]. Supporting this idea is the observation that PAA effects in quick-responding physiological systems seem to occur very close in time prior to the event, just as post-event responses occur very close in time following the event. Meanwhile, PAA effects in slower-responding systems generally anticipate those in faster-responding systems (compare slower-responding skin conductance results in [6-7] with faster-responding brainwave results in [12-13]). *Second*, while PAA is a small effect, is statistically reliable. The overall effect size of PAA in the recent meta-analysis is estimated at around 0.2 (Hedges' *g*), which is small, but not vanishingly so [7]. It is likely that the size of the effect could be masked by noise introduced by inter-individual differences. *Third*, one candidate for individual differences that could influence the size of the PAA effect is gender. Women tend to show different effects as compared with those of men of the same age in some PAA experiments [e.g., 14-16]. *Fourth*, on average, PAA does not lead to conscious precognition. For example, in a task in which the contrasting emotional trials were "win" and "loss" in a game of chance (e.g., picking which of four neutral images would appear next), participants did not perform above chance on this game even when the physiological measures taken from these same participants showed a clear and statistically significant differentiation between times prior to win and loss trials [16]. These results suggest that PAA is the work of nonconscious processing, and the results of this processing are not commonly shared with consciousness.

To summarize, based on what we know right now, PAA effects seem to be a mirror-in-time of post-event responses, are small but reliable effects that could get bigger if gender and other individual differences were taken into account, and are likely produced by nonconscious processes. If implicit precognition were to rely on mechanisms shared with PAA, implicit precognition should also share these same traits. Let us see if that is the case.

Implicit Precognition

Implicit precognition experiments are used to examine retrocausal effects in a way that is hidden to participants unless it is pointed out to them. For example, we know that practicing a shape-recognition task improves performance on shape recognition [17], but consider the same procedure but with the order reversed in time. This kind of reverse-order task has been done, and it showed that people were better at shape recognition for shapes that on which they would be given practice in the future [18]. From the participants' point of view, the order of the procedure is a bit strange, but it is not clear to them that they are performing a precognition experiment unless the protocol includes a discussion of precognition. It is easy to see the appeal of implicit precognition tasks, as they reveal time-reversed versions of conventional effects, and therefore are relatively easy to implement. If this mirror-image characteristic sounds familiar, it should. It is one of the characteristics of PAA discussed previously. In the case of an implicit precognition experiment, it is the time-reversed procedure that is the mirror image in time of the usual procedure, but the procedure is designed this way because the implicit precognition effects obtained from them are the mirror images in time of the usual effects. Similar to PAA effects, the time scale for implicit precognition is on the order of seconds to minutes, although longer delays between the effect and the correlated events should be examined.

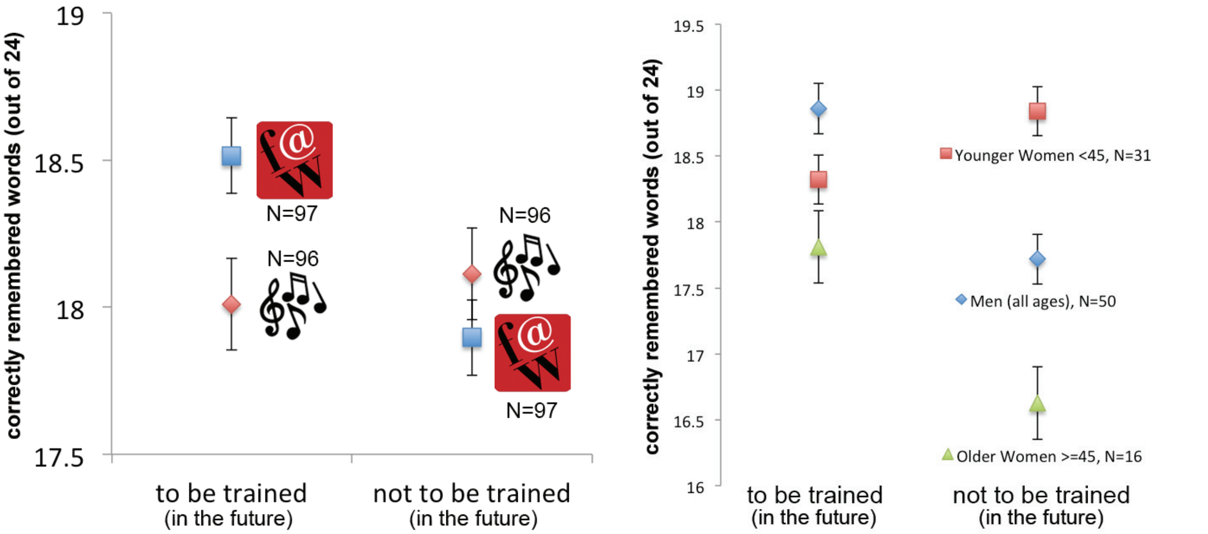
Implicit precognition experiments help participants to avoid the trap of consciously attempting to precognize future events, a method that does not seem to produce consistent results for most people [19-20]. This reliance on nonconscious processing is also shared with PAA. The idea that nonconscious processes are likely to subserve implicit precognition is also supported by the results from a recent meta-analysis of 90 implicit precognition experiments [21]. As was the case for the recent PAA meta-analysis [7], the implicit precognition meta-analysis revealed a very small effect size (0.09, Hedges' *g*, Confidence Intervals: 0.06 to 0.11), which was nonetheless a sixsigma effect. However, it turns out that implicit precognition experiments using tasks that required slower, deliberate responses did not produce reliable effects (0.03, Hedges' *g*, 95% Confidence Intervals: -0.01 to 0.08), while experiments requiring faster responses, when considered independently, produced a larger effect size (0.11, Hedges' *g*, 95% Confidence Intervals: 0.08 to 0.14) and were clearly responsible for the significance of the entire dataset. Thus it appears that faster responding facilitates implicit precognition, a result that was interpreted by Bem et al. [21] to mean that implicit precognition is largely served by nonconscious processes, which are notably faster than conscious ones.

We have seen that implicit precognition shares with PAA the characteristics of being: a temporal mirror-image of future responses, a small but reliable effect, and largely governed by nonconscious processes. What about gender effects in implicit precognition experiments? Analyzing gender effects when reporting results from implicit precognition experiments is apparently rare, as I was only able to find one such analysis. It showed that men had a larger precognition effect than women, but this difference was not significant [22]. In the recent meta-analysis of implicit precognition already discussed, gender was not described as a factor, but the authors provided no reports of gender or age effects [21].

I did find one interesting gender effect in an implicit precognition experiment of my own, and in order to explain it, I must first describe the original experiment on which it was based. The original experiment was Daryl Bem's "retroactive-facilitation-of-recall" experiment, in which participants were shown a list of words, then tested on word recall before getting practice on a randomly selected half of the words. Participants showed significantly better recall for the words that they would practice in the future [24]. This was an implicit precognition task because participants were not asked which words they thought they would study after they performed their word-memory test. However, the test employed slow and consciously deliberated responses, words typed by the participants without a time limit, as the dependent variable. As mentioned previously, although Bem's original retroactive-facilitation-of-recall experiment produced a significant effect, it has been difficult to replicate, as have other implicit precognition experiments using similarly slow response protocols [21]. Thus it seemed reasonable to attempt to replicate the same experiment using a protocol in which responses are faster (i.e., a *speeded-response* protocol), and doing so provided an opportunity to examine potential gender differences. The following description of that experiment allows the illustration of a gender difference in an implicit precognition experiment.

Working with Daryl Bem and the music service Focus@Will, I designed an online, speeded-response version of his retroactive-facilitation-of-recall experiment. It was similar to Bem's original experiment, except for five differences. The first difference was the obvious one – I included a speeded-response test to assess the precognitive effect, as contrasted with Bem's original deliberative response test. Second, I included a post-test that was meant to weed out anyone who did not pay attention during the practice period. In the experiment, participants saw a list of 48 words, performed a two-alternative speeded-response test in which they were asked which of two words was in the original list, practiced 24 of the words (randomly selected for each participant after the first speeded-response test), then performed a second two-alternative speeded-response test. The purpose of this second test was to allow a comparison of memory performance for the words that had been trained with the words that had not been trained. Data from participants who did not show equivalent or better performance for the trained words were dropped from the analysis, as the training did not work for these participants, and therefore a precognitive practice effect would not be meaningful. Note that this step was performed without regard to the dependent variables. The third difference between this study and Bem's original retroactive-facilitation-of-recall experiment was that this study was sponsored by Focus@Will, and they were interested in comparing performance while people listened to their heavily "streamlined" music (e.g., music lacking abrupt changes in pitch, rhythm, or intensity) as compared to regular music. Therefore, one group of participants listened to Focus@Will's streamlined music while they performed the task, and another group listened to their own choice of music while they performed the task. Fourth, the task was online instead of being administered in the laboratory, a change that takes the experimenter's bias out of the equation, at least in the local sense. Fifth, I removed data from anyone who achieved 95% correct and greater performance on the initial test, as these people do not require training to remember the words, and therefore a precognitive training effect would again be meaningless.

The results revealed that participants who listened to Focus@Will's streamlined music while they performed the task showed the precognitive effect, while the other group of participants did not. Specifically, recall for words in the original word list was better for the group listening to Focus@Will when the words were those that would be trained in the future as compared to the words that would not be trained in the future (2-tailed paired t-test, N=97, $p<0.018$; see Fig. 1a). Meanwhile, this difference was not seen for the other group who listened to their own choice of music. It is not clear why music should make a difference, but it is worth noting that Bem's original experiment was administered following a musical interlude that could be considered similar to the streamlined music created by Focus@Will [24].



(a) (b)

FIGURE 1. Word-recall performance in a retroactive-facilitation-of-recall experiment, in which training was given on a randomly selected 24 of the words in a 48-word list. This training *followed* an initial test, the results of which are shown here. (a) Performance on the initial test was significantly better for words that would be trained in the future as compared to words that would not be trained, but only for participants listening to streamlined music (marked by F@W icons). Participants listening to regular music did not show this implicit precognitive effect (marked with musical notes). (b) Performance on the initial test for listeners of streamlined music differed according to age and gender. Men of all ages (diamonds) and women 45 years and older (triangles) performed better on words to be trained in the future, whereas younger women (squares) performed better on words not to be trained in the future. [Note that because there were no significant differences between younger and older men, men of all ages are combined to reduce clutter.] Error bars represent +/- one standard error of the mean, within participants. See text for details.

Although the purpose of this digression was to discuss potential gender effects in implicit precognition experiments, I found something unexpected. When I analyzed the data to separate men from women, I saw an interesting interaction with age. All men, regardless of age, showed the precognition effect. However, while older women showed the same effect as men, women under the average age of the onset of menopausal symptoms (45 years old) showed an opposing effect (Fig. 1b). Because women's reproductive hormones change much more dramatically than men's during the course of their lives, this difference hints at a possible role for reproductive hormones in the mechanisms underlying implicit precognition. Further, my previous PAA data were drawn from participants under the age of 30, and in these data I saw a significant gender interaction in two different experiments, so it is possible that this age interaction could exist for PAA as well but has not yet been measured. In fact, a preliminary analysis of the PAA data suggests that this is indeed the case, although additional older women are necessary to fully test the hypothesis. Regardless of whether this gender interaction with age continues to be replicated, the gender effect itself seems consistent across at least some PAA and implicit precognition experiments, so gender should be considered a potential individual difference that, if it were accounted for in more PAA and implicit precognition experiments, could reduce noise in the data and increase effect sizes.

In sum, we can tentatively state that PAA and implicit precognition effects seem to share similar characteristics. They are both temporal mirrors of future responses to events, are small but reliable effects, may be influenced by gender, and finally, are largely dependent on nonconscious processes. Let us for now assume all four of these are correct observations, and further, based on the similarity of the two types of phenomena, that PAA and implicit precognition are governed by a shared mechanism. How might we model that mechanism?

AN EMBRYONIC MODEL OF MACROSCOPIC RETROCAUSAL EFFECTS

Based on present data, any responsible model of PAA and implicit precognition should be vague but testable. Only the four factors we have seen replicated need be explained, in addition to the time scales of the effects. Let us first consider the observation that these phenomena depend primarily on nonconscious processing. That rules out consciousness as being a major component of the mechanism, but there are so many processes not within consciousness that this does not really get us very far. In other words, this constraint does not differentiate between something that happens in our brains and something that happens in our livers, or even in the chairs on which we sit. But because my implicit precognition is expressed through my body, and yours is expressed through your body, we can reasonably conclude that at least part of the mechanism occurs somewhere in the nonconscious portions of our bodies.

Does the constraint that PAA and implicit precognition are mirrors-in-time of future responses help us? Maybe so, and this is where time scales enter the discussion. In order for any phenomenon to be relatively time symmetric, the duration of responses to events must be short enough to produce responses to important events as the life of the organism goes on. As a result of this logic, we can now say that the nonconscious portion of our bodies involved in PAA and implicit precognition must have a time constant that is on the order of milliseconds to minutes, not on the order of days, weeks, or years. We can test this aspect of the model by performing PAA and implicit precognition experiments in which future events are days, rather than seconds and minutes, in the future. According to the model, these experiments would not reveal PAA or implicit precognition.

We can imagine that the nonconscious portions of our bodies with suitably brief time constants behave like calm ponds in response to a dropped pebble. The pebble represents an event that is important to the physiological system, and in response to the event, ripples are sent out in all directions. Consciousness experiences only one set of ripples on one side of the riverbank, but by testing the other side of the riverbank using physiological (PAA) and behavioral (implicit precognition) experiments, we see that there are also ripples on the other side. The effect is reliable because the ripples are created every time an event perturbs the system. What this means in regular language is either that certain nonconscious physical systems that respond to perturbation in a temporally symmetric way, or that all physical systems respond symmetrically with respect to time and that certain nonconscious processes are less likely to be disturbed by noise or otherwise disrupted. While we can detect the retrocausal portion of this symmetry through experiment, we are not usually consciously aware of it. This ripple-in-the-pond model predicts that there should be no ripples when there is no pebble, a prediction we can test in multiple ways. We can examine whether pre-event responses disappear, as the model predicts, when there is no event. Similarly, we can determine whether PAA and implicit precognition effects scale directly with the size of the perturbation as measured by the size of post-event responses. Third, we can query the calmness of the pond. Assuming the “pond” in the model reflects a nonconscious physical system with a brief time constant and its “calmness” has to do with how many other responses are going on at the same time, we could directly test different nonconscious physical systems with different thresholds of responsiveness. Those that have a low threshold we would predict would not show the PAA effect except for very large perturbations, because they might be so unstable that any small perturbation would get lost in all the other responses (or ripples) already present in the system.

How does gender fit in here? Well, if reproductive hormones rather than gender are really the underlying cause of the gender differences seen in PAA and implicit precognition experiments, we have a shot an explanation. Steroid hormones, which include progesterone, testosterone, and the estrogens, influence gene expression in almost every cell in the human body. It could be that within the nonconscious physical system involved in precognition, testosterone boosts genes for proteins that make people more emotionally reactive *after* events such as winning a game, doing well on a test, or seeing violent/erotic images, and it is also possible that estrogen and/or progesterone mutes these same genes. Then by our ripple-in-the-pond model this would translate into higher reactivity *prior* to perturbing events in men and older women (who have lower estrogen and progesterone). Another hypothesis is that estrogen and progesterone increase disturbances in nonconscious systems that respond temporally symmetrically, so that an upcoming event is more difficult to detect. Either idea could explain why PAA and implicit precognition seem to be stronger in men and older women than it in younger women. The hormonal aspect of the model could be tested by examining the performance of younger women at different times in their menstrual cycles on PAA and implicit precognition tasks.

One of the problems with getting an intuitive feeling for the physical aspects of any model of macroscopic retrocausality is that we feel we have to throw out the arrow of time. However, this is not the case. We can assume that the arrow of time over the course of our lifespans continues in a forward direction. This is a good assumption given that we can test the gradual change in biochemical markers for aging and see a general trend in a forward-time direction. However, the time scale of seconds and minutes is much shorter than a human life. As the reader is no doubt aware, an isolated system of gaseous particles illustrates for us a forward arrow of time while it evolves from the injection of the particles in the system to the point at which the system is at equilibrium. But when the same system is observed at smaller time scales, it can be impossible to determine the direction of the over-arching arrow of time is going, so these time scales the processes are reversible.

My guess is that macroscopic retrocausal effects are similar to short-term glimpses at an isolated system of gaseous particles. Because they have a time constant that is much shorter than the lifespan of an organism, nonconscious physical systems from which we can obtain clear retrocausal results may interpret a lack of obvious temporal direction in the most conservative way possible vis-à-vis the survival of the organism – they assume it is going in both directions in time. Meanwhile, to represent the world coherently, consciousness presents a single direction in time, matching the arrow of time in our lifespans. Thus when we tap into nonconscious processes at brief time scales, we see both pre- and post-event responses. We record activity from both sides of the riverbank. On the other hand, when we tap into consciousness, we put ourselves at a particular location relative to the pebble and its ripples. In waking everyday experience, for most people, this position is what we call the present, and it is the "forward-time" side of the riverbank.

As a highly speculative aside, this idea may amount to equating consciousness with time and nonconscious processes, or physical processes in general, with space. I say this because for most people, in everyday waking consciousness, time moves consistently in one direction from a knowable past and into an unknowable future. In fact, it is difficult to imagine everyday waking experience, or experience at all, without an arrow of time of some sort. Either all events would happen at once or a single event would remain present forever. Neither of these is anything close to what consciousness is like [25]. Thus, is not clear how to define consciousness without time. Meanwhile, for nonconscious or any physical processes operating on a short time scale, it appears that the entire system – the pebble, the ripples, and the pond – might be represented all at once, like a snapshot. In a way what I am saying is that perhaps consciousness could contain the temporal aspects of the physical world, while the physical world could contain the spatial aspects of consciousness. If the mental is the physical in time and the physical is the mental in space, this would make the mental and physical complementary, just as time and space can seem to be. However, testing this tantalizing idea would require defining it much more clearly, which is beyond the scope of this paper.

As to the million-dollar question – how a physical system is able to respond to a perturbing event in a time-symmetric fashion – although I have tried to address it, I think it is the wrong question. Based on the time symmetry apparent in most physical equations, if we assume that most physical systems respond symmetrically in time, then the million-dollar question becomes how knowledge about a reverse-time order of events is generally shielded from our consciousness. I certainly do not know now, but I hope to find out in the future.

ACKNOWLEDGMENTS

Thank you to the Bial Foundation for generous support via Bursary 141/10, and Daniel Sheehan for multiple conversations on this topic. Also thanks to an insightful anonymous reviewer.

REFERENCES

1. S. B. Marwaha & E. C. May, SAGE Open, **5**, 1-17 (2015).
2. C. Koch, Consciousness is everywhere, http://www.huffingtonpost.com/christof-koch/consciousness-is-everywhere_b_1784047.html? (last accessed August 29, 2016).
3. J. Mossbridge, arXiv preprint arXiv:1503.01368, (2015).
4. D. Hoffman, "The interface theory of perception: Natural selection drives true perception to swift extinction," in Object Categorization: Computer and Human Vision Perspectives, edited by S. Dickinson, M. Tarr, A. Leonardis, B. Schiele (Cambridge University Press, Cambridge, UK, 2009), pp. 148–165.
5. J. Mossbridge and D. Radin, Psychology of Consciousness: Theory, Research, and Practice (2016 in press).
6. D. Radin, Journal of Scientific Exploration, **11**, 163-180 (1997).
7. J. Mossbridge, P. Tressoldi, & J. Utts, Frontiers in Psychology, **3**, 390 (2012).

8. J. Mossbridge, P. Tressoldi, J. Utts, J. A. Ives, D. Radin & W. B. Jonas, Frontiers in Human Neuroscience, **8**, 146 (2014).
9. J Mossbridge, P. Tressoldi, J. Utts, J. A. Ives, D. Radin & W. B. Jonas, arXiv:1501.03179v2 [q-bio.NC], (2015).
10. D. S. Schwarzkopf, Frontiers in Human Neuroscience, **8**, 332 (2014).
11. D. J. Bierman, The Journal of Parapsychology, **74**, 273 (2010).
12. R. McCraty, M. Atkinson, and R. T. Bradley, The Journal of Alternative & Complementary Medicine, **10**, 325-336 (2004).
13. D. Radin, C. Vieten, L. Michel, and A. Delorme, Explore: The Journal of Science and Healing, **7**, 286-299 (2011).
14. D. Radin and A. Borges, Explore: The Journal of Science and Healing, **5**, 200-211 (2009).
15. D. Radin and E. Lobach, The Journal of Alternative and Complementary Medicine, **13**, 733-740 (2007).
16. J. Mossbridge, M. Grabowecky, and S. Suzuki, "Physiological markers of future outcomes: three experiments on subconscious psi perception during concurrent performance of a guessing task" in 54th Annual Convention of the Parapsychological Association, 2010.
17. J. M. Vanderplas, and E. A. Garvin, Journal of Experimental Psychology, **57**, 155-163 (1959).
18. M. Franklin, S. Baumgart, and J. Schooler, Frontiers in Psychology, **5**, 907 (2014).
19. J. C. Carpenter, Journal of Parapsychology, **68**, 217-254 (2004).
20. J. C. Carpenter, Journal of Parapsychology, **69**, 63–112 (2005).
21. D. Bem, P. E. Tressoldi, T. Rabeyron, and M. Duggan, F1000Research, **4** (2016).
22. G. A. Hitchman, C. A. Roe, and S. J Sherwood, The Journal of Parapsychology, **76**, 109-145 (2012).
23. D. Bem, personal communication via email, 8/9/16.
24. D. Bem, Journal of Personality and Social Psychology, **100**, 1–19 (2011).
25. I. Barušs, and J. Mossbridge, Transcendent Mind: Rethinking the Science of Consciousness. (American Psychological Association Books, Washington, D.C, 2016).