

SEEMING BACKWARD-IN-TIME ACTIONS IN FORWARD-IN-TIME REALISTICALLY INTERPRETED ORTHODOX RELATIVISTIC QUANTUM FIELD THEORY

Henry P. Stapp

ABSTRACT: Many experiments seem to require causal influences acting into the backward light cone. Any such effect, if true, would conflict with the basic forward-in-time-dynamics of orthodox relativistic quantum field theory. It is shown here how such an appearance can arise from a difference between two different conceptions of the past. Two diagrams will illustrate how the Bem-reported results of his “erotic picture” experiments can be understood within forward-in-time realistically interpreted orthodox quantum field theory. A separate second topic is “quasi-orthodox quantum mechanics” in which nature’s responses to the observer’s probing queries are biased away from the Born-rule prediction, and in favor of “stimulating” human experiences, in concordance with Bem’s data.

KEYWORDS: Retrocausation; Quasi-orthodox

INTRODUCTION

This talk is about an important difference between two different conceptions of the past, which I call “the actual past” and the “historical past. If we are interested in what was going on during an experiment that concludes with an observation---which is coupled to an associated collapse of the evolving quantum state (i.e., density matrix) of the system being studied---then the “actual past” is what was actually going on in that system during the experiment. However, that “actual past” is not directly accessible to scientists working after the experiment has been completed. They need to deduce what was going on during the experiment from the empirical records (including memories) that exist **after** the experiment has been completed! The scientist/historians need to reconstruct what was going on before the collapse, on the basis of the records of that earlier temporal interval that survive the collapse.

The problem is that an observation-induced collapse generally eliminates certain

potentialities that existed before the collapse, and it simultaneously (according to the orthodox theory) eliminates all records of the eliminated potentialities. The “reconstructed history of the past” I call “the historical past”. It is basically a fiction that can differ from the afore-mentioned “actual past”! But this reconstructed version is *what seems* to us, after-the-fact, to have occurred during the experiment. It is the backward-in-time continuation, via the inverse of Schroedinger process, of the reality that exists after the collapse: our minds naturally seek to attribute observed physical effects to physically conceived causes.

In this talk I will show how certain seeming backward-in-time causal actions can be rationally understood **within the framework of realistically interpreted orthodox forward-in-time relativistic quantum field theory**. I shall illustrate this connection with two diagrams.

As a second **independent** topic, I shall consider a certain modification of strictly orthodox quantum theory, which I call quasi-orthodox quantum mechanics, that, without using QZE (Sudarshan/Misra/von Neumann Quantum Zeno effect), allows a person’s mental effort to influence his or her bodily behavior.

WHAT IS ORTHODOX FORWARD-IN-TIME DYNAMICS?

According to both Ordinary Classical Mechanics and Orthodox Quantum Mechanics, the state of the universe evolves forward in time, in the following sense.

The present instant ‘Now’, where the current reality exists, consists of a 3D subspace of 4D space-time. This 3D subspace “now” (or the “the present instant”) separates a fixed-and-settled past from a yet-to-occur future. “The 3D Present Instant Now” moves forward in 4D space-time, from earlier times to later times.

The fixed-and-settled past lying earlier than the present instant “now” cannot be revised: Backward-in-time causal actions that change the fixed and settled past are strictly forbidden in orthodox quantum theory. (Backward-in-time Feynman propagation of a particle is interpreted as forward-in-time propagation of the anti-particle.)

“ACTUAL PAST” VERSUS “HISTORICAL PAST”

Hawking and Mlodinow famously said, in their book ‘The Grand Design’: “We create history by our observations, history does not create us!

What does this mean, and why is it important?

According to Quantum Mechanics, an observation results in a perception that is coupled to an instantaneous collapse of the prior quantum state of the system to the

part of itself that is consistent with that perception.

Prior to this collapse, reality is represented by a forward-in-time evolving density matrix of the universe. This evolving density matrix leaves in its wake a growing sequence of previously existing states of the universe, each represented by a density matrix. I call this ordered sequence of previously existing density matrices the “actual past”.

In a scientific experiment one keeps **records** of what is happening! In the density matrix formalism, ***the records*** of those components of the evolving state of the universe that are eliminated in the collapse are eliminated along with the elimination of those eliminated components themselves. We find no records of the prior possibilities that we eliminated and hence did not occur!

The “historical past” is a fictional past reconstructed, **after the experiment is completed**, on the basis of the records that survive the collapse associated with the perception. The scientist/historians seek to discover what was going on before the observation/collapse by finding the past that evolves via the Schroedinger process into the reality that exists after the observation. But that procedure would be a logical error, due to the corruption of the records of the past produced by the observation-induced collapse.

THE KEY POINT

If a scientist/historian does not fully account for the fact that the “historical past” is conceptually very different from the “actual past”, then he or she might naturally imagine that the “actual past” has been changed to the “historical past” by some **backward-in-time dynamical action**.

But that would be a logical error! The “actual past” is not dynamically transformed into the “historical past”. The actual past, in forward-in-time orthodox quantum theory, is part of a fixed and settled past that is never revised. The “historical past” is a fictional reconstruction of the pre-collapse past based on the records that survive the collapse. That is logically a very different thing! The historical past is not a dynamically evolved continuation of the actual past! Nor is the actual past the result of a backward-in-time dynamical continuation of what existed after the collapse. The actual past, according to the orthodox forward-in-time theory, is fixed-and-settled at the moment it comes into being, and is never revised! There is no retro-causation! **The seeming backward-in-time causal action is an illusion, created by a failure of intuition to fully accommodate, in the process of reconstructing the pre-observation past, the collapse-induced corruption of the records of the past.**

THE NATURE OF NATURE'S CHOICES

Orthodox quantum mechanics involves two kinds of choices: human choices, and nature's choices.

What is the nature of Nature's choices?

According to the Principle of Sufficient Reason (which I try to honor):

“Nothing Happens Without a Sufficient Reason”.

But what are the reasons behind these choices?

Humans make choices of the questions we ask of nature, and nature makes choices of the responses she delivers to those questions.

Our human choices of how to act seem to stem from a felt wish to advance our felt values.

Could nature's choices similarly stem from her values?

QUASI-ORTHODOX QUANTUM THEORY

In the forgoing discussion of the orthodox theory the choices on the part of nature have been assumed to be in accord with the so-called Born rule, which is the quantum analog of the classical idea that equal volumes of phase space are equally weighted.

But the ubiquitous direct evidence of everyday life seems to show that our mental intentions can influence our bodily actions.

How can quantum mechanics account for this apparent influence of mind upon matter?

I propose considering, as a modification of Orthodox Quantum Theory, that nature's choices of responses to our queries are inclined to favor her values, which include allowing us to achieve what we value.

In this **quasi-orthodox QM**, if a person asks a question whose affirmative answer is something he or she positively values, and nature's responses tend to give us what we value, then we can, simply by asking the right questions, tend to make the physically described world behave as we desire. The apparent physical effectiveness of our mental intentions would then no longer be merely “The Illusion of Conscious Will”. The actual “illusion”, as mentioned above, would be that there is backward-in-time causal action!

AN APPLICATION

Bem's Precognitive Detection of Erotic Stimuli.

Bem's “Erotic Picture” Experiment.

The Subject Sees Two Monitors.



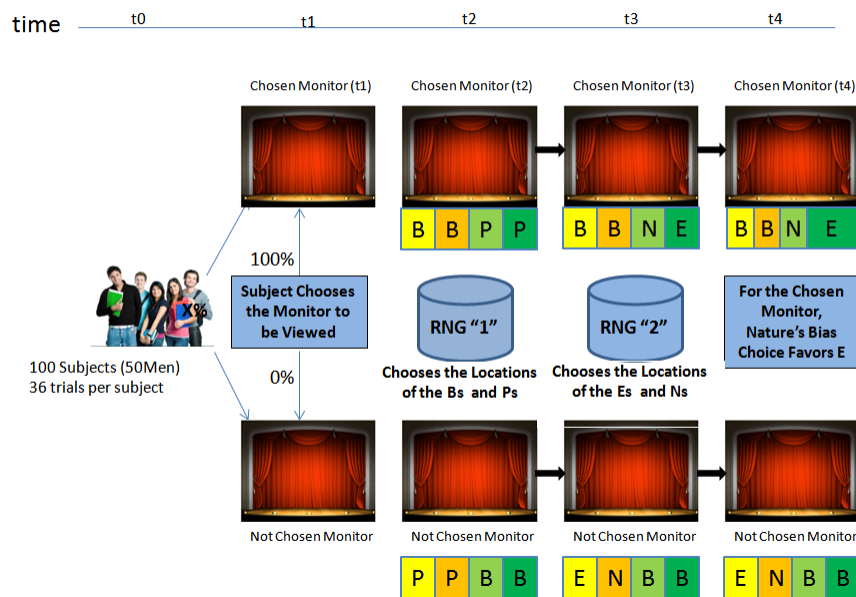
Left Monitor



Right Monitor

The density matrix in our case of the two monitors consists of two 4×4 diagonalized matrices. Each entry is associated with a visual image. In the diagram below, the colored four-component bar under each monitor represents the associated four diagonal elements, reading from left to right.

Here is the Four-Step Trial Sequence



The trial process proceeds from left to right. First, the subject chooses which of the two monitors he or she will view at the conclusion of the experiment. After this initial choice is made and securely recorded, two random number generators (RNGs) (which are arranged to be causally physically disconnected from the subject's free choice of monitor) make their random choices. RNG₁ chooses 50-50 the monitor in which a

mechanism will place the Blank Wall (B), and in which to place a picture (P). Then RGN₂ chooses whether the picture is Erotic (E), or Non-erotic (N).

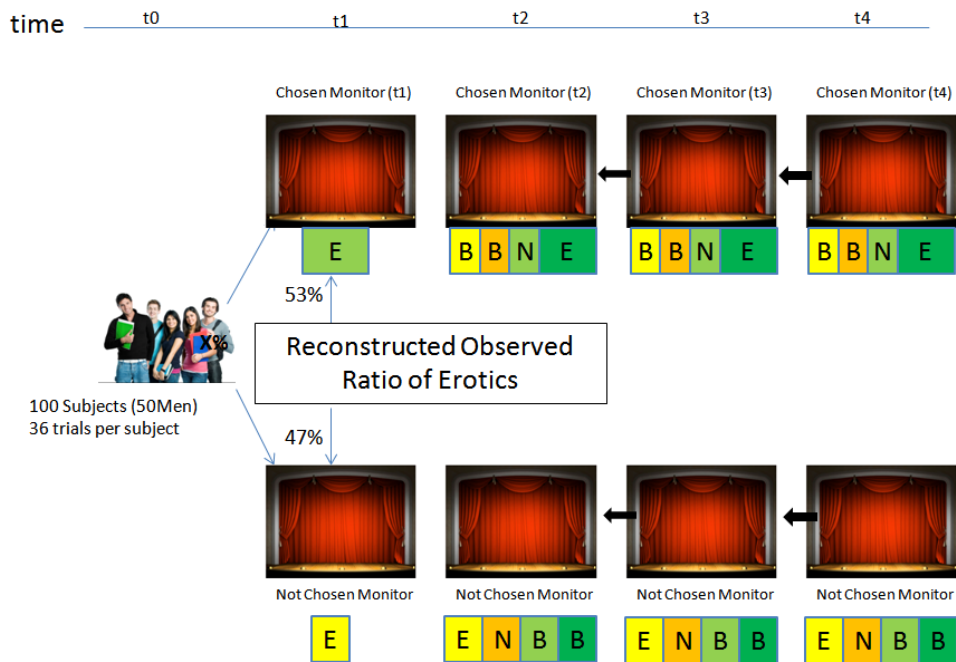
As mentioned above, the four-component colored bar under each monitor represents the four diagonal elements, reading from left to right, of the diagonalized density matrix associated with that monitor. The size of each little box indicates its statistical weight. Thus four boxes of equal size signify that each has weight 25%. Equi-colored boxes for the two monitors are dynamically coupled by the mechanism that the experimenters have set up to distribute the properties B, P, N and E unbiasedly between the two monitors.

The dynamical process just-described establishes, with the aid of two RNGs, certain correlations between the various kinds of visual images and the locations of the associated matrix elements.

The dynamical process proceeds from the leftmost column, representing the subject's choice of monitor, to the rightmost, representing nature's choice of what the subject will perceive at the conclusion of the experiment. The subject sees only what is displayed on the chosen monitor. No one perceives what exists, unperceived, on the monitor that is not chosen. Hence there is no associated "nature's choice", and hence no bias (in the quasi-orthodox case) of any nature's choices with regard to that monitor.

The weight represented by the size of the box specifies the probability defined by the Born Rule. The change in the size of the erotic box in the chosen monitor in going from the third to the final column reflects, in the quasi-orthodox case, the (assumed) biasing in favor of E of nature's choice. In the strictly orthodox case it represents the condition that the collapse reduces the prior density matrix of the system from the one in which the probabilities for (B, B, N, E) are (25%,25%,25%,25%) to one in which these probabilities are, say, (23%,23%,23%, 31%). The point here is that even in strictly orthodox QM, the experimenters can set-up the described (Bem) experiment. Let $\rho(t)$ be the density matrix of the system before the collapse, and let P be the projection operator that projects onto the E state, and that the collapse reduces $\rho(t)$ to $\text{PrhoP}(t')$, with t a time before the collapse and t' a time after the collapse. Then the reconstruction takes $\text{PrhoP}(t')$ back to $\text{PrhoP}(t)$. Thus actual $\rho(t)$ gets replace in the reconstruction by $\text{PrhoP}(t)$, which is the part of ρ that concerns E. Hence the E part of ρ becomes favored in the historical reconstruction. The enlarged E box in the picture on the far right in the first line of the above diagram corresponds to a less extreme version of the favoring of E in $\rho(t')$. [I have over-simplified the account given above in order to have simple expressions to write down to illustrate the main idea that follows from the more complex correct argument that a skilled physicist could supply.]

RECONSTRUCTING THE (HISTORICAL) PAST

Here is the Four-Step Sequence
That Reconstructs the Past

The historical past is constructed by starting from the final state, which is positioned on the far right in the above diagram, and determining the earlier states by using the inverse of the Schroedinger process.

Bem regards all trials except those with erotic pictures as just background. This restriction leads to the leftmost column and, for a sufficient enhancing of E on the right, to the Bem-reported ratio $53/47$ of the number of erotics appearing on the chosen monitor to those appearing on the monitor that was not chosen.

CONCLUSION

The seeming backward-in-time causal actions can be explained within strictly orthodox RQFT by a failure of the scientists who are analyzing the results of the

experiment to take full account of the corruption of the records of the past caused by the collapse associated with an observation, and hence the essential difference between the actual and historical pasts. This situation is completely analogous to the situation in delayed choice experiments, in which certain reconstructed histories are found to be incompatible with the initial boundary conditions and hence not allowable descriptions of a possible actual past. The reconstructed “historical past” is fictional “fake news”, not concordant with the “actual past”!

APPENDIX ONE: FIRST ADDRESS AT FOM 3:

The role of the observer in quantum mechanics

I am giving at this conference two talks on essentially the same topic: “The role of the observer in quantum mechanics.” There are, however, many competing versions of quantum mechanics, and “the observer” plays different roles in different versions.

I shall restrict my comments to the “Orthodox interpretation”. This is the name given by Eugene Wigner to John von Neumann’s casting of the ideas of the founders of quantum mechanics into a more rigorous mathematical form. I believe the term “orthodox” is appropriate because this interpretation is the original mathematically well defined formulation against which all others are compared in order to validate the “correctness” of their quantum predictions. And it conforms to the words of the founders of quantum theory, Heisenberg, Dirac, and Born.

In today’s talk, I shall use the words and ideas of von Neumann and of the founder’s to spell out the role of the observer in realistically interpreted orthodox QM. In tomorrow’s talk I shall use this interpretation to address the key issue of overriding importance: “Can a person’s conscious free will influence the behavior of his or her brain, and hence body?”

The direct experience of everyday life appears to inform us that one’s conscious will is efficacious in the physical world: I “will” my arm to rise and, normally, I see it rise!

Yet Western science and philosophy, to which I strictly adhere, has, from the seventeenth century time of Isaac Newton until the dawn of the twentieth century, claimed that these “appearances are deceiving”: that we human beings are actually mere mechanical automata, and that our lives are thereby reduced to meaningless charades.

On the other hand, realistic orthodox quantum mechanics naturally accounts the causal effectiveness in the physical world of one’s personal-value-based mental intentions!

That conclusion is what I intend to explain tomorrow!

=====

Today, I begin by recalling the meanings of “mind/mental” and of “matter/material”! Our mental lives are the subject matter of psychology, which William James identified as “such things as we call feelings, desires, cognitions, reasonings, decisions, and the like.” These aspects can be contrasted to “matter”, about which Isaac Newton said: “... it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, movable Particles.”

These words of James and of Newton, respectively, characterize the conceptions of mind and matter, respectively, that are used in classical mechanics, which is the theory that prevailed in science from the seventeenth until the twentieth century. James' conception of our human minds still applies, but Newton's idea of “matter”, or the physically described world, is now considered to be an “invention of the human mind”: No such particles exist in the orthodox conception of the “real” physically described quantum world. That world is represented by the quantum state ρ , which has the ontological character of a “Whiteheadian potentia”, which specifies the “possibilities/potentialities/probabilities for future experiences.”

In the year 1900 Max Planck discovered that nature did not conform to the classical precepts. That discovery was followed in 1905 by Einstein's account of the photo-electric effect, and in 1913 by Bohr's solar-system-like model of atoms. Bohr's model featured semi-stable orbits of electrons that made occasional jumps to other such orbits, with emission or absorption of photons.

But that 1913 Bohr model also failed! This failure was discussed by Heisenberg, who came to Copenhagen in the fall of 1924, having previously worked with Sommerfeld and Born on various problems pertaining to the behavior of atoms. Heisenberg recounted that upon coming to Copenhagen he took long walks with Bohr, and that Bohr would always discuss the difficulties with his 1913 model. “He suffered greatly from the impossibility of penetrating into this very unvisualizable, unreasonable behavior of nature. In discussions with Bohr I came to realize how difficult it was to reconcile the results of one experiment with those of another. (See Mehra and Rechenberg, vol.2, p.150.) These talks prepared Heisenberg to make the needed radical break with both the empirically and philosophically inadequate classical concepts, which had in prevailed in western science for 200 years, and also the more recent 1913 semi-classical Bohr model.

In the face of the profound failure of the prevailing ideas Heisenberg adopted the principle that he would build his theory directly on properties that were known to exist

because they could be directly measured. This policy focused attention on the measurement operation. Previously it had been assumed that measurements were essentially direct grasping (perceivings) by the observer of the pre-existing perceivable properties. But Heisenberg found that, theoretically, according to his still-vague ideas, the product of the perceived outcomes of pairs of measurements depends upon the order in which the two measurement operations are performed; and the difference depends upon the quantum constant, which Planck had discovered, and that characterized the failure of the classical concepts. *Thus our seemingly freely chosen actions of perceiving appear to alter the physical world being perceived.*

Bohr reported that at the 1926 Solvay conference a discussion arose between Heisenberg and Dirac as to whether, as Heisenberg averred, we have to do here with a choice on the part of the experimenter pertaining to which measurement to perform, or, as Dirac argued, a choice on the part of nature as to which outcome to deliver.

In “realistically interpreted orthodox quantum mechanics” both kinds of choices occur, with the observer’s “free choices” arising from the observer’s personal values, and nature’s choices arising from unknown causes that normally entail that these choices conform to the famous statistical “Born rule.” This rule is closely connected to the classical symmetry-based idea that equal volumes of phase space have equal statistical weight.

In the switch to quantum mechanics, the classical material aspect of reality is replaced by the quantum mechanical state (i.e., density matrix) of the universe, RHO. This state RHO normally evolves according to von Neumann’s Process 2, which is (essentially) the Schroedinger equation—except when that smooth causal Process 2 is interrupted by a “Process!” probing action instigated by an observer. This probing action by an observer “puts to nature” the question of whether or not his or her (the observer’s) upcoming experience will be the self-chosen *possible* experience ‘P’ that is associated in the quantum formalism with a corresponding projection operator P. This physical state RHO is mathematically connected to the possible upcoming mental properties via the formula: $\langle P \rangle = \text{Trace } P \text{ Rho} / \text{Trace Rho}$

Here $\langle P \rangle$ is the probability of a positive response to a probing observer’s query as to whether the perception ‘P’ associated with the projection operator P will presently occur in the observer’s stream of consciousness!

Thus whereas classical mechanics gives a formula specifying, in terms of the present state of the physical universe, precisely what the upcoming physical state of the brain/body will be, our orthodox QM specifies, in terms of the present state of the physical universe, RHO, the **probability** that the upcoming experience will be the possible experience “freely chosen” by the experimenter/observer.

The Born rule, although basically statistical, allows an observer, by appropriate

choice of questions (including the timing of the question) to effectively control, under certain circumstances, the stream of his upcoming experiences, and thus to some extent, the stream of objective physical events.

APPENDIX TWO: SECOND ADDRESS AT FOM 3:

Summary of methodology

Here we consider an experimental test of failure of the notion that mere bigness (without conscious probing) can cause a true collapse, and of a quantum explanation of ***an apparent retrocausation*** as an effect of a pro-life biasing of Nature's choice.

Protocol for modified (Daryl J.) Bem "Erotic" experiment:

1. The subject chooses, between screen 1 and screen 2, which screen to view later.
2. A faraway Random Number Generator (RNG) chooses between Outcome 1 and Outcome 2.
3. If RNG Outcome 1, then a mechanism places an erotic picture in Screen 1.
4. If RNG Outcome 2, then a mechanism places an erotic picture in Screen 2.
5. The subject then views the screen that he previously chose.
6. Empirical (Bem) result: the subject originally picked the screen that was ***later determined*** to contain the erotic picture.
7. Proposed new experiment: let other observers view output of RNG ***before*** the mechanism acts.
8. Expected result: Failure of the Bem-effect favoring of the "erotic" picture.
9. Reason: the Bem-observed favoring of the erotic picture was assumed (in RIOQM) to be caused by a biasing of Nature's choice, in favor of survival of a witnessing observer.
10. ***If the RNG output is not observed by observers*** then the two alternative macroscopic brain states will co-exist in a mixture, and Nature has a choice between options that can influence survival. To explain the Bem effect, I have suggested that Nature's choices are biased in favor of life.

11. But if the RNG output is observed, then a full collapse must occur, and the Bem effect must vanish. If the Bem effect vanishes when an observer watches, but otherwise not, then the (widespread) notion that mere largeness causes collapse is ruled out: some observer must look.

hstapp@mindspring.com