LINK THEORY & PSI

Clairvoyance, Precognition, and PK without Rewriting Physics?

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Abstract: In this paper, we discuss the unnecessarily antagonistic relationship between psychic phenomena ("psi") and physics theory today. A relational approach to both theoretical and physical experimental situations is proposed and examined using Etter's Link Theory. A hypothetical psi experiment is created to illustrate the full implications of random processes in which constraints are present, one of which may be "in the future".

1 Introduction

In order to achieve a true understanding of psychic phenomena ("psi"), we are going to have to give up a few things.

The persistent puzzle of psi, now well established in the laboratory as well as in everyday experience, has generally been considered to be in serious conflict with physical theory painstakingly assembled and verified over centuries. Rather than postulating some radical new physics, we need to give up some of the assumptions which lurk, often unrecognized, beneath our existing theories. By analogy to Special Relativity, we may have to relinquish the notions of absolute Space and Time, but cling more closely to the principle of constancy of the speed of light. As with the present case, we don't need or want to invalidate all of Newtonian mechanics, but we yearn for something deeper and more fundamental.

Toward these ends, we will focus first on those characteristics of psi, which are most disturbing and salient, and try to see what their presence implies for the necessary physical explanations. Following this, we recap the relational approach to modeling physical phenomena as represented in Link Theory [Etter & Shoup, 1999].

A simple hypothetical psi experiment is then presented and analyzed to show that by recasting the assumptions of the problem and adopting the relational approach we can easily see effects that could be taken as psychic phenomena.

2 The Nature and Importance of Psi

Traditionally, psi phenomena have been classified as Telepathy (mind-to-mind communication), Clairvoyance (knowledge of distant events or conditions), Precognition (knowledge of the future), and Psychokinesis (mind over matter). However, these categories and descriptions are now well out of date, misleading, and arguably an impediment to greater understanding. From decades of experimental exploration [Radin 97a], it has become increasingly clear that these categories are not clearly delineated, but are manifestations of a deeper reality yet to be fully appreciated.

Perhaps the most shocking, and thus the most important, characteristic of psi is its apparent independence of both Time and Space. Experimentally, it does not seem to matter much whether a remote viewing takes place before, during, or after the viewed event, whether nearby or at a great distance [Radin 97a]. This and other evidence suggests strongly that thinking about the phenomena in terms of the usual notions of causal information flow through Time and Space is unlikely to yield insight.

Thought about in the right way, psi phenomena do not necessarily contradict current physical theory, as we will try to elucidate below. No new forces or fields, etc. are required. (Indeed, it is difficult to see how a new force or field could be added at all without greatly upsetting existing theory.) It is only our still largely classical interpretations of both classical and quantum situations which continue to complicate matters. The supposed weirdness of quantum phenomena, for example non-local correlations in an EPR experiment, can be shown to be largely due to unnecessarily restrictive, neo-classical interpretations of the already known laws of quantum mechanics [Etter & Noyes 98].

Perhaps the most important message from psi experimentation is that our traditional notion of causality is inadequate, or perhaps just plain wrong, and a relational approach is more likely to be effective. We tend to think in terms of "A causes B", when the evidence strongly suggests that "A and B are related, and A precedes B" is a far more useful conceptualization that is already available in physics. More about this below.

It is worth pointing out that the existing laws of physics are almost exclusively time symmetrical in both classical and quantum realms, so order-independent or retro-causal effects ought not to be considered preposterous. In quantum theory, the wave function is fully symmetrical in time, although its so-called "collapse" under measurement is considered random and irreversible. Using a new approach, measurement can be understood as a transformation from the quantum to the classical domain, without the mysterious collapse [Etter & Noyes 98, Etter & Shoup 98].

With the stakes as high as Time, Space, and Causality, it is difficult to overstate the importance of research into psi phenomena. Progress in this direction may well lead to a reformulation and re-interpretation of the quantum theory, and thus to deep reconsideration and re-viewing of much of physics, but without great rewriting. Even the scientific method itself, based largely on a concept of limited causality and forward influence, may be in need of an overhaul, but this is beyond the scope of this paper.

It is also beyond the scope of this paper to consider the large implications for society and culture that would flow from a better understanding of psi. Nowhere in the history of mankind has common human experience so strongly conflicted with mainstream scientific opinion. Thus the nature and the experience of psi are deeply intertwined with our technological culture and its worldview. Historically, psi phenomena have been reported across all cultures, in all eras, and simply haven't gone away under increasing scientific scrutiny, as many have predicted. On the contrary, psi seems to be ubiquitous (usually at a low level), suggesting a deeper reality much like the interconnectedness often associated with eastern "non-scientific" thought. Psi brings us face-to-face with some of the most profound questions of human experience, and challenges our still-young scientific world-view as nothing else has.

3 How does it DO that?

There are at least three general classes of possible explanations of psi, and thus three corresponding possible outcomes for research in this still-controversial area:

1) Experiments are wrong and psi phenomena don't exist. Psi phenomena have been well explored in the laboratory for decades [see for example Bem & Honorton 98, Bierman & Radin 98, Radin 97a, Jahn & Dunne 89], and the probability that psi phenomena are entirely illusory has diminished consistently. Even if it were shown that all past laboratory psi experiments were somehow flawed, the explanation would have to be highly interesting, and would have a significant impact on science as well. Denial of the existence of psi phenomena seems to be increasingly the refuge of those who are simply not willing to look at the evidence with an open (but critical) mind.

2) Current physics is deeply flawed and must be replaced. It has long been thought that if psi phenomena are real, then physics as we know it would have to be seriously wrong, or would at least require significant modification. This belief alone has been responsible for much of the unwillingness of mainstream scientists to look at the evidence for psi, no less to consider it as important. In particular, precognition would seem to require information transfer from the future, supposedly a logical impossibility. A careful reading of existing physics shows that this fear is unfounded, and a major rewrite seems both unlikely and unnecessary.

3) Current physics is adequate, but deeper understanding and reinterpretation of its foundations are necessary. This is obviously a more appealing alternative, which we

advocate here. A reinterpretation and a recasting of the physical laws we already have will bring a better understanding of the strangeness of the quantum realm, plus a natural extension into the phenomena of psi, without requiring dramatic new physics or overturning of well-established laws.

4 Link Theory

Link Theory is a theory of *composite relations*, an accounting of *possibilities*, and *constraints* on joint possibilities. These constraints are by definition bi- or multi-directional, symmetrical and timeless. They simply state what is possible for one, two, or more variables taken together. We eschew the idea that one variable or state "causes" another to take on a particular value or set of values, in favor of a more egalitarian principle of co-existence or mutual possibility.

Link Theory, being a general theory of relations, has application in many domains, including logic, algebra, combinatorics, statistics and probability, and quantum mechanics. See the references [Shoup & Etter 99, Etter & Shoup 99] for details of Link Table representation and calculation, including the correspondence between conventional matrix algebraic forms and the equivalent Link Table forms. In these papers, it is also shown how either form may be used to derive several of the core laws of quantum mechanics. The point of the latter paper, also discussed at greater length in [Etter & Noyes 98], is that these core quantum laws may be constructed from simple mathematical considerations, and do not require any basis in physical reality at all.

The simplicity and utility of Link Theory can be shown by beginning with simple examples in the domains of logic and statistics.

5 Example - Logic

Using Link Theory, we can represent and compose familiar components in the domain of logic circuits. We first define Link Tables representing the simple logic gates NOT, AND, and OR, as shown below. The *case count* **n** represents the number of ways in which the variables may take on the given values. Note that **n** is 1 just where the relation is valid, that is where the values of the inputs and outputs of the gates agree with the usual definitions of these functions.[1] (For the logic domain, **n** is typically 0 or 1 unless an ambiguous "don't care" condition exists in the circuit.)

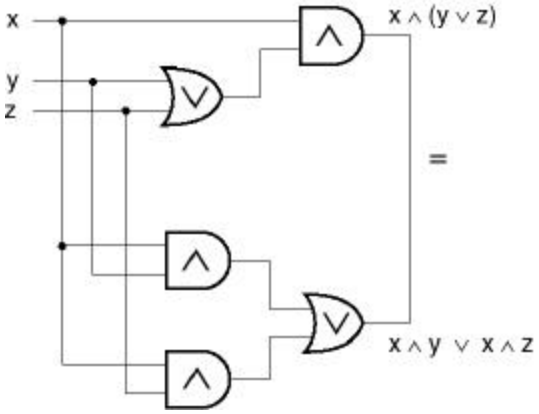
[1] In Link Theory, relations are symmetric, so characterizations of "input" or "output" are misnomers.

x	y	n
0	0	0
0	1	1
1	0	1
1	1	0

x	y	z	$n_{\wedge}$
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

x	y	z	$n_{\vee}$
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

By combining instances of the tables given above and linking (connecting) corresponding variables, we form the *composite relation* shown below, representing a Distributive Law of logic $\mathbf{x} \wedge (\mathbf{y} \vee \mathbf{z}) = (\mathbf{x} \wedge \mathbf{y}) \vee (\mathbf{x} \wedge \mathbf{z})$, AND distributes over OR. To represent the claimed equality, we simply connect (link) the outputs of the two expressions together – something most circuit representation paradigms (and real circuits) would not allow. The composite Link Table is shown at right.



x	y	z	n
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Since for every combination of values of $\mathbf{x}$, $\mathbf{y}$, and $\mathbf{z}$, the composite relation is seen to be valid (as shown by the resulting uniform case counts), the result is a tautology or "proof" of the law. If the circuit did not yield a tautology, the case counts would indicate exactly those values for which the law failed.

6 Dependence & Correlation

More interesting applications of Link Theory are in the domain of probability and statistical inference.

Consider two variables, **x** and **y,** on the domain { 1, 2, 3, 4 }. When all the case counts **n** are identical, **x** and **y** are independent and uncorrelated. But unequal counts signify a correlation. In other words, the number of ways in which certain joint possibilities can occur are not equal; some combinations of values are more likely than others. For example if **x** = 0, then it is impossible that **y** = 0 simultaneously, whereas when **y** = 3, all values are possible for **x**, with 1 and 3 more likely than 0 or 2. Thus our knowledge of **y** also gives us some information about **x**, and vice-versa.

independent, uncorrelated :

$p(B|A) = p(B)$

x	y	n
0	0	1
0	1	1
0	2	1
0	3	1
1	0	1
1	1	1
1	2	1
1	3	1
2	0	1
2	1	1
2	2	1
2	3	1
3	0	1
3	1	1
3	2	1
3	3	1

dependent, correlated :

$p(B|A) \neq p(B)$

x	y	n
0	0	0
0	1	1
0	2	2
0	3	1
1	0	1
1	1	0
1	2	1
1	3	2
2	0	1
2	1	0
2	2	2
2	3	1
3	0	1
3	1	0
3	2	1
3	3	2

In the general case, **x** and **y** are independent if $p(\mathbf{x}|\mathbf{y}) = p(\mathbf{x})$. That is, knowing **y** gives us no additional information about **x**.

Now consider the constraint or relation: **x** + **y** = **z**. In this example (table below at the left), we see that only 16 of 64 possible cases satisfy this joint constraint on the three variables taken together. The remaining 48 cases do not satisfy the relation, and thus have a case count of 0 and have been elided. Notice that any single variable taken alone may still assume any value in its domain, with equal probability. Furthermore, any *two* variables taken together exhibit no correlation at all with respect to each other, as can be seen from the uniform case counts (tables at the right).

x + y = z			n
0	0	0	1
0	1	1	1
0	2	2	1
0	3	3	1
1	0	1	1
1	1	2	1
1	2	3	1
1	3	0	1
2	0	2	1
2	1	3	1
2	2	0	1
2	3	1	1
3	0	3	1
3	1	0	1
3	2	1	1
3	3	2	1
- -	(48)	- -	0

=>

x	z	n
0	0	1
0	1	1
0	2	1
0	3	1
1	0	1
1	1	1
1	2	1
1	3	1
2	0	1
2	1	1
2	2	1
2	3	1
3	0	1
3	1	1
3	2	1
3	3	1

y	z	n
0	0	1
0	1	1
0	2	1
0	3	1
1	0	1
1	1	1
1	2	1
1	3	1
2	0	1
2	1	1
2	2	1
2	3	1
3	0	1
3	1	1
3	2	1
3	3	1

x	y	n
0	0	1
0	1	1
0	2	1
0	3	1
1	0	1
1	1	1
1	2	1
1	3	1
2	0	1
2	1	1
2	2	1
2	3	1
3	0	1
3	1	1
3	2	1
3	3	1

So, in a three-relation such as this one, every two-variable pair can be seen as independent and uncorrelated, and yet a strong correlation exists among the three variables when taken together. In fact, in this example, if the values of any two of the variables are fixed, then the third is also determined.

Next we consider the relevance and application of Link Theory to psi experimentation.

7 Comparing Random Bitstreams

Consider the two random bitstreams called **S** (Subject) and **T** (Target) below. Each is apparently a random sequence, with equal proportions of 0 and 1. Yet when we compare the two sequences, we find that **S** and **T** are highly correlated, having the same value in 3/4 of the pairs. Of course, even random-appearing bitstreams can be correlated, either by some common dependence or by chance alone.

S : 1 0 1 1 0 0 1 0 0 0 1 0 1 1 1 0 0 1 1 1 0 1 0 0 0 1 0 0 1 1 0 1 => 16/32

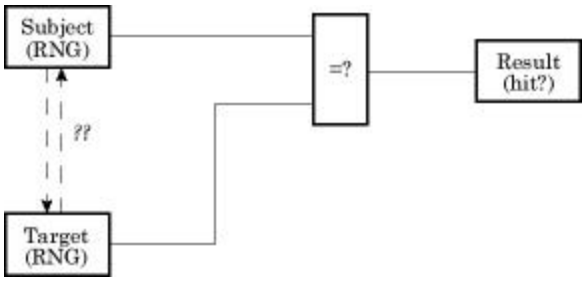
T : 1 0 1 1 0 0 0 1 0 0 1 0 1 1 0 1 1 0 1 1 0 1 0 0 1 0 0 0 1 1 0 1 => 16/32

R (**S**=**T**) : 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 => 24/32

8 A Simple Psi Experiment

Now suppose we construct a simple psi experiment where a Subject attempts to guess the bit generated by a Target random number generator (RNG), a "true-random" source based on quantum phenomena such as radioactive decay. Initially, we will assume that the Subject is guessing nearly randomly as well, and thus can also be modeled by another random process, possibly with a slight bias towards 0 or 1.

In this diagram, the boxes represent elements of the experiment, typically boundaries drawn around objects in the real world. We will also use Link Tables to summarize the elements behavior, that is, the constraint which they impose on the variable represented by the attached wire or Link. Initially, the output Result stream will be a free variable, but we may wish to make assumptions about it as well and examine the effects this produces.



No other paths of data flow or influence are present other than those explicitly shown as lines or wires in the diagram. In this simplified experiment, we will not provide any feedback from the Result to the Subject, therefore these two streams are assumed to be independent unless constrained by the equality relation. Initially, since the Subject and Target streams are purely random, we would expect no correlation among any of the three variables, and a 50/50 Result stream.

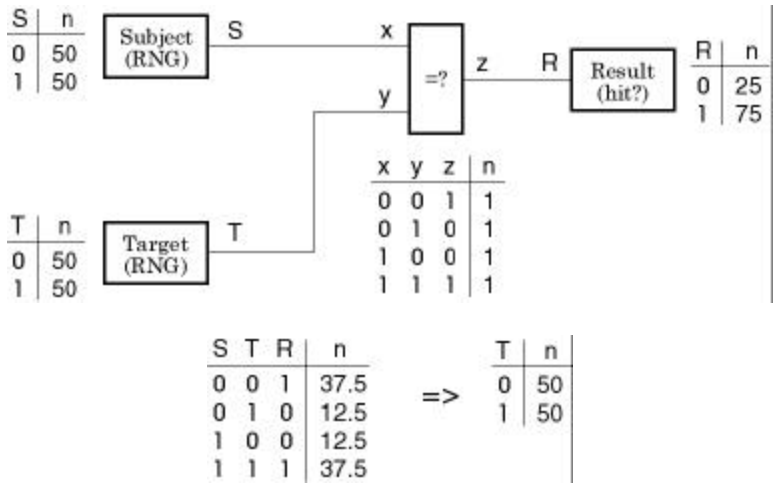
Suppose the Result (comparison) bitstream shows more hits than would be expected by chance, as psi experiments often do in the lab. We might then ask how such Results came about, and what additional information flow might have been required. Do the extra-chance results force us to posit an additional path of influence from Subject to Target (psychokinesis), or from Target to Subject (clairvoyance or precognition, depending on which is chosen first), or along some other path?

8.1 Unbiased Subject - clairvoyance or precognition?

If the Subject bitstream **S** and Target bitstream **T** are indeed random, independent, and unbiased, we would expect to find no long-term correlation between them by chance alone, and the Result bitstream **R** would contain about 50 or so 1's (hits) out of 100 trials. However, if some psi phenomenon is at work, and the bitstreams are somehow correlated even though remaining individually unbiased (as in Section 6), we might see many more hits. In this (exaggerated) example we have assumed 75 hits out of 100[2], as illustrated by

[2] Of course, in the laboratory we do not see performance at the 75% level in psi experiments of this general type, unfortunately (or perhaps fortunately). But consistent small extra-chance results do seem to be possible and have been observed over large numbers of trials and many experimental replications [Jahn & Dunne 89, Radin 97a]. It remains a significant puzzle (and an important clue) as to why, if indeed there can be consistent low-level psi, there isn't *more*. The survival value to evolving life forms would be very high.

the Link Tables shown below. Again, no bias is present in either the Target or the Subject bitstream, and each may appear entirely random when examined alone.



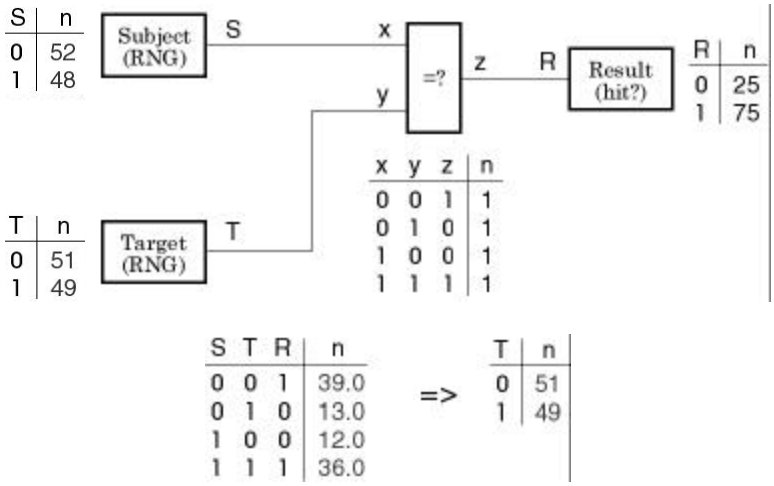
Upon reflection, it is easy to see that given the stated Result (75/25) and the assumption of unbiased (50/50) Subject and Target, *some correlation must have been present* between the Target and the Subject streams in this experiment. Was it this unexpected correlation between **S** and **T** that produced the high Result **R**, or the unusual Result that produced the correlation?

Clearly neither alternative fully describes the symmetry of the situation. (It is exactly this limitation in the usual assumption of forward causality that we wish to highlight.) It might be that **S** and **T** were somehow connected, and affected one another. But a constraint placed on **R** alone would also have given the same overall results, due to the freedom present in the random sequences **S** and **T**.

Rather, the three variables participate *jointly* in the equality constraint relation, which is in principle omnidirectional. If we see extra-chance Results, *no additional causal path between **S** and **T** needs to be present* in order for this overall outcome to have occurred. The apparent clairvoyance or precognition is merely a consequence of the result we saw in **R**. And after the experiment is complete, no further explanation is necessary, since all the data is in the "past".

8.2 Biased Subject - psychokinesis?

Now suppose that the same high Result is seen (75% hits), but that for some reason the Subject's guesses happened to be slightly biased, 52 0's for every 48 1's. With this additional constraint on **S** in place, a Link Theory analysis (below, or a conventional conditional probability calculation) shows that *the Target generator must also have been slightly biased*, 51 to 49.



In other words, *it appears as if the Target RNG is being influenced*, somehow pulled away from randomness as if by a psychokinetic mechanism. It is natural to infer that some influence on the Target generator must have occurred, yet no extra path or external influence on **T** was necessary to produce this effect. The outcome can be simply explained as a consequence of the statistical constraints that we imposed on the distributions of **S** and **R**, and the statistical freedom already available in **T**.

Is the tail wagging the dog? The point again in this case is that the three variables **S**, **T**, and **R** are jointly constrained by the comparator, and the apparent psychokinetic mechanism is just the constraints acting through the equality relation, in this case *in both forward and backward directions*.[3]

9 Psi without rewriting Physics?

To summarize, in the simple bit-guessing psi experiment above, we assumed two boundary conditions, one on the distribution of the Result and then later one on the distribution of the Subject's guesses. The former could be said to have been "a constraint on the future" prior to the experiment, but was "the way things turned out" afterwards. Assuming that the Subject was the agent, in some sense responsible for the unusual outcome, what path did he utilize to bring about these overall results, especially the apparent non-randomness in the Target?

[3] The idea of future constraints affecting the past, and their connection to psi phenomena, apparently originated as early as the 1960s with Helmut Schmidt [reported in Schmidt 1975 and Schmidt 1978] and Tom Etter [Etter 1960], independently.

To put it another way: Suppose that a psi experiment of this type has been conducted, and all data have been recorded. Suppose that we see some extra-chance results, and thus a corresponding unexpected correlation between **S** and **T**. How did this occur?

By the usual sort of causal reasoning, there are at least 4 possibilities:

1) The Subject was somehow able to *sense the Target* bits or the (future) Results and adjust his guesses accordingly. This is the standard clairvoyance or precognition explanation. The mechanism would have to include a previously undetected influence by some means using an undiscovered human sense organ or sensitivity. This doesn't seem very plausible, yet it is still a commonly assumed hypothesis about how psi must work. Worst of all, if the Target bit is chosen first, then some precognition must also be invoked. Naturally, physicists are typically quite skeptical of a paradigm of this sort.

2) The Subject was somehow able to *affect the Target* generator directly. This is the standard psychokinetic explanation, as apparently seen in the second case of the experiment above. Quantum processes now considered random in principle would have to be influencible, and information conveyed in some currently unknown way. Again, a new or unappreciated mediation by a force or field would seem to be necessary -- again unlikely in the face of existing physical evidence and well-tested quantum theory.

3) The Subject was somehow able to *make use of prior correlations* or entanglement between himself and the Target generator to adjust his guesses, similarly to 1 above but conditioned by past common cause. After all, real physical RNGs have a history, and are not actually isolated from the past as we have assumed. If current cosmological theory is accepted, then everything has interacted in the past, even if quite remotely. It is generally assumed that any residual correlations between these objects would have long ago been wiped out by unavoidable decoherence, but this is far from established.[4] And this hypothesis would still require some way to affect quantum random sequences in order to explain the psychokinetic effect in experiment 2 above.

4) The Subject was somehow able to *affect the Result* by interactions in the future that were then reflected backwards through the equality constraint to affect the Target (symmetrically to hypothesis 3 above, but relying on a future correlation). This is the hypothesis we have explored in the calculations above by placing a constraint on the Result bitstream.

With hypotheses 1 and 2, an extra path of information or influence is necessary between **S** and **T**, probably in serious conflict with well-established physical theory. Alternatives 3

[4] Recall also that significant ensemble correlations may exist among n variables that cannot be seen by examining any n-1 or fewer of them, by generalization from the example in section 6. So such correlations could remain deeply hidden and yet have noticeable effects in the world.

and 4 however do not require any such mysterious paths nor the difficulties associated with them.

In particular, hypothesis 4 can readily account for all of the so-called clairvoyance, precognition, *and* psychokinesis effects apparently exhibited in such experiments, without new paths or insult to established physics. Even the apparent "pulling" of the Target RNG is done via its "output", not some new mechanism in conflict with quantum theory.

The cost here of course is the requirement of some way for the Subject (or some other agent) to affect or constrain the future Result. Although this cost is high, even daunting, some form of influence on the Result may be a simpler explanation for the psi effects that we do indeed see even under stringent laboratory conditions.[5] (See [Schmidt 93] for a full description of several such experiments, including some with recorded random data.) It might be possible, for example, that the Result is affected by a very diffuse collection of future backward influences that sum to give the observed overall effect.

If the idea of a future constraint is disturbing, it is useful to recall another well-established way of reasoning in physics, the principle of *least action*. This principle, which dates at least to the 18th Century and Pierre Maupertuis, is based upon two boundary conditions, one of which is a final state that will exist at some time in the future. See Price [Price 96] for useful examples and discussions of least action, causality, and time (but without discussion of psi).

10 What is an RNG anyway?

According to current quantum theory, there are "causeless" *uninfluenceable* events, events that happen purely at random. These include radioactive decay, thermal noise fluctuations, and measurement of superposed quantum states. Quantum theory remains silent on just how this happens, and how a particular outcome is chosen from those that are possible in a given measurement of a quantum superposition.

Since a "random" choice has apparently been made in a quantum measurement, we naturally ask *where does the information come from* which determines this choice, and how does it enter the situation? Does a bit of information come from God himself for each "collapse" of a binary variable? Before the measurement, there are two possibilities extant, and afterwards one has been distinguished. This distinction requires a bit of information, not just a reduction in entropy.[6] (See [Etter & Shoup 98] for a partial

[5] Hypothesis 3 can be tested, to a certain extent, by looking for correlations among unrelated RNGs. See noosphere.princeton.edu/index.html for an effort in this direction. Hypothesis 4 can be tested by simply looking for the presence of corresponding Subject and Target biases in experiments that show significant psi functioning. These hypotheses are being explored at the Boundary Institute.

[6] Of course, there is one well-known way out of this conundrum, but the price is very high indeed: the multiple universe interpretation of quantum theory [Deutsch 97]. But the "multiple values" paradigm already embedded in the traditional idea of superposition seems adequate, and is certainly simpler.

explanation of quantum measurement in Link Theory terms, without the miraculous collapse.]

The thought experiment discussed above might suggest that a Random Number Generator is *not* merely *producing* values with a given distribution, but is somehow at least in part *reflecting* the biases in its future environment. Perhaps a true RNG in this situation is just an *empty box*, a free variable that does nothing but satisfy (react to) the constraints and influences it sees outside by virtue of its "output" connections -- literally the tail wagging the dog.

In the above example, since we have somewhat constrained both **S** and **R**, a random element such as **T** *has no choice* but to produce the distribution of values shown. If an RNG is indeed a "causeless" random data source, then how can it be otherwise? The alternative would be for the quantum process to have some internal mechanism that *ensures* randomness. (And extra-chance results including psychokinesis *are* seen in real-world experiments [Schmidt 93].)

11 What About Causality?

The concept of causality should be generalized in directionality, and replaced in our thinking and in our vocabulary by less-restrictive concepts such as *influence*, *dependence*, and *correlation*. Despite our everyday experiences with objects and events, physics theory already teaches us that causality is bi- or omni-directional and in principle timeless. Our common-sense notion of causality has been developed (evolved?) through years of experience in the macroscopic world. But, just as with Relativity, our common sense has limited applicability, and in fact may have similarly misled us.

It is human nature that the basic concepts of quantum theory are still defined in terms of our classical intuitions of objects, causes, space, and time. This is exactly the quagmire from which it is necessary to break free to fully understand and appreciate both the quantum realm and psychic phenomena. The possibility of an ultimately simpler explanation surely lies in giving up our usual (unwarranted) assumptions about unidirectional forward causality, as we have tried to suggest in these examples.

12 Summary & Speculation

In this paper we have tried to give evidence for the hypothesis that psychic phenomena can be understood simply, without any major rewriting of modern physical theory. We have here and elsewhere [Etter & Shoup references] begun to show how a new foundation may be laid underneath current physics. This new foundation we hope will be used to give far more cogent explanations for existing quantum phenomena, as well as predict and explain more elusive phenomena such as randomness and psi. By altering our

notion of causality, thinking relationally, and taking full account of both forward and backward influence, many of these mysteries may eventually become understandable.

The most important ingredient of this new approach is *timeless*, *relational* thinking. Consider the very thorough and provocative discussion of the arrow of time, causality and retrocausality by Huw Price [Price 96]. Price first quotes Wheeler:

> Does this result mean that present choice influences past dynamics, in contravention of every principle of causality? Or does it mean, calculate pedantically and don't ask questions? Neither; the lesson presents itself rather as this, that the past has no existence except as it is recorded in the present. [John Wheeler, in Putnam 1979]

and then goes on to say (in more depth than we have been able to here):

> Physicists have long known that the key ["advanced action"] might fit the lock, but with very few exceptions have thought (like Wheeler himself) that it is too fantastic to be the true solution. I have argued that this is a mistake, and that there are independent reasons to postulate a key of this kind. Had these reasons led us first to the key, quantum mechanics seems to be the kind of lock we ought to have expected to find. [Price 96, p. 257]

While a better understanding of psychic phenomena will undoubtedly have a major effect on science and on society, the importance of psi in the quantum realm alone could be surprisingly large even in the short term. The exciting possibility and embryonic reality of quantum-mechanically based computers is surely relevant here, since the unusual states of matter which are being created and employed in quantum computing may well be closely connected to those which mediate psi, namely highly-entangled, multiply-constrained states. It may be that odd unexpected phenomena are already being seen in quantum computing laboratories.

With due consideration for the gravity of the subject, and given all of the implications for science and for society already apparent, we believe the study of psi phenomena is among the most important activities which can be undertaken in science today.

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