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# *What is Beyond the Edge of the Known World?*

***Abstract:*** *Experiments show that psi differs from known physical processes in a variety of ways, and these differences are described herein. Because of these, psi cannot be accounted for in terms of presently known physical laws. A number of theories, of which we review a sampling, suggest ways in which known physical laws might be expanded in order to account for psi. However, there is no agreement on which of these theories, if any, will ultimately provide a general explanation. A further problem in studying psi is that it is elusive, i.e., methods are not presently known by which it can be reliably produced. However, if psi is real, its study can open the door to a new frontier of knowledge and contribute to our understanding of consciousness.*

In the early fifteenth century it was not thought possible to sail past Cape Bojador on the northwest coast of Africa. Maps of the time showed Jerusalem at the centre of the world, with the continents of Europe, Africa and Asia arranged symmetrically around it. Surrounding them was an ocean called the 'Great Outer Sea of Boundless Extent'.

However, in previous years there had been improvements in both ship-building and navigation, with the compass coming into common use. So Prince Henry of Portugal became determined to send an expedition around Cape Bojador. Many expeditions failed, each time for a different reason, but finally one succeeded. Soon thereafter Portuguese sailors travelled around the southern tip of Africa and then to India. A few years after that Columbus set sail across the Atlantic. The attempts to travel past the edge of the known world were successful (Spar, 2001).

The present search by parapsychologists to understand psi in many ways resembles the search for a way to travel past Cape Bojador. As then, there are no maps to provide guidance. Present-day technology and experimental methodologies can help make the search. But is there only boundless ocean (no psi phenomena) beyond present knowledge? Is there any land (phenomena) at all? If psi

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exists and we can come to understand it, the rewards of new knowledge could be great. So far parapsychology has had some encouraging views of what may be land, and indications of what that land is like (if it's there), as we will see below. But, in this analogy, parapsychologists have yet to round Cape Bojador.

More specifically, and as we will see in further detail in the following sections, present knowledge of psi (or what appears to be psi) is as follows. Experiments show that it differs from known physical processes in a variety of ways. On the other hand, correlations of psi with some physical variables are known (e.g. local sidereal time), although the reasons for these correlations are not known. There are a number of theoretical models for psi (we will review a sampling), but there is no generally accepted theory of it. Finally, psi is elusive, in that the psychological conditions which produce it are not well understood and it cannot reliably be produced at any given time. Indeed, some major efforts to replicate experiments have failed to produce a detectable amount of psi, as we will see. In order to be considered an established phenomenon, it would seem that either a theory should be known which explains the differences between psi and presently known physics and gives testable predictions, or at least it should be possible to reliably produce it. But neither is the case at present.

We should note that there are two types of psi usually studied in parapsychology experiments: extrasensory perception (ESP) and psychokinesis (PK). ESP refers to the transfer of information without using any known physical mechanism, and PK refers to the action of mental intention on matter without using any known physical mechanism.

## Ways in Which Psi Differs from Presently Known Physical Principles

Psi appears to follow principles which are very different from the presently known laws governing the physical world. For one thing, a variety of experiments have shown that the distance between source/sender and effect/receiver makes no difference to results (Jahn and Dunne, 1987; Rao, 2001). In presently known physics nearly all influences decrease inversely as the square of the distance involved. The only exception, quantum non-locality, can only influence correlations between random sequences — it cannot transfer any information (Eberhard, 1978) and so cannot account for psi effects. (We will examine this point in more detail in the section on Theories of Psi. For now we need only note that unless conventional physics is modified in some way, quantum non-locality cannot explain the transfer of information by psi.)

Another difference is that in presently known physics all transfer of information involves a signal (which can travel no faster than the velocity of light). The transmission of information by psi is presumably not instantaneous, because that possibility is contrary to special relativity.[1] However, no physical signal has ever been found. Electromagnetic signals, which would be the obvious thing to look for, have been ruled out because numerous experiments have shown that psi

[1] An instantaneous signal can define an absolute time, the same in all inertial frames, and special relativity does not permit this.

results can be obtained even when the receiver is shielded by a Faraday cage (Stokes, 1997).[2]

Another distinction between psi and physical effects is the way they depend on surrounding conditions. A physical result depends on various conditions, at varying distances and locations, as specified by physical laws. But a person who responds via psi to some distant event does not respond to the totality of conditions which could produce a physical effect, but only to some particular event which has meaning to him or her. No explanation is known of how this selective response can be produced.

*Classical and quantum randomness*

In order to understand the relationship of psi to randomness, we should first understand the way randomness appears in presently known physics. First we should make a distinction between (a) events that merely follow a random pattern because they are determined by a large number of independent causes and (b) events that are quantum random. The first type of events can be described in terms of classical (deterministic) physics, and we will refer to these as 'classically random'. An example would be the flipping of a coin, because the results of each coin flip depends on random air currents, the way it is thrown, etc. On the other hand, quantum random events are inherently unpredictable, i.e., it is not possible to completely describe them in terms of specific causes. An example of a quantum random event is the location where a photon arrives on photographic film in the double slit experiment (a well-known experiment in physics). The pattern the photons make when many have arrived can be predicted — it is a series of bright lines. Furthermore, any individual photon must arrive at a place where a bright line, not a dark one, will be when the full pattern is made. However, aside from that, the location where any individual photon arrives is quantum random — inherently unpredictable. The process is like assembling a jigsaw puzzle, with the pieces being added in random order. You always get the same picture at the end, and the randomness only has to do with which piece is added next.

Quantum randomness is associated with a phenomenon called collapse of the wave function. However, the phenomenon of collapse is not well understood. The problem is that although the equations of quantum mechanics can be used to make detailed predictions about physics experiments, collapse is not described by these equations, but is separate from them.[3] So physicists do not agree on what collapse is and when or whether it occurs. A minority of physicists say there is no such thing as collapse (e.g. Bohm and Hiley, 1993; Etter and Noyes, 1999). However, most physicists consider collapse to be an objective physical event. Some say it occurs regardless of whether an observer is present, but others say it can

[2] The possibility that psi is carried by extremely low frequency (ELF) electromagnetic waves has been explored, as these could penetrate some Faraday cages. However, such waves can be ruled out because their capacity for carrying information is very low (Puthoff and Targ, 1979).

[3] This distinction is explained in detail by Penrose (1989).

only occur in the presence of a conscious observer. (For examples of interpretations of collapse, see Freeman (2003) and Herbert (1985).)

Does quantum randomness affect our daily lives? Most physicists agree that collapse occurs when measuring instruments are used which are designed to detect quantum events, although the latter group would require a conscious observer also. For instance, in the double slit experiment, most physicists who say that no conscious observer is needed would say that collapse occurs when each photon reaches the film. But the group who says an observer is needed would say that collapse occurs when a conscious observer views the film. However, events in people's lives do not usually depend on the results of such experiments. Most physicists would probably also agree that collapse takes place in nature even without the presence of scientific measuring instruments, although why, when or how it takes place is not understood. Many physicists in the first group (no conscious observer needed) would probably agree that collapse takes place at the molecular level. But events in people's lives do not ordinarily depend on events at the molecular level and so would not depend on quantum randomness. Most physicists in the second group (conscious observer needed) would probably feel that collapse takes place at the macroscopic level. Even so, probably most events in people's lives would be viewed as determined by classical physics, but some events might depend on quantum randomness. So we can answer the above question by saying that in some interpretations of quantum mechanics quantum randomness might sometimes affect our daily lives. We will leave the possibility open.

We should note, however, that experiments in parapsychology laboratories make use of microscopic events involving quantum randomness, such as radioactive decay or quantum tunnelling. So the random sequences produced in these experiments can depend on quantum randomness. Let us now go on to see how randomness is involved with precognition and psychokinesis, and the issues each raises with respect to presently known physics.

### *Precognition*

The way random processes play a part in precognition experiments is that targets are usually chosen randomly after the subject's guesses have been recorded. Sometimes this process uses mechanical shufflers or the like and is obviously classically random. Sometimes a quantum random process is used. For instance, a subject might try to predict the time when an electron from radioactive decay is detected by a Geiger counter (Schmidt, 1969). The reader is probably asking at this point, given that quantum processes are inherently unpredictable, does precognition work for these? No formal study has been done which compares precognition results for targets selected in a classical random process with those for targets selected in a quantum random process. However, no obvious differences in the two types of experiment have been noted, and it appears that precognition works about as well for quantum randomness as it does for classical randomness. No explanation is known for how this can be.

One way to learn how precognition works is to model various possibilities and see which model(s) the data fit best. One possibility is that a person learns about present conditions through clairvoyance (ESP in present time) and then makes a rough extrapolation into the future. In this way the future could be known roughly, but not accurately. In another possibility we can assume that the macroscopic events of the future are entirely pre-specified and can be displayed in a Great Cosmic Record in the Sky. In order to know a future event a person would simply have to find the relevant place in the Record, presumably an easier task than in the former case. But we should also allow for the possibility of a future that changes. We will allow for the possibility that quantum randomness can affect the course of some daily events. Also, views differ on whether we have free will, but if we do, this also would affect the future. We can describe the third model as the Great Cosmic Website in the Sky, connected to everything and constantly updated.[4]

According to the first model, precognition involves not only knowledge of present conditions, but also extrapolation of these conditions into the future. Not all of the conditions which affect the future might be taken into account, or the projections might be inaccurate, so this method would presumably be less successful than clairvoyance. In the second model, precognition and clairvoyance would be equally successful. In the third model, precognition would be about as successful in some circumstances, but not in others, depending on the possibilities for change. A meta-analysis which compared the results of precognition and clairvoyance experiments done up to that time shows that these were approximately equally successful (Steinkamp *et al.*, 1998). This study would seem to support Models 2 or 3, but not Model 1.

Further light can be shed on comparisons of the models by some recent experiments which have determined the precognitive target in more complex ways. Specifically, the precognitive target was determined from the closing price of a specific stock, together with the temperature of a world city, on a certain date (Steinkamp, 2000). Because weather is sensitive to a large number of conditions and stock prices involve many individual decisions, the target would depend on a complex array of factors. One experiment showed significant results for the clairvoyance target, but chance results for the precognition target (Steinkamp, 2000). This finding would support Model 1 and Model 3 (the latter because of the dependence on volition and perhaps quantum randomness), but not Model 2. However, follow-up studies have not shown significant results in either category,

[4] This model could work in the following way. The Cosmic Website could track all present physical conditions and project the future according to the mathematical laws of physics. The specific outcome of a quantum random event is inherently non-computable, as we have seen, but each time one occurs the Website updates. Because all physical conditions are tracked, the patterns in people's brains which describe their present intentions are also tracked and the effects of these intentions are included in the display of the future. If free will exists, then by its nature it cannot be described by a mathematical formula (otherwise it would not be free). (For an analysis of the physics involved, see Mohrhoff (1999).) However, each time a free-will decision is made which produces physical action or simply affects intentions in the brain, the Website updates. For the most part freei-will decisions are conditioned by the brain, and any changes to the future are small, but sometimes a more substantial change is made.

although with near significance for precognition in some cases (Steinkamp, 2001), so results are inconclusive.

We can distinguish between the models in another way. According to Model 1 there would be a decrease in accuracy as the period between prediction and the actual event increases because of the increased difficulty in making an estimate. In Model 2 the time period probably would not matter, and in Model 3 it might matter somewhat, depending on conditions. Time intervals described in anecdotal accounts range from minutes or hours to years. (Anecdotal cases in which the time period is a year or more are usually dreams (Stokes, 1997).) Analyses of several collections of anecdotal accounts show that the number of accounts reported decreases with increasing time interval, but the accuracy and number of details stays about the same (Stokes, 1997). However, anecdotal accounts can be subject to selective reporting, so these results are inconclusive. Time intervals involved in laboratory experiments on precognition vary from seconds to several days or longer. A meta-analysis of precognition experiments which explored whether success depends on the period between prediction and actual event was also inconclusive (Honorton and Ferrari, 1989),[5] so this question remains open.

Probably our best conclusion as regards the models is that not enough is known to decide which ones fit the data better, and further experimental work is needed. However, given that precognition is (by definition) the ability of a person to predict a future event which is determined by factors not known to that person by any presently known physical means, we can conclude that precognition is not explained by presently known physical laws.

### *Psychokinesis*

Experiments on PK can be generally described as follows. Because it is a small effect, experiments to investigate it are usually designed to produce a random sequence of events, with the goal of influencing this sequence to be non-random. Statistical analysis can then be made to detect PK. Tumbling cubes (dice) and devices called random event generators (REGs), which produce binary bit sequences (0's and 1's) from a random source such as electronic noise, are often used in experiments (Radin, 1997).

A random sequence has on average an equal number of 0's and 1's, and an operator (person attempting to use PK) tries to produce more 0's in half her target sequences and more 1's in the other half. Meta-analysis shows that operators can successfully produce these desired shifts (Radin, 1997). The distribution of bits in a random sequence has the shape of a Gaussian curve with a mid-point at zero. The distribution of bits in a set of PK trials will have the same shape, but the mid-point will be slightly shifted towards more 1's when the goal is 1's and

[5] The data of the meta-analysis shows a decrease in results with increasing time periods. However, this result is not consistent among different subgroups of subjects, and Honorton and Ferrari (1989) suggest that the difference in results between subgroups might be accounted for by differences in motivational factors. Therefore, as Stokes (1997) points out, the overall results may depend on these factors rather than precognitive attrition. Stokes (1997) also reviews other experimental findings, but does not find conclusive evidence for precognitive attrition.

slightly shifted towards more 0's when the goal is 0's (Jahn and Dunne, 1987). In each case the curve as a whole is shifted, and this can be interpreted to mean that the effect of the intention of the operator is to alter the probability of each event from 50/50 to a slight bias favouring the desired result (Jahn and Dunne, 1987). In this respect PK seems able to produce an ordering of random physical processes, with the direction of ordering associated with the intention of the operator. It is not known how this can occur.

In addition to trials in which the operator holds an intention, two other types of trials can be made. First, all experiments include control runs (also called calibration runs), which simply ensure that the random sequences being produced continue to be random when no operator is present. Also, some laboratories include runs, called baseline runs, in which the operator is present but is instructed to hold no intention. Baseline runs typically show no shift in the Gaussian curve, as would be expected. But curiously, a very large number of trials shows the consistent result that in this case the width of the curve (a measure of a statistical quantity called the variance) is narrower than in the control runs (Jahn and Dunne, 1987). It is as if the operator, in an effort to have no intention, decreases the variation normally present in a random sequence in some sort of unconscious process.

It has recently been found, in separate investigations by Pallikari (2003; Pallikari and Boller, 1999) and Schmidt (2000a, 2000b), that in the PK datasets they analysed, sequences of bits cluster more than they would in a random sequence. In other words, in a random sequence there will be two consecutive 1's or two consecutive 0's a certain proportion of the time, three consecutive 1's or three consecutive 0's a smaller proportion of the time, and so forth. But in the above datasets, analysis using a statistical measure of correlations within a sequence showed that the same bit appeared consecutively, or nearby, more often than random.[6] This is called the 'gluing effect' by Pallikari (2003) and 'bunching' by Schmidt (2000a, 2000b). Pallikari (2003) did not find the gluing effect in a baseline run she analysed. However, aside from that, little is presently known about this effect, e.g. whether it occurs consistently in PK runs or is sporadic,[7] whether an anti-correlation effect is sometimes produced, and similar questions.

PK results (shifting of the mean) appear to be independent of physical parameters involved in producing a random sequence when comparisons are made between parameters which are not markedly different. For instance, in experiments using tumbling cubes results do not seem to depend on whether only a few or up to ninety-six cubes are used at a time (Stanford, 1977). In a similar vein, when operators were presented with interspersed trials from two REGs, with results from one depending on one binary bit and results from the other depending on one hundred binary bits, results from the two machines were not

[6] Pallikari and Boller (1999) used a Hurst exponent for their analysis, and Schmidt (2000a) used a new measure which he developed.

[7] Stanford (1977) summarizes several early experiments which looked for clustering (which he also called 'stringing') of PK hits and misses. These experiments did not find such an effect, which implies that it does not always occur.

significantly different (Schmidt, 1974).[8] However, in a scaled-up version of the latter experiment, with results depending on two hundred and two million bits, respectively, results were significantly better for the machine which presented the *larger* number of bits (Ibison, 1998). Further experiments would need to be done in order to confirm this result. However, assuming it is confirmed, no explanation is known of why PK results would be better when a larger number of bits must be acted on.

It has also been found that if two unrelated people both hold the intention to influence an REG, the result is somewhat better than if only one does it (Dunne, 1993). If the two people have a close relationship, results are about four times better than those of a single operator (Dunne, 1993). Experiments also show that if a large number of people hold a common focus of interest, REGs can be affected during the time this focus is held. For instance, during an Academy Award ceremony, which had a worldwide television audience of about one billion people, REGs showed non-random results during times of high interest, such as opening an envelope to give an award, but normal random behaviour at other times. Similarly, during the Opening Ceremonies of the 1996 Olympic Games, watched by about three billion people, REGs became non-random, but operated normally before and after (Radin, 1997).

### *Time-displaced PK, the experimenter-psi effect, and the complexity of psi targets*

Experiments show that if a random sequence is entirely specified — for instance, by a mathematical algorithm — no PK results can be produced on that sequence (Jahn and Dunne, 1987), a finding which is not at all surprising. (The latter type of sequence is called pseudorandom.) But then what are we to make of the following experiment (Schmidt, 1976), which has shown the same basic result in many replications over the past twenty-five years? The experimenter records a series of random sequences, which are physically random (e.g. from radioactive decay), not pseudorandom. He does not look at the results, but makes a copy (by automated means) to present to the operator, and places the master copy in a safe place. The operator then plays the recorded copy and attempts to influence the sequences, just as though he were experiencing them in real time. Common sense would say that the operator cannot possibly affect them because they have already been recorded. However, when the data is examined, it shows PK results in accordance with the intention the operator was instructed to hold. (The copy of the data the operator acted on is identical to the master copy, so the data itself was presumably not changed.) This effect is called ‘time-displaced PK’. (The name derives from some of the proposed explanations for the effect.)

Three explanations for this phenomenon have been considered in parapsychology. The first is called the ‘experimenter-psi effect’. This explanation notes

[8] In an earlier experiment Schmidt (1973) found that if binary trials were presented at two different rates, operators did better at the lower rate. However, because of the rate difference the operators had conscious knowledge of which machine they were using in each trial, and this could have predisposed them towards a preference for the lower rate.

that more than one person can affect the outcome of a PK experiment, and the persons who affect it are not necessarily aware of their effect. So PK results can be produced by the experimenter and/or any other persons involved in the experiment, not only the so-called operator. In early versions of the above experiment (Schmidt, 1976) the operator was instructed by the experimenter as to what intention (target) to hold, so the experimenter could have produced the PK. In later experiments, sometimes a third person specified the targets after the data had been recorded (Schmidt, 1993). In that case the experimenter might foresee by precognition the targets the third person will choose and produce these by PK. Alternatively, the third person could use ESP at an unconscious level (with this faculty perhaps augmented by linkage to the experimenter and others involved in the experiment). By this means he or she could learn the pattern present in the recorded sequence and then choose targets that best fit this pattern.

Another explanation, proposed by Helmut Schmidt, the originator of these experiments, is that PK can only occur when a conscious observer collapses the quantum mechanical wave function (Schmidt, 1982). Because nobody has observed the data until the operator acts on it, the operator in that case would be able to produce PK results. (Presumably the master copy and the operator's copy would collapse simultaneously.) Schmidt tested this hypothesis by giving a group of operators sequences of randomly interspersed pre-observed and non-pre-observed data. However, the results were inconclusive (Schmidt and Stapp, 1993), and the question of whether pre-observation has any effect is unresolved.

A third, rather exotic, possibility is that psi signals can travel backwards in time (theories reviewed by Stokes, 1987; 1997; see also Shoup, 2002). In that case the operator would hold the intention to affect the data, and the psi signal would then travel backwards in time to affect what had happened earlier.

Although the experimenter-psi effect would seem to provide a simple explanation for the above experiments, a possible problem for this explanation is that in later experiments the specification of the PK targets has become more complex. For instance, in a set of experiments done by Helmut Schmidt with various third parties, the pre-recorded data was divided into consecutive blocks. (No one saw the data before target assignment; it was simply identified by blocks.) The third party assigned the targets by obtaining a copy of a pre-specified newspaper and then deriving a 6-digit seed number from the last digits in a pre-specified weather column. This number was used to determine an entry point into a random number table, and the random sequence generated by that entry point then determined the targets for the consecutive blocks of data (Schmidt, 1993; Schmidt and Stapp, 1993). Obviously, all the targets were determined by the seed number obtained from the weather readings.

The experiments using the above procedure cumulatively showed a significant deviation from the mean (Schmidt, 1993). This result can be explained by experimenter-psi if the experimenter (with his efforts perhaps augmented by unconscious linkage to others involved in each experiment) knew the 6-digit seed numbers by precognition, accessed the random number table by ESP, and then produced data by PK which conformed to the targets.[9] However, this process is obviously very complex.

Can psi use a process that is this complex? We saw earlier that PK results appear to be improved when they depend on a larger number of bits. On the other hand, it is inconclusive as to whether precognition results can be obtained in a process as complex as this. Whether time-displaced PK can be explained in terms of the experimenter-psi effect depends on the limitations, presently unknown, as to what psi can do.

Although PK itself is not explained by presently-known physics, the time-displaced aspect of the above experiments is not actually that far from it. If the explanation is experimenter-psi, there is no time displacement. Although the explanation for collapse of the wave function is not considered established in contemporary physics, collapse by a conscious observer is among the hypotheses considered. Because the dynamical equations of physics fulfil a condition called 'time reversibility', the possibility of a signal travelling backwards in time is allowed by these equations (Shoup, 2002).

## Correlations of Psi with Physical Effects

When information reaches a person via psi, in whatever way this may occur, this information evidently has to be processed by the brain before the person can use it. One reason for this conclusion is that event-related potentials (negative slow wave at 150–500 msec) are associated with the presentation of psi targets (McDonough *et al.*, 2002).

Another reason for this conclusion comes from comparison with the way the brain processes sensory data — it is sensitive to differences in physical quantities, such as light intensity or sound intensity, and processes these differences, rather than absolute levels. In a similar vein, although there is some scatter in the data, several parapsychology experiments suggest that pictures which have a greater change in the variation of light intensity when different parts of the picture are compared (indicating a more complex picture at the sensory level) produce better psi results than those which have less change in the variation of light intensity (May *et al.*, 1994; 2000).[10] This suggests that the brain processes incoming psi information at a basic sensory level.

Additionally, Millay (1999) has shown that colours and shapes transmit better than the conceptual understanding of what these represent, which also suggests that incoming psi data enters the brain at a basic sensory level.

Incoming psi data can also produce physiological effects. For instance, experiments have shown that if one person attempts to influence another by psi, the recipient shows physiological effects such as changes in skin conductivity (Braud and

[9] An alternative, more exotic, possibility is that the experimenter, linked with others in the experiment, affected the weather readings by PK to produce targets which fit fluctuations in the data sequences.

[10] A picture having a greater variation of light intensity across it is more technically described as having a greater Shannon entropy. The pictures which produce better psi results have a greater change (gradient) in Shannon entropy when each part of the picture is compared to adjacent parts and these changes are averaged.

Schlitz, 1991; Radin, 1997; Schlitz and LaBerge, 1997). Physiological effects can also occur precognitively. When emotionally provocative pictures are shown, skin conductance, heart rate and blood volume are affected not only during the presentation, but also two seconds before. Pictures with a calming or neutral theme, randomly interspersed with the others, do not show this effect (Radin, 1997).

Correlations of psi with several physical conditions are also known. Analysis of a large number of ESP experiments has shown that fluctuations in the earth's magnetic field[11] have a negative correlation with psi results (Spottiswoode, 1997a). A possible interpretation of this result is that the magnetic field fluctuations produce some sort of low-level interference with brain processing, so that processing of a weak effect such as psi is interfered with.

It has also been shown that ESP results are correlated with local sidereal time (LST). (The latter describes the relative position of the stars for a given observer.) More specifically, at 13:30 LST, plus or minus about an hour, ESP scores increase three-fold over their average value (May, 2001; Spottiswoode, 1997b). Nearly all the ESP data was collected at northern latitudes, and for these latitudes the central part of the galaxy is below the horizon at 13:30 LST (May, 2001). A possible interpretation is that some sort of radiation, or perhaps fluctuations in radiation, comes from the central part of the galaxy and interferes with brain processing of weak effects. When the central part of the galaxy is below the horizon at 13:30 LST, its effect is shielded by the earth, and brain processing of weak effects would be thereby improved. It is unknown what sort of radiation might produce such an effect, however.

## Theories of Psi

As we have seen in the preceding section, it does not appear that psi is governed by laws which are similar to presently known physical principles. On the other hand, assuming it does follow laws, these must necessarily be *compatible* with known physical principles because these are experimentally verified. So it seems likely that there would be points of commonality between the laws of psi, whatever these may be, and known physical principles, and most theories of psi start from an assumed commonality.

Herein we will simply consider a sampling of theories that show the sort of ideas being considered in the field. Before doing that we will examine quantum non-locality, to see why conventional physics must be modified if this phenomenon is to be invoked to explain the distance independence of psi. We will then examine some general theories of psi which include explanations for its independence of distance.[12] Finally we will consider a few of the more detailed models of PK. For an extensive bibliography of theories, see Stokes (1987; 1997).

[11] The correlation is with the ap geomagnetic index.

[12] Experiments have shown that when an operator is at a distance from the PK apparatus, comparable results are obtained to when the operator is nearby (Jahn *et al.*, 1997). This finding suggests that PK is independent of distance although the possibility that these results can be accounted for by experimenter-psi has not been ruled out.

*Quantum non-locality*

The reason the concept of quantum non-locality must be modified from conventional physics when used in a theory of psi is that psi effects involve the transfer of information, whereas quantum non-locality permits correlations, but does not permit transfer of information. It is important to understand this distinction, and we will take it up in some detail. But first, let's see what the phenomenon is. Quantum non-locality permits a correlation between two sequences of measurements, one sequence at location A and one sequence at location B, with this correlation independent of distance. We saw earlier (in the section on Randomness) that if a sequence of measurements has a range of possible results, then the overall results must fulfil some pattern (the probability distribution), which is determined by the laws of quantum mechanics. However, if the two sequences are linked by quantum non-locality, they are constrained in a further way — in that case each measurement at A has a correspondence, to the extent of the correlation, with a measurement at B. For instance, suppose both measurements can be represented by binary sequences. Let's suppose the correlation links 0s with 0s and 1s with 1s, with a correlation of 75%. Then 75% of the time, when there is a 0 at A, a 0 occurs at B and similarly, when there is a 1 at A, a 1 occurs at B. This correlation occurs independently of the distance between A and B.

If the sequence at A could be controlled, it would be possible to send a message to B. (If the correlation is less than 100%, the message would have some inaccuracies, but nevertheless a message could be sent.) But the order in which each result appears is random, i.e., it is inherently unpredictable and uncontrollable. For instance, in the above example there is no way to control the order of 0s and 1s. There is no way to impose a message on the sequence, so no message can be sent in this way.

There is more to know about non-locality which at first glance appears to be a promising way to send a message, so let's go on. The pre-determined overall patterns at A and B can vary according to different knob settings (parameters) on the measurement apparatus. The degree of correlation is also specified by the laws of quantum mechanics and depends on the knob settings. So we ask, couldn't we use the knob settings at A as a code? For instance, if there are three knob settings, A1, A2 and A3, these could be used for a three-element code. Measurements at A could be made for a while using knob A1. The person at B could choose some knob setting, say B2, produce the corresponding sequence, and check it with the known probability distributions and correlations which correspond to each combination of B2 with the knobs at A. It would seem that he could determine by this means which knob was used at A. Unfortunately, the laws of quantum mechanics and special relativity, taken together, imply that the probability distributions and correlations combine in a way which prohibits the person at B from learning which knob A used. In fact, these laws taken together prohibit the transfer of information via non-locality by any method at all (Eberhard, 1978).[13] (This

[13] Eberhard (1978) points out that signals could be sent via non-locality if an alternate to special relativity could be used in which the order of all events was determined in an absolute way in some preferred frame of reference.

finding is known as Eberhard's Theorem.) So even though a correlation exists between the sequences at A and B, it is not possible for a person at A to transfer any information to B.

### *Theories involving quantum non-locality*

For the above reason theories of psi which invoke quantum non-locality propose a modification, in one way or another, to presently known physics. For instance, Josephson and Pallikari-Viras (1991) propose that living organisms can detect patterns in sequences that by scientific standards would be considered random. They point out that randomness is determined scientifically by taking an average over many sequences, and they suggest that living organisms may be able to discriminate information in individual sequences even though the overall pattern of many sequences appears random. In that case the information in the sequences could be transmitted non-locally.

Von Lucadou (1995) takes a different approach. Physical laws involve both abstract principles and properties, such as mass and distance, which the principles apply to. Von Lucadou proposes that the principles involved in quantum mechanics can apply unchanged to systems which can be described in terms of properties that are analogous to mass, distance and the other quantities used in conventional physics. He further proposes that psychological variables can be used in such an analogous system, which could thereby describe the action of psi. Because this proposed system would use the same laws as conventional physics, there would be no way to transfer information non-locally — there would only be correlations between random sequences. However, von Lucadou proposes that ESP and PK both occur via correlations only.

Atmanspacher, Römer and Walach (2002) make a different proposal regarding non-locality. They list the mathematical conditions which underlie the structure of quantum mechanics, and ask how these might be varied or weakened in order to be applied to other fields. They suggest that a weakened version of quantum theory could be applied to a model in which persons are linked by a collective unconscious, with non-local transfer of mental states possible between those who are linked.

### *Theories involving hyperspace*

Alternatively, it has been proposed that ESP is independent of ordinary three-dimensional space because of connections in additional dimensions. For instance, Rauscher and colleagues have proposed extending Minkowski space (the four-dimensional space used in special relativity) to the complex plane and have shown that events separated by space or time in ordinary space can coincide in this extended space (Rauscher, 1993; Rauscher and Targ, 2001).

In another hyperspace theory Sirag (1993a,b; 1996) considers the ten-dimensional space which forms the basis of string theory (and thereby forms the basis of all physical laws). He points out that a generalization of this space can be shown mathematically to intersect with another space, with different properties.

Because the first space incorporates all the principles of the physical world, the second space must be something different, and Sirag proposes that this other space describes the properties of universal mind.[14] The intersection of these spaces would describe the way consciousness and the physical world interact, and therefore would account for the properties of psi. In particular, the properties of the intersection include time, but not physical space (Sirag, 1993a), so the lack of dependence of psi on space could be explained in this way.

*Theories of psychokinesis*

Now let's examine some theories of PK. As we have seen in the examples of time-delayed PK, in many experiments it is difficult to know whether psi results should be ascribed to psychokinesis or precognition, and May and co-workers have explored the possibility that results that appear to be due to PK could actually be due to precognition (May, Utts, *et al.*, 1995). They point out in their theory, called Decision Augmentation Theory or DAT, that in many experimental situations the process which produces binary bits is ongoing, and the beginning of a sequence to be affected is decided by the initiative of an operator, by a button push or some similar action. Therefore, if an operator knows by precognition what sequence is about to be produced by random noise or radioactive decay, it is not really necessary for her to affect this process by PK. Instead, she can simply push the button when a favourable sequence is coming up. They show that the *z*-score (a statistical measure) has a different dependence on the number of bits affected, depending on whether PK or precognitive selection is operating, and in this way the two processes can be distinguished experimentally. This test has been applied to sets of experimental data that included sequences with different numbers of bits. However, conclusions on whether PK or DAT was operating depend on details of the analysis, and there has not been agreement about this (Dobyns and Nelson, 1998; May *et al.*, 1995). Additional experimental considerations to distinguish DAT from PK have been proposed by Ibison (2000).

Several PK theories — Schmidt (1982) and Walker (1975; 1979) — have proposed that PK occurs via collapse of the wave function by a conscious observer. These theories have also proposed modifications to the equations of quantum mechanics which would allow for PK (non-random transitions) to occur. In these theories a system can be affected by PK until it is viewed by a conscious observer. Therefore, according to these theories, PK results can be found in sequences which are *not* pre-observed, but not in sequences which are. As discussed above (in the section on time-displaced PK), Schmidt compared results for the two kinds of sequences in an experiment, but results were inconclusive (Schmidt and Stapp, 1993).

Walker (1975) has also proposed that PK can only produce changes within the limits of the uncertainty principle. Such changes would be extremely small. However, Walker (1975) has shown that for cases in which an effect of such a

[14] The first space is based on a finite subgroup of $SU_2$ and the second space is a Lie algebra. The mathematical properties of the first space have a known correspondence to properties of the physical world. However, it is not known what properties of mind correspond to the properties of the Lie algebra.

change can be magnified exponentially, the final change can be macroscopic. Specifically, he showed that if a travelling cube (used in many early PK experiments) undergoes a small change in orientation at the beginning of the trajectory, then after the cube travels a certain minimum distance, it undergoes a macroscopic change in endpoint which increases as the cube travels forward.[15] According to this theory the wave function would reflect this possible change in endpoint, and wave function collapse at the end of the trajectory would make the PK deviation manifest.

Burns (2002a) also proposes that PK can only make changes within the limits of the uncertainty principle, but in a different context. The action of vacuum radiation produces constant fluctuations in matter particles within the limits of the uncertainty principle. The effect of these fluctuations is magnified as molecules interact with each other, with the result that the direction of travel of molecules is randomized after only a few interactions (Burns, 1998). As a result the action of vacuum radiation can account for entropy increase at the microscopic level (Burns, 1998; 2002d). Burns (2002a) proposes that PK occurs through the ordering of these random motions in particles. She shows that the impact of about $10^5$ ordered air molecules could change the initial position of a travelling cube sufficiently to produce a sideways deviation of several centimetres after 50 cm of forward travel (Burns, 2002b,c).

Pallikari (2003) makes a different sort of proposal. As we saw earlier, experimental data shows that the action of PK on a random binary sequence not only produces a shifting of the mean, but also a bunching or gluing effect, in that both 0's and 1's tend to be adjacent to or near each other more often than would be found in a random sequence. Pallikari proposes that this gluing is the only physical effect PK produces. In that case, a shift in the mean can occur in relatively short sequences because the gluing would leave an imbalance in the number of 0's and 1's, but no shift in the mean would be found in long sequences. She points out that if gluing is the only effect of PK, any effect of mean-shifting would be sufficiently small that its lack of observation in scientific experiments could be explained.

## Psychological Factors Associated with the Production of Psi

Having considered physical aspects of psi, both experimental and theoretical, let us now turn to psychological variables which may influence the production and reception of psi.

A few personality traits have consistently been associated with increased reception of ESP. For instance, those who believe that ESP will occur in a testing session score better on the average than those who do not; this result is called the 'sheep–goat effect' (Palmer, 1971; 1972; 1978).[16] Extraverts obtain higher ESP

[15] A more detailed analysis of the dynamics of the cube has recently been done (Burns, 2002b, 2002c). The results differ from Walker's in some particulars, but confirm the above conclusions.

[16] This correlation has been found for a belief that ESP will take place in the testing session, and is not found as strongly for simply a belief in ESP in the abstract (Palmer, 1978; Rao, 2001). In a similar vein persons who report having previous psi experiences are found to score better in ganzfeld experiments (Dalton, 1997).

scores on the average than introverts (Honorton *et al.*, 1998; Palmer and Carpenter, 1998). Less defensive subjects (as measured on the Defense Mechanism Test) tend to score better on ESP tests (Haraldsson and Houtkooper, 1995). Also, those with creative ability tend to score better (Dalton, 1997). Little is known about the most favourable traits for senders of ESP, however (Bem and Honorton, 1994).

Some findings seem related to the comfort and relaxation of the subject. For instance, experimental studies have shown that relaxation of the subject increases ESP scores (Rao, 2001). Also, it is generally thought that psi results are better when the laboratory personnel the subject interacts with are supportive of obtaining those results (Dalton, 1997; Delanoy, 1997). This view is supported by a study in which two parallel sets of experiments were run, with conditions the same except that in one the subjects were informed of experimental procedures by a psi proponent and in the other by a sceptic. The experiment with the psi proponent showed statistically significant results, but the one with the sceptic did not (Wiseman and Schlitz, 1997). Additionally, if there is a sender, results are better if the sender and receiver are emotionally or biologically close (Dalton, 1997).

Sometimes instead of matching a target, a subject will produce psi results which miss the target to a statistically significant amount. This phenomenon is called ‘psi missing’. This phenomenon seems to occur more often when the subject is uncomfortable with the experiment or some conditions in it, or is sceptical that psi exists (Rao, 2001). In a probably related phenomenon if a subject is asked to switch back and forth between contrasting targets during an experiment, he may have a positive score on one and a negative score (psi missing) on the other (Rao, 2001). The latter is called the ‘differential effect’.

It seems likely that ESP scores are better when interest in the target and/or the experiment is heightened, and this is often considered to be the explanation for the ‘decline effect’ which has been found in a broad array of ESP and PK experiments. In this effect psi scores are better in the first test unit, decrease in the second, revert to random or near random at about the third, and then gradually return to the previous scores. This effect occurs at all levels, e.g. at the trial level (the third trial of a run reverts to near random) and run level (the third run of a series reverts to near random), and even occurs across sets of experiments done by the same laboratory (Dunne *et al.*, 1994). The effect of series position on results is also known in conventional psychology (Dunne *et al.*, 1994), which supports the idea that the decline is caused by flagging interest at the mid-point of a series. However, the actual cause is unknown.[17]

The characteristics of ESP targets presumably contribute to the participants’ interest. Some experiments have shown better results for dynamic ESP targets, such as film clips, than for static targets, such as photos, although this has not

[17] We should note that although there is considerable scatter in the magnitude of results from different laboratories for any given type of psi experiment, a polynomial regression plot shows a decline to near random and subsequent recovery across laboratories and across decades for various types of experiments (Bierman, 2001, Figures 4, 7, 8). (A few categories are fit by a steadily declining line.) Bierman (2001) proposes that these effects are due to the relationship of psi to the physical/ontological nature of reality, rather than being a psychological effect.

been a consistent finding (Rao, 2001). A review of ESP experiments suggests that multisensory targets (e.g. music with pictures, sound with videos) are preferable to targets that are solely visual (Delanoy, 1988).

In order to help the subject become aware of the target, it is generally thought that an environment of uniform low-level visual and audio fields, as is provided in ganzfeld experiments (see description by Palmer in this issue), is helpful, because psi appears to be processed in the brain like a weak sensory signal (Broughton, 1991; Rao, 2001). However, whether sensory reduction actually does help scores has apparently not been specifically tested.

Besides all the above considerations, it appears to be helpful in producing psi if the subject has a heightened focus and holds certain attitudes. With respect to heightened focus, several psi experimenters suggest that a subject should only do one session per day, which should be the highlight of the day (Delanoy, 1997; Targ and Katra, 1997). Stanford (1977), in reviewing descriptions in the literature of attitudes which may help produce PK, cited 'intention without effort to make things happen' and 'release of effort'. In the first attitude the goal can be treated as a game and approached in a playful way. In the second the intention to make something happen is first held and then let go. In a phenomenological study Heath (2000) described components common to the experiences of eight people who had produced PK events. These components included a sense of connection to the target and/or other people, a feeling of dissociation from the usual ego identity, the presence of playfulness and/or peak levels of emotion, and release of effort.

## Replicability of Psi Effects

A large number of experiments have now been done on phenomena which appear to be psi, those described in this article and others, such as those on psi in the dream state (Sherwood and Roe, 2003) and remote viewing (Hyman, 1996; Radin, 1997; Utts, 1996). We will not review the statistical analysis of these experiments here (see Radin, 1997). However, this analysis strongly supports the view that some sort of anomalous process is affecting data which would otherwise be random. But is this process psi? Let us remind ourselves that by psi we mean information transfer (ESP) and/or physical change (PK) involving the presence of consciousness, using no presently known physical mechanism, which occurs independently of distance and to some extent across time. Given the various effects on the data (such as described herein), the process appears to be psi. But alternative hypotheses are always possible. The most that can be said is that an anomaly is demonstrably present, but it conceivably could be a garden-variety anomaly of unknown nature.

Nevertheless, although the existence of psi is not proved, there is sufficient evidence for it that if psi were any ordinary phenomenon, it would probably be provisionally accepted and non-controversial. That this is not the case appears to be due to (1) its elusive nature (as we will discuss next), (2) its major differences from known physical principles (as we have seen herein), and (3) the lack of any generally accepted theory which can account for those differences.

Even though some factors important to producing psi are known, methods to produce it reliably in the laboratory remain unknown, as all parapsychologists are aware. It is the practice in parapsychology to publish all studies intended to study psi, whether it appears or not (this is done because the inclusion of null results is needed for a proper statistical analysis).[18] And it is commonplace to see papers which say in essence, 'This experiment was intended to study X attribute of psi. Unfortunately, we didn't detect any psi.' It may be possible to learn specifically what psychological states are needed to produce psi, such that one can reliably produce it. But without such knowledge psi is elusive.

One of the most frustrating aspects of this elusiveness is the failure to replicate large studies which in cumulative effect had given highly significant statistical evidence for psi. The ganzfeld experiments give one example. A meta-analysis of experiments in 1985 showed a $p$-value of $2.2 \times 10^{-11}$ (where the smaller the $p$-value is compared to 1, the less likely it is that results were obtained by chance) (Honorton, 1985; $p$-value from Milton, 1999). In other words the analysis strongly suggested that an anomalous phenomenon was present. At this point parapsychologist Charles Honorton and sceptic Ray Hyman jointly published guidelines for replication of the experiments (Hyman and Honorton, 1986). Eleven further studies, which met these guidelines, were then done by Honorton's laboratory, and these were also statistically significant ($p$-value of $3.3 \times 10^{-4}$) (Bem and Honorton, 1994; $p$-value from Milton, 1999). By 1997 thirty additional experiments had been published from other laboratories. If this effect is to be considered replicable, it is reasonable to expect that a sufficient number of these experiments would produce significant effects that the cumulative total of this data would also reach statistical significance. However, although some of these experiments showed statistical significance (i.e., evidence that psi was produced), not all did, and a meta-analysis did not show statistical significance (Milton, 1999; Milton and Wiseman, 1999). As Palmer (2003) has discussed, after ten more studies were published and added, results went back into significance ($p$-value of $4.8 \times 10^{-3}$). However, meta-analyses which go in and out of significance as more studies are added cannot be said to give robust evidence for a phenomenon. If by 'replicable' phenomenon we mean that researchers can be given a list of instructions on how to produce it, and most (not necessarily all) will then be able to produce it, then a more definitive specification of how to produce results is needed.

A similar problem is seen in the attempt to replicate the results of the extensive PK database of the PEAR (Princeton Engineering Anomalies Research) laboratory. Results for the first set of experiments were compiled over a period of twelve years. The shift in the mean value of the data was small (about $10^{-4}$ bits deviation for every bit processed), but the database was so huge that the resulting $p$-value was $3.5 \times 10^{-13}$ (Jahn *et al.*, 1997). In 1996 a consortium of three laboratories (at Freiberg and Giessen in Germany, plus the original PEAR lab) was formed in order to replicate these results. Physically random sequences were

[18] The omission of null results is called the 'file drawer' problem.

generated using the same type of equipment as in the first project. Experimental protocols and data analysis procedures were essentially the same. But no shift in the mean was found, not even in the portion of the data generated by the PEAR laboratory. Although the experimenters raised various possibilities that might be involved in this difference in result, they were unable to specify any definite reason for it (Jahn *et al.*, 2000).

## Conclusion

In spite of this elusiveness, if there were some theoretical structure which could make predictions about the dependence of psi on physical parameters, such that when psi does appear it would follow these predictions, probably psi would be accepted, at least as a subject of study. But, as we have seen, there is no generally accepted theory of psi — only some competing proposals. It would seem that psi needs either a recipe for reliably producing it or an experimentally verifiable theory of its relationship to known physics before it will be considered an established phenomenon.

On the other hand, psi should not be written off as having negligible chance of existing simply because it is not consonant with presently known physical laws. Or at least, something else should first be taken into account. Not everyone believes that free will exists. However, as we have seen, presently known physical laws encompass only determinism and randomness. So if free will exists, and if by this concept we mean something free and intended, not determined or random, then free will is not described by these laws (Burns, 1999). Furthermore, the only difference between free will and PK is that free will initiates action by affecting neural processes within the brain, whereas PK can act outside the body. So if PK is written off because it is not consonant with contemporary physical laws, then free will must be written off also.

For that matter the concept of consciousness does not appear in any presently known physical laws. Furthermore, the description of consciousness is very different from that of physical matter, in that consciousness does not appear to occupy physical space and characteristics such as qualia appear to be different from known physical quantities. So regardless of the ontological status of consciousness — emergent physicalism, dualism or anything else — it seems likely that the principles which govern it will differ from known physical laws. Psi phenomena may be giving us an advance view of some of these principles.

In summary, we have likened the signs that psi exists to the signs of land past Cape Bojador seen in the fifteenth century. Are these signs only akin to a tangled mass of seaweed, drifting aimlessly in the current, which merely appears to be land? Or is there a huge continent of further findings, with all that this implies? Time will tell. In the meantime, although you — the reader — may not want to join a voyage to the edge of what may be boundless ocean, you may want to be informed of the reports from people who do voyage there. It is the purpose of this Special Issue to inform you of the present state of these explorations.

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