A Biophysical Approach to Psi Effects and Experience

Paul Stevens

Psychology Ph.D.

The University of Edinburgh

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This thesis is dedicated to my family, who supported me no matter where my interests led.

Declaration

I affirm that this thesis was composed by myself and that all of the work herein is my own original research.

Paul Stevens

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Abstract

Psi, the unknown factor(s) in instances of apparently anomalous interaction between an organism and its environment, has long defied attempts to be usefully incorporated in a theoretical framework. By considering the different levels - physical, physiological and psychological - at which psi phenomena may be viewed as having an effect, a system theoretic approach is taken to model the way in which two systems may interact. The physical level is first considered, making the assumption that there exists an energetic psi signal. Inferring the required properties of such a signal from the types of system successfully used in psi experiments, it is proposed that the signal may be seen as acting to modify fluctuations in the electromagnetic zero-point field, its precise characteristics being determined by the activity of the electrodynamic system which generated it. A typical target system is simulated, and the presence of a perturbation - the psi signal - is shown to parallel the type of effect seen in empirical data. An experiment looking for possible distance attenuation effects using a system predicted to be sensitive to the proposed signal type is detailed. Expanding on this basic concept, a more detailed study is made of different systems and the possible types of emissive activity they may undergo. The same systems are then considered for their receptive properties. It appears that the systems most capable of detecting a psi signal are biological cells, with the site of primary interaction being the cell membranes, the semiconductor properties of which are compared to non-biological systems. Two experiments are reported, one looking at human and the other at non-biological sensitivity to electromagnetic fields, these being considered to be detected in an analogous manner to a psi signal. Similarities in the electromagnetically modified activity of the different systems were found. Next the psychophysiological factors which would better enable a human to make use of psi signals are considered, with another experiment demonstrating the use of subconscious response techniques. Finally, the possible mental experience of a human using psi is considered, comparing the premises of this thesis to laboratory and anecdotal reports. A final experiment which made use of a proposed psi enhancement technique, utilising a learned correlatory response between internal state and external feedback, is described. Based on the ideas presented, potential sources of interference are discussed, along with suggestions as to how to minimise such noise. Overall, the findings of the experiments offer support to the idea that psi interacts with organisms on a cellular level, with the psi experience being determined in part by the psi sensitive person's subjective interpretation of their perturbed physiological activity. Although at an early stage, this approach appears to offer a useful conceptual approach for psi research.

I. Introduction

The concept of psi

Throughout much of human history, there have been occasional reports of phenomena which do not fit neatly within our current models of interaction between an organism and its environment. From the Delphic oracle of ancient Greece and the miraculous healings of Biblical legends, to the poltergeist ('noisy spirit') and haunted houses, and more modern concepts of telepathy and psychokinesis, a significant proportion of the population say they believe in and experience such phenomena. Before the rise of scientific thought as the driving force in society, such phenomena were ascribed to supernatural agencies such as gods, demons or the spirits of the dead - acknowledged but often feared as being out of the control of ordinary man. With the advent of the extremely reductionistic, scientific approach to understanding the world that arose at the time of Victorian society, supernatural phenomena were no longer allowed to exist, for as such they would necessarily be outside science, and so must be able to be subsumed within a scientific framework. In 1882, the Society for Psychical Research was founded by a group of distinguished academics, it's purpose to "examine without prejudice or prepossession and in a scientific spirit those faculties of man, real or supposed, which appear to be inexplicable on any generally recognised hypothesis". With this declaration, much of the supernatural had been reduced to a 'faculty' of man that was open to objective study, although the inclusion of the 'inexplicable' phrasing has led to many problems due to the popular conception that such phenomena are inexplicable by any generally accepted theory within the framework of current day science. A better wording might have been that such phenomena were *not sufficiently understood* to be explicable by any generally recognised hypothesis. Even so, this was the start of the introduction of research into the field of the 'paranormal' as a scientific discipline, growing throughout the 1920s, and continuing through the laboratory protocols further developed by J. B. Rhine and colleagues in the 1930s and carrying on to the present day (Mauskopf and McVaugh, 1980). Despite a slow acceptance of psi research as a valid discipline, the fact remains that a large proportion of the population report what they interpret as psychic experiences, and the laboratory evidence in favour of as yet generally unrecognised interactions between organisms and their environment is steadily increasing despite ever more stringent controls.

The term 'psi' was introduced by Thouless and Wiesner (1948) to be a neutral term for a variety of 'paranormal' phenomena, free of the implicit assumptions that are contained within labels such as psychokinesis ('movement by mind') or telepathy ('feeling or perception at a distance'), and of the whole assumption of paranormality. It was originally split into two categories of psi-kappa and psi-gamma, denoting active and passive psi, the first subsuming those phenomena such as psychokinesis which appeared to involve an effect upon another system, the second covering phenomena such as extrasensory perception, which showed a more receptive aspect. The main problem with the terms is that they do not have a precise definition, indicating which phenomena may be counted as psi and which are excluded. Psi has been defined as the 'unknown factor' in psychic experiences, and often this is modified as being a factor which is not reliant on the conventional sensorimotor channels. That is, it is what is left when we have ruled out causes we do understand but still find an apparent deviation from chance expectation! Obviously this will cover a huge range of possible phenomena and makes the task of attempting to model psi daunting.

So, for the purposes of this thesis, I will sketch out the domain of phenomena which I will refer to as psi, and which this thesis attempts to address. This is not to say that 'paranormal ' phenomena outwith the specified range are beyond the scope of this model or future variations of it, merely that there are phenomena often included under the psi heading about which we currently have little or no reliable data. I am including those experiences which show an apparent transfer of information, to any degree of complexity, between living organisms, generally called extrasensory perception (ESP), remote viewing (of another person's location), and direct mental interaction with living systems (DMILS or bio-psychokinesis). I am also including apparent cases of information transfer between a living and a non-living system, commonly called psychokinesis. For this, I have concentrated more on micro-psychokinesis (the apparent change in the statistical properties of target systems) than on macro-psychokinesis (directly observable effects on physical systems) as the former has a considerable amount of relevant data collected under controlled, laboratory conditions (e.g. see Radin and Nelson, 1989 for a review) whereas the latter is based primarily on anecdotal reports and a few isolated case studies. There have also been many cases where macro-psychokinesis phenomena have been found by researchers to be fraudulent (Delanoy, 1987). Even so, I will speculate on possible macro-PK phenomena under the model at various points in the following chapters. The phenomenon of

clairvoyance (which originally meant a visual impression of the target, but now tends to be for any target-related impression that is thought to represent a direct perception of that target) is more complicated. I will discuss cases where the non-living target system has electrodynamic - i.e. involving the movement of electrical charge - properties (which I will suggest are required for the generation of a psi signal), but for cases where this is not so, little mention will be made. The ways in which other systems might be involved in psi interactions would be a lot more complex than that of electrodynamic systems, involving the modification of existing signals rather than emission. Precognition too will not be considered in depth, as its implication of the breakdown of cause and effect would require a further extension to any theory to allow for the retrograde temporal propagation of a signal, or to account for the lack of the experienced asymmetry of time. For the purposes of this thesis, it is assumed that, should precognition actually represent the transfer of information from future to present, the basic mechanism would work in the same way as the real time processes described here. Precognition will thus be considered to be a form of ESP, albeit with some even more unusual properties.

The approach taken in this thesis may be seen as a reductionist approach in that it is assumed that the psi phenomena here described have a physical existence involving energy exchanges between the measured systems. The author thus rejects an ontological dualist position in favour of a methodological dualism. The former would have psi acting as the interface between mind and matter, whereas this thesis takes the distinction to be based only on the different levels of description which are used when investigating psi phenomena.

The need for a theory of psi

One of the major, and most telling, criticisms aimed at psi research is that much of the work on the physical level is data- and not theory-driven. For many years, such research had a strong component of essentially proof-oriented work, with researchers having to attempt to prove the existence of psi phenomena as well as studying the actual properties of psi. Despite many calls, both from within and without the field, for a switch to a more process-oriented research, aimed at finding out how the phenomena work, much of the current research into physical mechanisms still shows little evidence of being guided by a theoretical framework. Even in the cases where the original research was rooted in theory, much of the subsequent work has shown more of a ritualistic approach than a systematic development.

In other disciplines, there has rarely been a breakthrough until some form of coherent framework has been developed which not only ties together the observed data but also predicts new results which have not yet been observed but which are testable. At present, the only approaches in psi research which can claim to have done this would be the more psychology based noise-reduction model (see Irwin, 1978 for a summary) which brought about Ganzfeld extrasensory perception (ESP) work, and the conceptual developments based in some interpretations of quantum theory which led to research into the psychokinetic (PK) influence of microscopic and atomic processes, originally based on the findings of macroscopic level PK - an approach pioneered by John Beloff at Edinburgh University (Beloff and Evans, 1961). However, neither of these models have yet been rigorously formulated nor successfully expanded into a more general theory.

Different levels of the phenomena

Part of the problem doubtless lies in the nature of the psi phenomena. In no other field do we find such a mix of physical effects intermingled with psychological states to such a degree that even a working definition of the observed effects has proved to be impossible, resulting in our current negative-definition of psi - we can only say what psi is not. The problem is increased by a lack of a rigorous theoretical understanding of randomness. As many psi effects are observed in systems having a random element, it is difficult to decide whether a psi effect is the result of a causal influence or some little understood behaviour of the random system itself. The ostensible effects reported in real life situations also seem to cause extreme reactions in experients and witnesses, ranging from avid acceptance and incorporation into a convoluted belief structure, to total disbelief and disavowal on a priori grounds of even the possibility of the phenomena's existence. Although this has been part of the development of many of the scientific disciplines, it has not been so in recent history for any but psi research.

To fully understand psi, we need to look at it on all its levels and in all its manifestations. We need to investigate physical and therefore, as we are often dealing with biological systems, physiological components of psi phenomena. However, if we are to avoid losing an important part of psi, we must also understand some of what is occurring on a psychological level. Psi appears to be linked to some of the least understood areas of human expression - myth and legend, spirituality and mysticism. If these areas do indeed relate to a link between

psychology and physics, then we may be able to learn valuable lessons about both by looking at psi.

II. Current psi theories

Before introducing new theoretical ideas concerning psi phenomena, a brief description of some of the most popular existing theories might be helpful, both as a way of seeing the assumptions that are inherent in psi research, and to show why a new theory is required. For a more comprehensive overview, see Stokes (1987). Some of the theories look at essentially physical aspects of psi phenomena, some look primarily at psychological factors, and some use a combination of the two. Here we will concentrate on the theories which attempt to account for the observed physical properties of psi, although these will necessarily include some of the accompanying psychological factors.

The first two theoretical approaches have been further developed by researchers other than Schmidt (1975) and Walker (1975; 1984), but the descriptions below have the essential characteristics of what have come to be called the *Observational Theories* (OTs).

Teleological Model (TM)

Schmidt (1975) originally proposed a teleological (goal-oriented) model that postulated psi as representing a "...modification of the probabilities for different world histories". If the psi agent concentrates only on the desired outcome of an event, psi would act to skew the probability of that event happening, or having happened in the case of retrospective psychokinesis (retro-PK). As such, this model was not of a psi mechanism but rather looked at the way psi was experienced by the psi agent. It was one of the first parapsychological approaches to include a unified psi: PK, ESP, precognition - all were aspects of one common psi principle wherein reality was altered to match expectation. This model meant that psi is independent of space and time as when and where in the world history psi occurred would be irrelevant. Psi is also independent of task complexity as the psi agent aims only for the desired outcome. As most human actions are essentially goal-oriented, this brought psi more into the realms of human experience. Feedback was considered to be vital: the psi agent can have an effect only if it is coupled to its environment in such a way that it may receive a stimulus. There was also what was called a 'divergence problem'. That is, all future psi agents could also have an effect on the present world history. In effect, this meant that for any experiment, the participant was not the only psi agent. So too are all future readers of the experimental paper!

As this model has much in common with the quantum mechanical theory of psi, criticisms of the two approaches will be handled together.

Quantum Mechanical Theory of Psi (QMTP)

Walker (1975, 1984) related consciousness to quantum-mechanical hidden variables. In quantum theory, any system may be described in terms of a wave-function - a complex superposition of waves, the squared amplitude of each being related to the probability of an individual event occurring. The complete wave-function would describe *all* possible outcomes of that system. Thus the wave-function of a coin-toss describes the possible outcomes of heads or tails, with the amplitude of each being equal to $\sqrt{0.5}$, the square-root of the 50% probability of getting a head or a tail. While this wave-function describes all the potential outcomes at once, experience tells us that we will actually observe only one outcome. This led to the idea that conscious observation somehow affects the system, causing the wave-function to 'collapse' into one specific state - the one we observe. If this is indeed the case, then perhaps the consciousness of an observer can actually affect, to some extent, which outcome actually occurs - a process which sounds very much like the concept of psychokinesis.

Walker developed this theory by pointing out that the brain itself is also a physical system, and so it too develops probabilistically into a number of superposed potential states. That is, the collapse doesn't take place due to the physical act of observation, but is linked to an act of 'mind', consciousness taking on the role of a 'hidden variable' of the wave-function which describes the physical system. Schmidt (1976, 1984) also explicitly stated that PK was related to the collapse of the wave-function in an extension to his original teleological model

An important feature of this theory is the unity of psi. PK, ESP and precognition are all aspects of the observation process. In fact, the basic process may be seen as similar to the idea of retro-psychokinesis in that the observation of the system would appear to affect the outcome of the system, no matter at what time that outcome would be said to have been determined in a classical sense. For example, the collection of random number data at time t=0 could be 'affected' at any subsequent time as long as it was not observed at t=0. ESP then becomes the selection of the system to correspond to the prediction.

As in the teleological model, psi is seen as being independent of space and time. A requirement of hidden variables is that they must, according to a well-known result of quantum theory called Bell's Theorem (Bransden and Joachain,

1990), be non-local in nature. This would mean that the space-time location of the system to be 'affected' is not relevant.

Psi is also independent of task complexity. Again, the important feature is the act of observation, so it is only the feedback which is important. This means that some form of true feedback to the 'observer' is vital. However, this again brings up the divergence problem although in this model, while future psi agents can also have an effect, it is argued that they can act only to increase the variance of experimental results rather than change what has already been observed.

Although popular in the field, the QMTP and the general teleological approach both have many problems. As mentioned, the inevitable divergence caused by future observers will introduce variance into the results. Walker (1984) argues that such variance is exactly what we observe in the wildly erratic results that have characterised psi research. This does not seem to be the most economical explanation, and does not allow for the overall replicability that has been shown to exist by the various meta-analyses (Bem and Honorton, 1994; Radin and Nelson, 1989; Honorton and Ferrari,).

Secondly, the QMTP theory is based upon what is essentially an *interpretation* of quantum theory, rather than its formalism. Quantum theory does not contain any objectively real collapse of the wave-function, by consciousness or any other agency - it is essentially a way of describing the associated probabilities of the possible outcomes of a system. In terms of the standard Copenhagen interpretation (Bransden and Joachain, 1990), it is erroneous to assign a wave-function to a single object. The observational theories imply that the wave-function has some external reality, as opposed to being merely a mathematical construct. Schmidt's teleological theory does not offer even a qualitative mechanism, but suffers in the same way as the QMTP in that it assigns a reality to the probabilities associated with individual events, rather than seeing them as descriptors of average outcomes of ensembles of events.

Furthermore, for consciousness to be able to cause a collapse, that consciousness must itself be outside of the system, else it too would enter into a state of superposition along with the target system and be part of the wave-function description. Unless some new physical principle is invoked, as Penrose (1994) does when he proposes that an objectively real collapse occurs when the superposed system encompasses a gravitational mass greater than a certain limit, this must essentially be considered a dualist theory. Walker argues that it is a 'practical dualism' (Walker, 1984) but this does not negate a fundamental problem of any

dualist approach: the lack of a definition of non-physicality that can still allow the non-physical to interact with the physical.

The final criticism addresses one of the fundamental tenets of the OTs: that the target system can be considered to be unobserved until the psi agent is given explicit feedback. That is, it may be considered a closed system, at least with respect to any conscious minds in its vicinity. Consider the simplified case of a one-sample, binary-choice, delayed presentation PK (a retro-PK) experiment using the radioactive decay of an atomic sample as its random source. At t=0, the time of data collection, the atomic nucleus will either have decayed or not. This will have resulted either in an electronic pulse from the radiation detector or the lack of one. The controlling computer will then read this as either a 1 or a 0, and will have written this bit to a hard disk drive. The wave-function thus describes the two possible outcomes of {decay occurred → detector gives electrical pulse → computer records a 1 } and {decay did not occur → detector gave no pulse→ computer records a 0 }. The OTs consider these two states to be in a state of superposition: neither state can be said to have occurred until a conscious mind observes the computer's record, at which time one of the two possible states will become reality.

However, let us consider in more depth what actually occurs. The decay of the nucleus will cause the radioactivity detector to produce a signal that carries down the connecting wire to the computer. This signal will radiate electromagnetic energy into its environment. On reception of the signal, the computer will undergo electrical activity in performing its preset instructions and writing information to its hard disk, again emitting electromagnetic energy into its environment (this latter has been roughly measured: a hard disk access alone causes magnetic field changes of around 1 mT in magnitude. The fine-scale structures of these field changes will vary depending on what is being written). This electromagnetic energy will propagate outwards from its source, interacting with any systems in the vicinity. If one of these systems is the experimenter (or any hapless bystander!), then that person will have very small changes made to their physiology. The 'closed' system has already interacted with much of its environment! While it may still be possible to argue that these changes will be far too small to be counted as being 'observed' by the consciousness of that person, this becomes difficult unless a clear definition of both consciousness and observation are given.

Thermal Fluctuation Model

Richard Mattuck (1982) presents an interesting variation of the QMTP based on the idea that the mind somehow utilises the thermal energy of molecules to alter the outcome of an event. Even in non-quantum systems there is a degree of uncertainty associated with any measurement, with the actual measured values showing small fluctuations around a mean value. These fluctuations are partially due to the agitation of the measured system by the random thermal energies of particles in the system (remember that an atom at a given temperature is equivalent to that atom having a certain kinetic energy in a random direction. The hotter the material, the more its atoms are 'jiggling' about), and have been shown to be related to the uncertainty principle in quantum theory (Milonni, 1994). Mattuck relates a PK effect to the processing of information at a certain rate, although he does not suggest a mechanism for this, apparently appealing to the same 'consciousness as observer' induced collapse as do the OTs. He does however offer a detailed analysis of the 'rate of information change' associated with a theoretical PK effect on various components of an example target system, but finds that all yield required information change rates at least an order of magnitude higher than the proposed information processing rate of mind. While more testable than any of the other OTs - the utilisation of thermal motion would result in secondary observable physical changes in the system e.g. a temperature change - this theory still suffers from many of the same criticisms as the more general OTs.

The Model of Pragmatic Information (MPI)

This model (von Lucadou, 1987; von Lucadou, 1994), generally thought of as one of the OTs, utilises a system-theoretic approach to psi rather than a quantum approach. It does however assume that the description of any system will have a axiomatic structure similar to that of quantum theory. Von Lucadou formulates a basic descriptive equation for the 'pragmatic information' I contained within a system, denoting the information which is meaningful to the observing organism, such that: $I = R \times A = B \times E = n \times i$ (for n=1,2,3,...). The first equality states that the pragmatic information will be determined by the reliability, R, of the system (a change in the *structure* of the system) multiplied by the autonomy, A (a change in the *function*, of the system). The second equality states that the pragmatic information will also be determined by the product of the novelty, E, of the information in the system and the confirmatory value, B of that information. The final equality puts forward the idea that there is a minimum amount of

pragmatic information, i (analogous to the idea of quanta in quantum theory). He then goes on to show how quantum theory axioms may, by analogy, be used to show the dynamics of inter-relationships between these concepts.

Von Lucadou also uses the system-theoretic concept of 'organisational closure'. An organisationally closed system is defined as one which dynamically defines its boundaries by the interaction of its constituent parts. Such a system will be seen as a unit when viewed from outside. A physical example would be an atom, which exists only through the interaction between a nucleus and its electron, but which has properties that exist only because of this interaction. A psychological example would be a social group whose members share some common belief structure that is an amalgam of the individual beliefs, these individual beliefs also being influenced by the group belief. In a psi experiment, organisational closure is related to the interaction between the psi agent and the target system, and is characterised by the internal pragmatic information of the system. The experimenter is outside of this closure but wants to get external pragmatic information in the form of experimental results. A psi effect is then defined as a meaningful correlation between the psi agent and the target system, although this correlation is *non-local* in the sense of quantum theory. The properties of one system are dependent on that of another, possibly distant system without any causal connection.

The major problem with this theory is that it uses qualitative concepts such as novelty as if they were quantitative to give the quoted equations. As the concepts are not quantitative, this reduces the testability of the theory. The concept of organisational closure has also been criticised in other fields for its lack of a useful definition, as almost any system may be described as being organisationally closed on some level.

The use of non-locality also produces confusion. In quantum theory, it has a precise meaning, and can only be applied to systems that are 'entangled' through previous interaction. In the MPI, the psi effect is a manifestation of such entanglement, but the entanglement itself is of unknown origin. The model thus offers no further insights into the physical component of psi. This also implies that psi also cannot be used as a carrier of signals, contrary to the apparent results of some laboratory studies. Examples include the identification of person-specific signature in PK data (Radin, 1989), the potential for identification of general emotional states of a remote person based on physiological measurements or the

receiver (Delanoy and Sah, 1994), and some instances of ganzfeld ESP (e.g. Dalton, 1994).

Finally, there is the aforementioned problem of the assumption that only the intended, explicit feedback is present - the system is considered to be closed to the rest of its environment.

In general, this theory has not gained general acceptance in the field of psi research, partially due to a lack of clarity in defining its terms, but more due to the lack of any practical application in psi experimentation.

Psi Mediated Instrumental Response (PMIR)

Another use of the systems theory approach to psi phenomena is that of Stanford (1975) who proposed a general model wherein an organism uses psi, as well as sensory means, to scan its environment for information related to its needs. This is often, but need not necessarily be, an unconscious process. In this model, cybernetic PK is viewed as being an instrumental response to this scanning. As the model is seen as an active scanning process by the organism, the use of psi would be governed by a variety of factors, both situational and psychological.

In this approach, PK and ESP are seen as separate processes, although telepathy can be seen as involving both extrasensory scanning for information about another organism and mental/behavioural influence of that organism by PK. Psi events occur in relation to the needs of the organism, and depend on the closeness in time of the relevant object or event.

One of the most interesting aspects of this model is that psi can occur without the need for conscious perception of the need-relevant circumstance, making this one of the few approaches that does not explicitly imply a link between consciousness and psi. It also allows that explicit feedback is not necessary as ESP provides relevant information. Although the author only states that this role is fulfilled by ESP, it at least allows for the more subtle forms of feedback due to the extended interaction between the target system and its environment mentioned earlier.

Stanford (1990) later modified the model into one of conformational behaviour, removing the scanning component and saying that the organism merely reacted to relevant psi-mediated stimuli in its environment. That is, conformance behaviour deals with "changes in the ordering of a relatively unordered system in relationship to a relatively ordered system", which allowed simpler organisms who

would not normally be thought of as being capable of scanning their environment, to utilise psi.

Although the theory tells us nothing about the physical nature of psi, it does provide a framework that is both ecologically valid and useful in designing psi experiments. We know that people can show instrumental responses to unconsciously perceived sensory stimuli (Bornstein and Pittman, 1992), so psi-mediated information might be expected to act in the same way.

Decision Augmentation Theory (DAT)

In an approach diametrically opposed to the OTs, this theory (May et al, 1995), which developed out of the Intuitive Data Sorting theory (e.g. Utts, May and Frivold, 1987), posits that humans may have the ability to make decisions, based on information gained precognitively. Thus, rather than causing the desired outcome, they take advantage of natural fluctuations in the target system, selecting times and situations that will show an outcome close to that which was desired. For example, in a 'score high' PK protocol, the RNG might produce a binary data-stream of:

0101001000**1011101011**0110100110**1010001101**0110101110010 10
↑ ↑
A B

If the data collection for a 10-bit sample was started at point A, then the 'PK score' would be 0.7 (seven 1s and 3 zeros). For point B it would be 0.5 (five 1s and five 0s). Entry at point A would then have given an above chance PK score, whereas point B would be at chance-level. DAT says that the psi agent could have received some sort of precognitive cue that would have enabled them to start data-collection at point A rather than B. If this biased selection process were continued, then we might conclude that the psi-agent had influenced the data stream to be non random when in fact it was still completely random overall. A further consequence of this process is that the final PK score will be inversely related to the sample length, and to the number of decision points available to the psi agent.

This model, being precognition-based, requires psi to be time independent to some extent although there is some debate as to whether it is an actual future which is precognitively 'seen', or just a probabilistic future associated with a specific desired outcome.

The main advantage of this approach according to the authors is that it removes the need to explain the two disparate active (PK) and passive (ESP) psi processes. It also allows for a PK effect in pseudo-random (and therefore deterministic) data, which would be difficult to explain by a causal influence model. As positive results with pseudo-random numbers have been reported by some researchers (e.g. Lowry, 1981; Radin, 1982), this is an advantage.

However, it is not clear that this first claim is true. The assumption is made that a precognitive cue rules out the need for a PK influence, but such precognition would presumably imply an influence of the future on the past. From the perspective of the future, this would be a case of retro-PK! The only way round this would be if precognition was a non-energetic process, which has the same problems as the dualist approach, or if precognition were itself a selection process akin to the OTs.

The approach also appears to have problems explaining the data from biological PK (now more commonly called DMILS - **D**irect **M**ental **I**nteraction with **L**iving **S**ystems). Although the topic is controversial, DAT can not be used to account for macroscopic PK, which after all was the impetus for starting micro-PK research. DAT advocates tend to downplay this problem, citing a lack of evidence for macro-PK. At the time of writing, the model also suffers in that it is purely quantitative, based on the findings of past data. It has not yet been used to predict the outcome of novel data. Nor does it consider any of the human aspects of psi and is thus seen by some as being overly reductionistic. Dobyns (1993, 1996) also questions whether the experimental data fit a selection model better than an influence model as DAT adherents have claimed, presenting some Monte Carlo simulations showing that this is not the case.

Electromagnetic Theories

The theories based in electromagnetism tend to be split into two main categories. The first is that there is a psi signal which is electromagnetic in nature, similar in nature to a radio signal (Edge et al, 1987). Advantages to this idea are that we know that organisms use electrical signals as part of their normal physiology, and we do indeed emit electromagnetic radiation which relates to physiological activity, and we understand the principle by which information may be encoded onto electromagnetic waves (this principle, called *modulation* is how audio and video signals are transmitted by radio waves). Criticisms of the idea include the low power of biologically-generated signals, the inverse-square distance

attenuation of electromagnetic radiation, and the apparent insensitivity of psi to conventional electromagnetic shielding. It should be noted that this last point does not take into account the difficulty involved in attaining complete shielding - low frequencies are highly difficult to shield against, and even higher frequencies may only be attenuated. It has also been pointed out (Edge et al, 1987) that the brain operates on low wavelengths (as exhibited by electroencephalographic recordings), usually below 40 Hz, and such wavelengths of electromagnetic radiation would have a very slow rate of information transfer. However, it is not clear that the brain is actually operating at these frequencies or whether they represent global beat frequencies resulting from the interaction of neuronal groups operating at far higher frequencies (up to the GHz range).

The second category is that originally advocated by Persinger (1989). He proposed that psi involves the naturally occurring radiation that makes up the Earth's electromagnetic field. He proposed a simple synchronisation effect wherein the conditions of this field affected two people simultaneously, causing both to have similar experiences. When the two later compared notes, they might conclude that they had experienced a case of psi, erroneously supposing the experience was due to the transfer of a signal between them. While this could possibly explain some simple experiences, it could not account for more complex experiences, or ones where there did indeed appear to be a transfer of information. For such cases, Persinger goes on to propose that the naturally occurring wave might be used as a carrier wave in the same way as with the mental radio model, with the weak electromagnetic field of the psi agent imposing the desired information onto this stronger wave. Again the main criticism of this theory is the low information transfer rate of the extremely low frequency natural waves, plus the absence of a mechanism by which this information could interact with the target system. Essentially, the theory describes ESP and does not account for PK.

New Physics Theories

Finally a brief mention will be made of theories which would require either an extension of current physics, or some new paradigm that allowed for psi. The case is eloquently made by Keith Harary (1982) in his paper "Psi as Nature" when he says:

> "...psi relationships may be operationally defined as certain aspects of nature's normal functioning that observers do not usually notice. Observers base their view of nature upon their usual perceptions and define certain less frequently perceived relationships, which do not fit in with this limited perspective, as extraordinary occurrences."

A description which describes a very human characteristic! With this idea in mind, several researchers have put forward a variety of approaches which incorporate some form of novel physical mechanism underlying psi. A popular idea is to introduce a new form of energy or matter. In Russian research, it is often *bioplasma*, a fourth state of matter responsible for a host of paranormal phenomena; in China, it is *chi* or *qi*, a form of energy with biological affinities (Ankun et al, 1986). Unfortunately, the exact properties of these new forms is usually not specified and the theories are thus not testable.

Schmeidler (1972) utilises a concept similar to that of microscopic space-time connections called 'wormholes' to propose that psi acts to form a connection between two points in space-time, with specialised brain cells actually processing the psi information. Other theorists have invoked extra dimensions to explain distant connections in psi experiences. Approaches such as these are not testable at the current state of technology and are a somewhat uneconomical way of explaining an effect that is, at least based on laboratory data, a weak effect.

Other theories have concentrated on neutrinos (energetic particle with zero or near-zero mass), due to their low rate of attenuation, or tachyons (hypothetical particles that travel at superluminal velocities, getting faster as their energy decreases!) with their reversed-time path, or even new psi fields and particles (see Bigu, 1978 for a review).

The main problem with all such approaches is that they either propose new physics based purely on psi phenomena, or they utilise existing ideas that cannot be shown to be applicable to the situations in which psi appears. The former approach will be unlikely to convince anyone as the existence of psi is still seen as being largely not proved by most scientists outside psi research, and indeed by some researchers within the field, and is at best too weak to be indicative of an overturn of current, successful physical theories. The latter approach is better, but will not work unless the predictions of the theory lead to improved psi in controlled situations, or if the particular physical properties used can be shown to be applicable to those situations where psi is observed.

Whichever approach is used, to date, none of the new physics theories can be said to have had a significant impact on our understanding of psi.

III. A systems approach

If a further understanding of psi, and a theory of how it operates, is to be achieved, it may be worthwhile to reconsider what we know about it, and to look at some of the assumptions that have been made concerning the phenomena. We can start by looking at the common components of any ostensible psi event: the experiencer, the subjective experience and the objective phenomenon (if any).

Characteristics of psi experiencer

- **Personality variables**

Much of the research into psi has focused on the characteristics of the psi experiencer. PK studies have looked at variables such as anxiety (Broughton and Perlstrom, 1991), field-independence and sex-typing (Stevens, 1994), and general changes in states of attention (Palmer and Kramer, 1984). ESP studies have looked at many measures including extroversion and defensiveness (Edge et al, 1987), hypnotic susceptibility (Sondow, 1986), psychotic symptomatology (McCreery and Claridge, 1995), and general measures of cognitive style (Snel et al, 1995). Findings have been somewhat mixed, possibly due to the lack of repeated testing of the same participants, and have not yet led to any generally accepted measures that should be taken in psi studies. The one exception to this is in the area of belief in psi, generally referred to as the sheep-goat effect (SGE). The name was first used by Gertrude Schmeidler, who metaphorically separated her participants in the believing 'sheep' and the doubting 'goats'. (e.g. see Palmer, 1971). Basically, her study, and several since, found that belief was an important factor in predicting success in psi, both under ESP and PK protocols, although whether belief begets psi or vice versa is questionable (Tony Lawrence, personal communication).

While it is generally agreed that psi success depends rather heavily on psychological factors, it is as yet unclear whether this indicates some absolute distinction based on biological differences, or is merely an indicator that psi is simply a human ability like any other, success depending on how the psi agent feels at the time of the experiment.

- **Lack of specific psi sensor**

At the time of writing, there is little indication of a sense organ that detects psi, nor even of a specific area in the brain which deals specifically with psi stimuli. Several researchers have suggested a variety of possible sites, such as the temporal lobe (Persinger, 1989) , the limbic system and the pineal gland (Roney-Dougal and Vogl, 1993), but so far all suggested systems may well be involved but none can account for the myriad effects and experiences reported. As the psi experience also exhibits a variety of sensory modes, it seems unlikely that a single sensor exists.

It has been suggested that psi may share some common points with, or even be a form of, synaesthesia - a state where a stimulus in one sensory modality may be experienced in a different modality. Synaesthetes may, for example, taste shapes or hear colours (Cytowic, 1994). This ability is not thought to simply be an extreme case of the linguistic metaphors that we use in everyday life but due to an inherent difference in neurological structure. As synaesthesia allows the experience of a sensory stimulus unrelated to the sensory channel through which the information was obtained, it is tempting to look for similarities with psi, where the specific channel through which information is gained is not known, but where the experience is often in terms of one of the familiar senses. Alvarado (1994) presented analyses of some questionnaires which showed a significant correlation between seeing apparitions, out of body experiences, and dream ESP with reports of limited synaesthesic experience (based on a subsection of Tellegen's (1992) Absorption Scale). He also reports on other researchers' findings which suggest that distortions in ESP response drawings show a synaesthesic-like component. Cytowic (1989) points out that clairvoyant dreams, precognition and 'a cosmic Weltanschauung' occur more often in synaesthetes that in a non-synaesthete population, also detailing instances of psychokinetic and healing phenomena, and of feelings of presence.

Although there are differences between psi and synaesthesia, most notably the long term consistency of an individual's synaesthesic experiences that we have not yet found in psi research, the two appear to have enough in common to have caused a number of researchers in different disciplines to suggest a link. The conclusion we may draw from this is that psi information is more akin to that of a cross modal information flow rather than a direct sensory channel.

Characteristics of psi experience

- **Wide range of sensory modalities**

Part of the difficulty in understanding psi is that the experience itself is not restricted to any one sensory modality. That is, the psi experience may appear to be visual, auditory, olfactory, or kinaesthetic, and possibly even gustatory. The imagery may be perceived to be internal, as in imaginative experiences, or sometimes external, as a hallucination (Green and McCreery, 1978).

- **Similarities to subliminal perception**

In forced choice subliminal perception studies, participants tend to respond with items which were obtained through subliminal perception of the stimuli. In free-response designs, the response tends to be symbolic or associated with the stimulus (Dixon, 1978) - a finding that appears to be replicated by free-response ESP work. Indeed, Dixon, an expert in the area of subliminal perception research, commented on the way that some academic departments consistently provided support for subliminal perception whereas others did not - often a similar sceptical argument is made against the existence of psi. Subliminal perception also appears to work better if the stimulus has an emotional content, again a finding of ESP research (Ballard, 1980) and in reported cases of spontaneous psi (Green and McCreery, 1978). Caroline Watt (1993) found that there was an apparent link between perceptual defence, as measured by a subliminal perception task, and success in various ESP tasks. Roney-Dougal (1993) also found data which suggested parallels between the two areas of perception, with several attitude and cognitive style measures found to correlate with subliminal perception success also correlating with psi success.

- **Differences to 'normal' consciousness**

Popular opinion has it that, to be psychic, the psi agent will invariably be in some form of trance (meaning some abnormal state of consciousness). Rush (Edge et al, 1987) describes it thus:

> "Another notable characteristic of psychic experiences is their strangeness. This quality is felt and commented on by almost everyone who reports such an incident, in such terms as 'weird', 'uncanny', 'unnatural', 'unreal'. Frequently cold sensations and 'goose-flesh' are reported, together with strong emotions of awe and sometimes terror."

Although this is likely to be biased in that the more extreme incidents will tend to be reported more often than trivial ones, there is often some suggestion of a slightly altered state of consciousness (ASC) in the majority of psi experiences (Zingrone and Alvarado, 1994). For laboratory experiences too, there can be an ASC, even with the small effects that are normally found. A survey by Rhea White (Parker, 1975) suggested that many participants in laboratory experiments could in fact be described as being in an ASC. She described the ASC as being characterised by a state of 'detachment', 'abstraction', relaxation', and so on. So the impression is that the ASC, except in extreme cases, is not vastly different from normal waking consciousness and may have been experienced in non-psi contexts, but that there is some degree of alteration of consciousness when psi occurs. This alteration is enough for the experiencer to be able to distinguish it from their normal state, and appears to describe a state of physical relaxation and/or undirected or dissociated mental activity (Harary, 1982).

Characteristics of psi phenomena

- **Small effect sizes**

Despite many effects to strengthen them, the typical effects found in a laboratory setting are very small. Expressed as an effect size (a statistical measure), microPK effects are of the order of $3x10^{-4}$ i.e. 3 parts in 10,000 are affected in the intended direction (Radin and Nelson, 1989);the Ganzfeld ESP experiments show a slightly better effect size of around 0.35 (i.e. a 35% success rate where in a four-alternative choice protocol we would expect 25% by chance - Bem and Honorton, 1994), and an overview of DMILS experiments show an effect size of around 0.25 (Braud and Schlitz, 1991). None of these effects are readily noticeable by their effects alone, although it is conceivable that they could start a chain of effects that could become observable to the naked eye. The effect sizes reported here are overall effects for large numbers of studies typically using unselected participants and a wide variety of experimental protocols - individual studies do sometimes show larger effects. It should also be noted that larger effects still have been reported in spontaneous cases, although these must be treated with care due to their anecdotal or uncontrolled nature.

- **Goal oriented nature of psi**

It is often said that psi appears to be goal-oriented in that the psi agent needs concentrate only on the desired end result (e.g. visualise a particular

configuration of a feedback display) and not have to worry about the underlying process, an idea which seems to have been promoted as much by the theoretical concepts of the observational theories than by experimental data. Studies that have compared target systems of differing complexity include Schmidt and Pantos (1980) and von Lucadou (1991). Both authors report no significant differences between the systems.

This has generally been taken to indicate that the area of 'influence' in psi target systems could not be the target system itself, but the point at which the psi agent's consciousness became involved. That is, the psi agent somehow manipulates, or is aware of, the final state of the target system rather than the processes which bring about that state. One wonders whether the preponderance of proof-oriented rather than process-oriented research in the field might be related to this assumption that process is unimportant for the final outcome!

But is that necessarily the case? Many human abilities can appear to be goal-oriented. For example, when we wish to pick an object up, we do not have to visualise the precise processes of muscle activity that will enable us to do this. Rather we think about the end result, and this triggers a series of learned responses which give the desired end result. Does this mean that sensory-motor activity could be said to be independent of task complexity? Obviously we know that this is not the case and that the underlying processes are extremely important even though this is not apparent under normal circumstances. We need only to think of the effects of relatively minor alterations to those underlying processes, such as the presence of disease or chemical toxins, to know that the goal can suddenly become more distant ! The relative ease with which we can handle everyday tasks comes about after years of continuous learning. What was a highly difficult procedure to begin with gradually becomes more refined until conscious awareness becomes less and less necessary. In fact, with well learned tasks, trying to retain conscious awareness can actually become a hindrance - something that is all too obvious whenever a conscious attempt is made to place one's feet when going down a flight of stairs.

It is known that a precise knowledge of process is not required - studies in conscious somatic control have shown similar degrees of success, in peripheral temperature studies, with participants visualising external glowing heat or wearing a pair of gloves as with them imagining increased blood flow to the hands - but this is a testament to the superlative abilities of the human brain to recognise, and utilise, patterns rather than any parapsychological properties (e.g. see Schwartz,

1974). In such a case (basically one of biofeedback with implicit rather than explicit feedback), the brain learns to associate a set of supplied symbols with the myriad subconscious stimuli it is receiving, whatever those symbols are. Subsequent use of those symbols can then activate the associated processes that bring about the required outcome. If this is the case, then we need to look for the analogy of the subconscious stimuli in the case of a psi experience. That is, what signals might the psi agent be *receiving from* the target system, over and above the explicit feedback, that enable them to gain information about its operation? If such a signal does in fact exist, then the complexity of the target system becomes unimportant in itself. Instead we would need to know about the complexity of the useable signals which it was emitting.

- **Random element in target systems**

Another observation not generally recognised is that the most often used target systems in psi experiments tend to have some random element. For example, in micro PK experiments, the most commonly used target systems are solid-state semiconductors, the random element coming from electronic noise (Fraser, 1983), the decay of radioactive elements (Schmidt, 1974) - either specific samples or the ambient background radiation from naturally occurring elements in the Earth - the decay of which is stochastic and is governed by a Poisson distribution, or the statistical distribution of macroscopic particles undergoing random displacements (Nelson et al, 1988). In ESP and DMILS experiments, the target system may be considered to be a living system. As all biological cells undergo a stochastic gating process (Hille, 1984), these systems too have an inherent randomness.

- **Spatiotemporal Dependencies**

One particular bone of contention for the sceptics, and for many advocates, is that psi is generally supposed to have some degree of spatial and temporal independence. Positive results have been found over large distances (e.g. Schlitz and Gruber, 1980) and has been interpreted as including the foreknowledge of events that have not yet occurred (Honorton and Ferrari, 1989) or the modification of events that have already happened (e.g. Schmidt, 1976). There is additionally no known substance that has been shown to act as a shield to psi effects, although admittedly there has been relatively little work in this area (Targ and Harary, 1986; Tart, 1986).

- **Directional effects**

A fairly commonly reported effect is that of 'psi missing' (e.g. see Carpenter, 1977). This is the name given to results which are consistently, and sometimes meaningfully, in the opposite direction to that intended. A simple example would be a DMILS experiment where the receiver's physiological activity actually became higher when the influencer was attempting to lower their activity. Had it then turned out that the receiver was angry with, or otherwise disliked, the influencer, this might be seen as *meaningful* psi missing - the receiver had subconsciously reacted to the intent of the influencer, but by showing an emotional reaction rather than in the way intended. Such results would not contribute towards the success of the study, but would still indicate that psi was operating. Again such a directional effect is often found in biofeedback studies into control of somatic processes (Schwartz, 1974).

Some researchers have additionally reported 'release of effort' effects (e.g. Palmer and Kramer, 1984), where the target system is perturbed immediately after the psi agent has stopped consciously trying to influence the system, and 'balancing effects' (e.g. Pallikari-Viras, 1993), where release of effort coincides with the system apparently acting to oppose whatever changes were made during the influence period. It is interesting to note that the former effect is also found in biofeedback research (Schwartz, 1974) and that the latter sounds very biological in nature, possibly akin to the relaxation effects found after cells have been over-stimulated (for example, after images in vision, where over-stimulation of retinal cells by one colour results in an after-image of the complementary colour).

- **The unitary nature of psi**

There is some indication of a relationship between ESP and PK, mainly as the classification of the type of psi depends on the viewpoint of the experimenter or experiencer. To illustrate this, consider the three basic types of psi: ESP, DMILS and PK (healing is considered to be subsumed under the DMILS heading and precognition under ESP). The diagrams indicate the end result of the system for each of the cases. It can be seen that giving or gaining information is reversible depending on which system is taken as the active one. For example, the ESP case seen from the viewpoint of system 2 is the same as the 'giving' direction of the DMILS case, and is also the same as the PK case if we consider the organism to be a physical system

Figure IIIa: Outcome of system for each psi classification

ESP = organism gains information from a remote organism (includes precognition)

System 1	←	System 2
(Biophysical System)		**(Biophysical or Physical System)**

DMILS (*Bio-PK*)= organism gains /gives information from / to a remote organism.

System 1	←→	System 2
(Biophysical System)		**(Biophysical System)**

PK = organism gives information to a remote physical system

System 1	→	System 2
(Biophysical System)		**(Physical System)**

(in the Bio-PK case, the term DMILS was adopted to emphasise the possibility that the process could be a two-way *interaction* rather than a one-way influence). This interchangeability would only be incorrect if the psi effects are dependent on some unique properties of the brain, the biological system or the physical system, or if psi is a property of Mind (mind with a capital M denoting a non-physical or undefined property).

Breakdown into a basic system

One approach which has been found to be useful in other disciplines is that of general systems theory, which attempts to "...formulate principles that are valid for 'systems' in general" (Bertalanffy, 1973). This theory defines a system as being a set of components in *mutual interaction.* These components may be at different descriptive levels in a hierarchical structure. Any part of a system can be seen as interacting with any other part, albeit often by an indirect route. The direction of action is usually arbitrary, based on the way the systems have been defined. It is also suggested that the 'whole can be greater than the sum of its parts', the simpler components showing emergent properties based on the nature of their interactions rather than their inherent properties. Edge (1986) offers the example of a mosaic, where the final picture is not due to any inherent properties of the mosaic tiles, but to the global pattern they create. Such an approach has been useful in other areas,

allowing a simplification of a complex system into a small number of components and their interrelations that can be more easily visualised,. This often allows the system to be modelled, but is free of some of the implicit assumptions within the techniques used by a specific discipline. For example, much of the research into human psychomotor function has benefited from general systems theory (e.g. Arbib, 1987), as have a variety of research topics in cognitive science (e.g. see DeGreene, 1970).

In parapsychology too, general systems theory has had some impact, von Lucadou's model (see chapter II) being an obvious example. Munson (1986) points out the advantages of it as a descriptive tool with psychophysical neutrality and no priority given to either physical or mental phenomena. His approach emphasises the meaning of the term 'information' both as signifying 'power of organisation' (also called *negentropy)*, and as 'the acquisition of knowledge', and illustrates that a systems approach shows us the reciprocity of the two. Munson equates this with the twin concepts of ESP and PK, showing that the difference is one of direction of viewpoint. As he puts it, '...discovering the world is no different from creating it' - by observing a system, we must interfere with that system, often making it conform to our expectations by the way in which we make a measurement. This is even more apparent when precognition is considered by the traditional viewpoint of 'seeing the future' and the OTs formulation of 'selecting the future'. He concludes that the systems approach may be useful to psi research by revealing unrecognised relationships among relevant factors, and advocates its use especially in the interpersonal system of experimenter and participant.

Edge (1986) also emphasises the way in which general systems theory techniques make us look at phenomena in terms of their *interaction* rather than merely their action, asking whether, in a typical ESP experiment, the receiver might also be having an effect on the sender. He then goes on to show how this approach also stresses the fact that any event we study is embedded in its environment - there is no such thing as a closed system - and points out that many psi experiments ignore a possible cognitive function of psi, removing any use for the psi ability we expect the participant to utilise. He concludes by saying that the reformulation of a psi experiment's design into a system while in its planning stages may enable the experimenter to better understand which factors might affect the outcome, and how better to make the task meaningful to the participant.

Based on the earlier indications of an interchangeability between the different types of psi phenomena mentioned earlier (see figure IIIa), and in the light

of Munson's comments, the three main characteristics of a psi event - physical effect, physiological activity (including behavioural effects) and reported mental experience - may be put together to enable the construction of an overall system (albeit a simplistic one) of the basic components and their interrelationships. Figure IIIb shows a system that deals with the components of experiencer (having both psychological and physiological components), experience (a psychological component) and the phenomena (a physical component), and their interactions. The psychology subsystem has two parts: internal structure and communication, and the interface between the level of psychological processes and of physiological processes. It thus deals with pure psychology (such as belief, expectations) and psycho-physiological concepts (such as perceptual constructs).

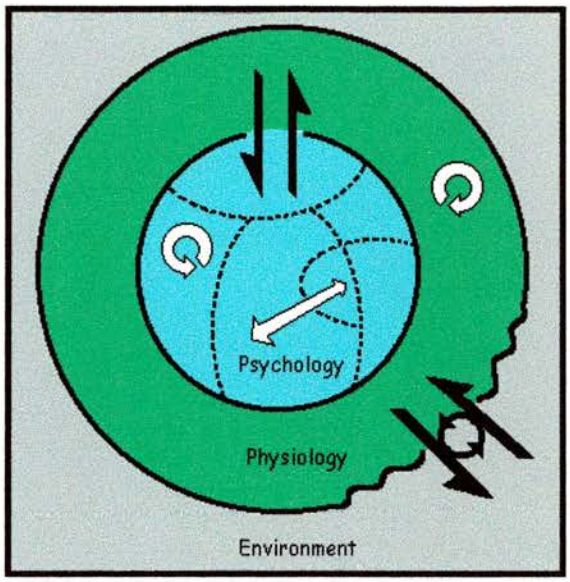

Figure IIIb: the psi system

The physiology subsystem will not be considered by itself as only those aspects of the physiology which contribute to the psi interaction are of primary interest, and these will be examined in terms of the psycho-physiological and environment-physiology boundaries. This latter interface deals with any type of energetic interaction between physiology and external environment (such as sensitivity to ambient energy fields). Direct sensory channels would also be covered by this interface but will be neglected within this model. There is however no reason to suppose that sensory channels would not fit within the basic model as it stands. Finally the environment subsystem deals with the possible nature of psi signals and sources of interference. The four levels that are of interest are summarised in table IIIa.

Using this approach, we can study different levels of the system separately. The first level, ψ_{SIG}, deals with the actual energetic signal that is hypothesised to underlie any psi experience, be it ESP, PK, or whatever. Thus the difference between a real and imagined experience could in principle be determined by whether the experience involves an actual transfer of energy between the psi

agent and the target system. Due to the arbitrary labelling scheme that denotes psi to be either ESP or PK, the signal underlying all psi processes is assumed to be the same at this level.

Table IIIa: System levels

Region of Interest	Symbol	Description
ENVIRONMENT	ψ_{SIG}	Assumed energetic perturbation, propagating in space.
ENVIRONMENT-PHYSIOLOGICAL BOUNDARY	ψ_E	Emissive psi - the processes which generate ψ_{SIG}
	ψ_R	Receptive psi - the perturbation of processes in the target system by ψ_{SIG}
PHYSIOLOGICAL - PSYCHOLOGICAL BOUNDARY	M_E	Psychophysiological characteristics that control ψ_E
	M_R	Psychophysiological characteristics needed to utilise ψ_R
PSYCHOLOGICAL	M_ψ	Mental experience of ψ_R or ψ_E

The next level concerns the processes which are thought to generate a psi signal, namely the physiological activity of the psi agent. A distinction has been made between ψ_E, termed *Emissive Psi*, and ψ_R, termed *Receptive Psi*, as it is thought that different conditions will occur in the psi agent's physiological system depending on whether a signal is being passively received or actively emitted. However, this should not be taken to mean that only one or the other occurs - rather psi would be a complex interplay of both ψ_E and ψ_R.

We next have M_E and M_R. These are related closely to ψ_E and ψ_R, being the processes that make the link between psychological activity and physiological activity. No attempt will be made to say whether the mind causes the physiological changes, rather than being caused by or running in parallel to, as this is not the place to get into a philosophical argument as to the nature of volition. For the current model, it is enough that there is a link between the two, and that it can be viewed as a two-way link with mind affecting physiology and vice-versa. As the model posits a psi signal generated by physiological activity, then obviously successful use of the more complex forms of psi will necessitate some degree of control over those processes. This level will deal with the psychological and psychoperceptual concepts that relate to the control of psycho-somatic (including neurological) processes. Even if psi is operating on a subconscious level, the physiological changes that will be caused by the reception of a psi signal will

inevitably affect people on some level, even if this level is below an awareness threshold.

Finally there is M_{ψ}, which is concerned with the psi agent's *mental experience* of all the sub-levels ψ_R, ψ_E, M_E and M_R. This level need not necessarily occur if the psi process acts on a subconscious level, but will be important for any conscious level psi. The following chapters will consider each level in more detail.

IV. The psi signal

This thesis proposes a psi signal to be an electromagnetic wave generated by electrodynamic (involving the movement of electrical charge) events. In a biological system, these events take place on a cellular level. In non-biological systems, the events will involve whatever electrodynamic processes are of relevance to the psi phenomena under study. The generation of a psi signal is thought to be the result of normal activity rather than any novel, psi-specific process. Specifically, the motion of a charged particle (an electron or ion) within the generating system produces electromagnetic radiation. Interference effects between interacting electromagnetic waves (as any activity within the system will involve large numbers of particles) will encode information about system activity that will propagate outwards, eventually interacting with the target system. So, can these proposals be justified ?

A physical signal?

A signal is defined as a parameter by which information is conveyed through a system (Pitt, 1979). Essentially, a signal may be represented mathematically as a function F such that the transmitted signal S_{Tx} and the received signal S_{Rx} are related as: $FS_{Tx} = S_{Rx}$. For any physical signal, information is encoded in the spatial and temporal distribution of some form of energy. The function F then represents the loss of information through attenuation, noise, encoding and decoding procedures, and so on. So, does psi need to be due to any sort of physical signal ? Although this view is not one that is accepted by all parapsychologists, there appear to be a number of advantages to taking it as a working hypothesis, at least for those phenomena which appear to involve an interaction between different parts of a system.

First of all, we know that living organisms radiate different forms of energy, all of which contain a lot of information about that organism. The extent to which other organisms might be able to detect and make use of such information is only just beginning to be explored. Assuming that psi in at least some of its forms might be related to some aspect of such energetic emissions does not seem implausible. Such a model also establishes a continuum between living organisms and inanimate objects as the latter also emit energy, often covering frequency ranges similar to those utilised by biological organisms.

Secondly, if psi were *not* physical then there are problems in having a non-physical phenomenon interact with a physical system. Such an interaction would require the invocation of some acausal principle. Moreover, if psi is related to the concept of a non-physical mind, as some of the dualist perspective would argue (Beloff, 1994), then the problem is just relegated to how such a mind might interact with the physical brain. While this could turn out to be the case, the lack of any viable theories that could model such an interaction mean that taking this approach is unlikely to further our understanding of psi phenomena. It should also be noted that in the dualist approach psychokinesis is sometimes considered as the interactionist principle by which mind orders brain (e.g. Popper and Eccles, 1983). Making psi purely a property of mind thus results in a circular argument (i.e. mind orders brain through the action of mind).

Finally, and perhaps most simply, there is no convincing reason to assume psi is not energetic. At our current level of scientific knowledge, we know of no non-energetic phenomena that can directly affect physical systems. It would seem premature to suppose psi is fundamentally different from other phenomena without having good reason to do so. So the question becomes, do we have reason to conclude this is the case?

As mentioned in the last chapter, other researchers have proposed that some characteristics of psi phenomena differ from our concept of everyday reality in that psi can apparently exhibit some degree of independence from both spatial and temporal parameters. That is, the distance in both space and time between the target system and the presumed psi agent is, to some extent, not an important factor in the success of a psi task.

Precognition is one of the most problematic of the ostensible psi phenomena to explain from a theoretical viewpoint. Taken at face value - that precognition actually represents foreknowledge of an undetermined future event rather than some more conventional explanation- it implies one of three possibilities. One, the propagation of a physical signal from a future time to the present time - a notion that seems to undermine all we know about causality, allowing effect to occur before cause. Two, the ability to select a future event that corresponds to the foreseen event, which would require a scenario as laid out by the observational theories, or by the many-worlds interpretation of quantum theory (for an accessible discussion of this see DeWitt and Graham, 1973). Three, that the precognition is not an actual future but a potential one. This could imply real-time information

gathered via psi or sensory means, together with extrapolation or some as yet not understood physical principle governing the evolution of a particular time line.

This last option is easier to contemplate from a common sense perspective, but implies an amazing capacity to (subconsciously!) gather information by extrasensory means, plus a high capability for extrapolating possible outcomes from that data. The extrapolation idea has some support based on experimental data (e.g. see Morris, 1968) but, to date, the only experimental test of the latter possibility would be one by Radin (1988). His study appeared to show that the more probable a future was (based on a pseudo-random decision), the more likely a person blind to those probabilities would guess it.

However, as it has not yet been replicated, a single study is not sufficient to conclude that this is the way precognition might work. Nor was the design sufficient to rule out option one as an explanation.

Option two is the ultimate in self-fulfilling prophecies, and suffers from the same criticisms as the OTs.

Option one, although difficult to imagine when viewed from an everyday perspective, is perhaps the least unpalatable from a physics standpoint. Although we experience time as a one-way flow from past to present to future, theory often allows for a bidirectionality with respect to time on the microphysical level. Many of the fundamental theories are time-reversible and do not rule out the possibility of retro-temporal processes. This peculiar fact was actually utilised by Richard Feynman (1949) to avoid some otherwise problematic negative energy states that appear in some calculations dealing with the properties of antimatter (subatomic particles which are equivalent in terms of mass to matter but which have an opposite electrical charge), where he replaced the positron (the antimatter equivalent of an electron) with an electron which propagated backwards in time. Currently, this is purely a theoretical exercise and no observations confirming time-reversible processes have been made.

Basically, only option three is viable given our current understanding both of physics and psi. It does not rule out the existence of a physical signal, and certainly does not offer any incentive to suppose a non-physical one, other than the practical problem of formulating a suitable form of energetic signal that might account for the observed phenomena.

So if there is a physical psi 'signal', another consideration is that of the strength of the signal. If the source of the signal is a biological system, there are some fundamental constraints on the power of any signal generation which will give

quite a weak signal strength. The strength of the signal also affects the way in which the signal is received. Any physical system has inherent noise - for a signal to be successfully received without it being so degraded as to be content free, the signal to noise ratio must be high (i.e. the signal must be higher than the level of the background noise). This is the conventional approach taken in many analyses of the possibility of a psi signal. Authors have tended to conclude that, as any signal would have to be very weak if it were generated by a biological system, it would be too degraded by noise for it to be useful. However, there are some properties of certain biological systems that may get around this constraint. A fuller discussion of such parameters will be given in chapter IV. For now, it is enough to say that such considerations are not an absolute bar to psi being an energetic signal. So what could be the nature of this signal? Based on the knowledge of the functioning of biological systems, and of the typical target systems used in psi research, I favour a psi signal consisting of an electromagnetic wave.

Signal properties

If an electrical charge is accelerated (as when a current starts to flow, or in an oscillating circuit), electromagnetic energy is radiated in a direction perpendicular to the acceleration, with a power proportional to the amount of accelerated charge. This radiated electromagnetic wave is considered to have, as the name suggests, two components - an electric field and a magnetic field. The changing electric field generates a magnetic field, and the changing magnetic field generates an electric field, resulting in the propagation of energy through space. The waves are always transverse to the direction of propagation. Figure IVa. shows this schematically for a electromagnetic plane wave. (A detailed discussion of basic electromagnetic theory can be found in any standard physics text book, e.g. Kraus, 1992). To help the reader to visualise the properties of a transverse wave, note that the mechanical oscillations of air confined to one direction of propagation (e.g. in a narrow pipe) are also transverse waves. For an electromagnetic wave propagating through space, the amplitude of the wave is given by equation [1].

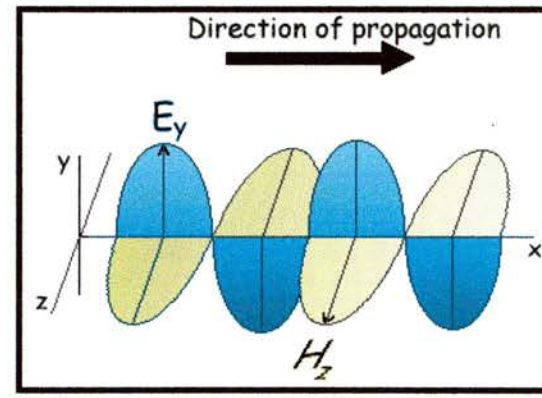

Figure IVa: Electromagnetic Plane Wave

$$E_y = \sin(\beta x + 2\pi ft) + \sin(\beta x - 2\pi ft) \quad \text{---[1]}$$

The two terms indicate that there is a sinusoidal wave travelling in both the positive and negative x-directions outwards from the source. This wave's amplitude will decrease as the inverse of the distance from the source ($1/r$), with the associated energy decreasing as the inverse of the distance squared ($1/r^2$). This last point is worth dwelling on as a commonly held misconception is that the $1/r^2$ dependency (often referred to as 'the inverse-square law') limits the distance over which a signal may be successfully transmitted (Edge et al, 1987). This actually represents the strength of the signal, whereas the important aspect is the intelligibility of the signal at the receiving system - a property which depends more on the amplitude, which contains information about the characteristics of the source system and which decreases only as $1/r$. As long as the wave can impart its information to the receiving system without being corrupted by noise, the signal can be considered to have been successfully received.

For a psi signal, it is envisaged that the change in the flow of charges in the source system - for example, as electrical pulses start to travel along the axon of a neuron, or when they terminate at the synapses - generates patterned electromagnetic waves which are then radiated outwards at local light speed. For a single source (i.e. a single charge, or packet of charge), this wave will be related directly to the characteristics of that charge. However, for a system of charges with differing velocities or at sequential times, the individual waves will have different field vectors and different phases, and will interfere, both constructively and destructively. Thus for any particular configuration of charges undergoing acceleration, there will be a specific patterned electromagnetic wave propagating outwards.

This classical electromagnetic wave, without any further modifications, may be capable of causing many of the phenomena reported in local, laboratory-based psi research. If humans are indeed sensitive to very weak electromagnetic fields (a discussion of this is in chapter V.), then a lot of information about the source system may be gained by interaction with this wave. Likewise, any other target system sensitive to electromagnetic radiation might be affected if the specific parameters of the wave were within the target system's window of interaction. As was noted in chapter II, there have been objections to an electromagnetic-signal based theory of psi. While it is probably true that a conventional electromagnetic

carrier wave (the mental-radio model) could not account for psi phenomena, this assumes a carrier wave that has the information encoded onto it. What I am proposing is that the characteristics of the 'carrier' wave itself make up the necessary information. That is, rather than imposing additional information content onto the base wave characteristics by some form of encoding (e.g. like the amplitude or frequency modulation used to carry audio information by radio waves), the base frequency and duration of the wave are all the information that is conveyed by the psi signal. The detection process is then either by associative feedback or what could be called a resonance between emissive and receptive systems. However, the detection and emission processes will be considered in depth in the next chapter. Here we will concentrate on the interaction of the psi signal with the target system.

Signal interaction at the target system

Some phenomena - such as local, real-time ESP (i.e. not including cases of true precognition) and dowsing - may be explainable purely in terms of an electromagnetic wave. However, there are effects commonly seen in psi research which can not be explained purely by classical electromagnetic theory. Examples of target systems which have shown apparent perturbations related to human intention include background radiation levels and quantum noise systems (Edge et al, 1987), neither of which would conventionally be expected to be affected. What may be needed is a further step between the generation and reception of the psi signal. Considering the target systems which have been used in psi research (considered in more depth later on in this and in the next chapter), an attempt can be made to infer at what physical level a psi signal would need to operate. Although highly speculative, it is suggested that this step may involve the quantum electromagnetic fluctuations of the vacuum.

In the Newtonian physics paradigm, the vacuum was seen as a region of completely empty space, devoid of all matter and energy. Modern physics, especially the branch known as quantum electrodynamics, instead predicts a field with energies fluctuating around the zero-point even in the absence of any sources (Milonni, 1994). These 'zero-point field' fluctuations are generally seen as being

related to Heisenberg's Uncertainty Principle[1] (Bransden & Joachain, 1990), although some researchers consider it to be a dynamically generated equilibrium state due to the motion of all charged particles in the universe (Puthoff, 1989a). The standard quantum approach does not say that such fluctuations are 'real', only that effects are observed as though they existed. The approach taken by Puthoff and others assumes they have a real, classical existence (Milonni, 1980). For the purposes of the ideas presented in this chapter, no assumption is made as to whether such zero-point field fluctuations actually exist, only that effects may be observed as if fluctuations were present.

It is known that controlled local modifications to the zero-point field are possible, some of which have been demonstrated in the laboratory. One example is the attractive Casimir force between closely separated conducting plates. Another is found in electrical engineering, where a measure of inductance per length, (related to the property of resistance) is given for a vacuum, implying it has properties that impede the propagation of energy. Essentially the propagation of electromagnetic waves through a vacuum is modelled as though through a transmission line with an intrinsic impedance of 367.7 Ω (Kraus, 1992). The terminology used is based on discarded notions of an aether - the hypothetical medium which permeated all of space and the vibration of which was originally thought to constitute light waves - but the values are based on empirical measurement, suggesting that there is still some aspect of a vacuum, even under current physical models, that may interact with electromagnetic waves.

I am suggesting then that an electromagnetic wave generated by the source system's activity (the psi signal) may cause modifications to fluctuations in the electromagnetic zero-point field. This approach may be necessary as a number of systems that would not be expected to be sensitive to conventional electromagnetic waves do have a dependence on the electromagnetic fluctuations of the zero-point field. A good example is the electronic-noise (a blanket term covering both thermal

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[1] Roughly, this principle states that incomparable observables e.g. the position and momentum of a subatomic particle cannot both be known with absolute precision. The more precise the measurement of either of these values, the more uncertain is the other, due to the fact that any measurement of a system will disturb that system (Pitt, 1979). This means that the minimum kinetic energy of any particle will not be zero. That is, even a particle at a temperature of absolute zero will still have a non-zero energy.

and zero-point field fluctuations) based random number generators used in many micro-PK experiments (Fraser, 1983). Another example is the gating action of biological cells (Hille, 1984), thus hinting at a possible link between ESP (affecting the random factor in mental activity of another human) and PK (affecting the random factor in activity of another physical system). This approach also suggests that we might find effects due to electromagnetic fields, even very weak ones, which would not conventionally be expected, and that there will be parallels between psi sensitivity and electromagnetic sensitivity. Shielding may also be made more difficult as traditional shielding techniques at best only attenuate electromagnetic signals. If the effect of an electromagnetic wave is to cause a local modification of the zero-point field, then this may occur to some extent irrespective of the strength of that wave. For an electromagnetic psi signal, we may then see an effect that would be unexpected based on the signal strength.

There is also some new theoretical (though highly speculative) work attempting to describe both inertia (Matthews, 1994), and possibly even gravity (Puthoff, 1989b) in terms of the electromagnetic zero-point field. Such work gives tantalising hints that the ability to make controlled changes to the zero-point field may result in changes affecting even macroscopic systems. If psi is indeed electromagnetic, then future developments along these lines may be of interest to psi researchers.

Simple simulation of PK interaction

Although a direct testing of the ideas concerned with the physical nature of the psi signal - target interaction is beyond the scope of this thesis, it should be possible to do a simple simulation that would at least show whether the basic premises would give results comparable to empirical data. If the data produced by the simulation do match empirical data, this still cannot be taken to be evidence to support the speculative ideas presented above, but it would offer some support to suggest that the principle behind the ideas is worthy of further investigation, as it offers a useful way of conceptualising the psi effect. Essentially, any theory is just a self-consistent model that predicts measurable effects. It is not necessarily a *realistic* representation. Under the proposals of this thesis, the simplest interaction would be between a psi source and a passive target system - a basic psychokinesis protocol. A numerical computer simulation was thus attempted to be compared with some data from PK research.

For the simulation, the following assumptions were made:

- The zero-point field fluctuations at any point can be modelled by the superposition of sine waves of varying frequencies and phases.
- The zero-point field has random initial (t=0) conditions for the phase distribution.
- A simple ψ_{SIG} could be modelled by a sinusoidal wave of constant velocity that would not suffer attenuation over the distance considered, nor would it show a net interaction with the underlying field. The velocity is an arbitrary value equal to that of the zero point field component waves. Each pulse is discrete and repeats with an interval long when compared to the periods of the zero-point field component waves. Only a simple wave form was used for ease of modelling, although it is acknowledged that it will be far more complex in any real-life situation. It was hoped that this psi signal might be representative of the ongoing modification of the zero-point field by a conventional electromagnetic wave.
- A random number generator could be modelled as giving a '1' output when the underlying zero-point field at its location exceeded a specific (though arbitrary) amplitude threshold.

The first assumption is loosely based on the theoretical premises of stochastic electrodynamics (e.g. see Boyer, 1985). This suggests that the zero-point field can be treated as a superposition of plane electromagnetic waves having a random phase distribution. That is, it can be visualised as being composed of a large number of coexisting waves moving in all directions, all these waves having similar amplitudes but varying frequencies. As the waves are not in phase (i.e. the peaks and troughs of different waves are not in synchronisation), the overall appearance of the field will be of one that is randomly varying. As an analogy to aid visualisation, think of the surface of the sea, with the height of the waves representing the amount of energy. This too can be seen as being composed of superposed waves, the source of the individual waves being the wind, the tides, passing ships, and boundary effects where the waves interact with rocks. Due to constraints on time and processing ability, the zero-point field was simulated by a superposition of fifty sine waves. Although the number required to accurately model the field would be far in excess of this, this appeared to give a reasonable approximation to a 'random' field. Some degree of patterning was still noticeable, but it was hoped this would be sufficient to at least give some indication as to

whether the basic concepts would provide a working model of a PK system, albeit a simplistic one.

PROCEDURE

An array of points in a two dimensional space were constructed in the computer memory. For each (x,y) point the electric field strength, E, was based on a sine wave with initially random values for the x and y modifiers, A and B, and a random start point modifier, C. The ratio of A to B is related to the direction of the wave (B=0 corresponds to a wave in the x-direction, A=0 to a wave in the y-direction. Equal values of A and B would mean a wave propagating at a 45° angle), while the magnitude of the values would relate to the frequency of the wave. The start point modifier, C, would be related to the phase of the wave. This gave an energy density which had a value between ±1. Negative values were used so that the model could allow for destructive as well as constructive superposition. Subsequent sine waves were added in the same manner, and then each point was scaled down to again give a range of ±1. The model thus described a simulated field for a two dimensional space according to equation [2].

$$E(x, y) = \frac{1}{50}\sum_{n=1}^{50} \sin(A_n\mathbf{x} + B_n\mathbf{y} + C_n\mathbf{t}) \qquad \text{——[2]}$$

The entire field was then updated by incrementing t and holding all other values constant. A random event generator (REG) was modelled by selecting an arbitrary fixed point in the field array, and 'measuring' the amplitude of the underlying field at fixed points in time. If the field exceeded zero (the range was ±1), then the REG registered a 1, if not, it registered a 0. Again this is a very simplified modelling technique, as a real REG would be dependent on a large number of factors before it registered an event, but as the zero-point fluctuations contribute towards the likelihood, this would be representative enough for the purpose of an initial feasibility study. As the sample rate of a typical REG (around 9600 Hz at best) will be far less than the frequency of the electromagnetic waves for most wavelengths, it was decided to increment t with a high value each time. This removed the slight periodicity which was seen due to the small number of sine waves used, and should not have violated any of the assumptions used. Ten trials of 200 bits each were collected and compared to similar samples taken from an actual REG (a standard model available from Professor Dick Bierman, University of Amsterdam). The mean and variance for each data stream was calculated. The binary numbers were also

converted into 8-bit numbers (a common practise in some PK experiments), and the mean and variance for these were calculated.

RESULTS AND DISCUSSION

Table IVa shows a summary of the data produced by the REG. Table IVb. shows the values produced by the computer simulation of a REG. For the comparison between the simulated REG and a real one, the agreement is fairly close (for the means, a Wilcoxon z of 0.153, p=0.88; for the variances, z=0.169, p = 8.87 i.e. no significant differences in means or variances for the real and the simulated REG). The bit mean is 0.489 for the simulation, 0.497 for the real REG (theoretical expectation would be 0.5). Bit variance in both cases is around 0.25. The byte mean is 123.684 for the simulation, and 132.404 for the actual REG (theoretical expectation would be 128), so here the simulation gives a slightly lower range than would be expected, though not by much. This is due primarily to the slight periodicity still evident in the simulated field (due to the low number of superposed sine waves used). The byte variance is quite a bit lower. However, the correspondences in general look sufficiently similar to illustrate the underlying concepts may be feasible.

Table IVa.: Data from real REG

	Bits		Bytes	
	Mean	Variance	Mean	Variance
	0.528	0.252	148.583	5319.254
	0.472	0.252	156.708	6366.281
	0.472	0.252	156.708	6366.281
	0.528	0.252	149.750	5525.198
	0.563	0.249	109.292	5684.679
	0.447	0.249	102.500	6194.359
	0.563	0.249	109.292	5684.679
	0.447	0.249	102.500	6194.359
	0.412	0.244	131.958	5780.433
	0538	0.251	156.750	7099.438
Mean	0.497	0.245	132.404	6021.496
Standard Deviation	0.224	0.045	4.774	22.325

Table IVb.: Data from simulated REG

	Bit		Byte	
	Mean	Variance	Mean	Variance
	0.473	0.252	128.080	4726.430
	0.478	0.252	112.040	3900.997
	0.522	0.252	150.120	5316.861
	0.393	0.241	105.280	3614.372
	0.398	0.242	100.000	6043.000
	0.512	0.252	131.640	4908.119
	0.532	0.252	135.320	6842.456
	0.572	0.248	140.560	5753.220
	0.488	0.252	108.440	4252.558
	0.517	0.252	125.360	6869.870
Mean	0.489	0.250	123.684	5222.788
Standard Deviation	0.232	0.063	3.965	33.104

Next, a 'psi signal' was added to the background field, as both a single and a double pulse. The double pulse was added in case a perturbation close in time would show different effects from discretely spaced perturbation. An illustration of a single cycle for the simulated two dimensional surface is given in figure IVb. The psi signal can be seen as being a ripple in the background field which is constant over the space considered. The figure does not show the 'random' zero-point field fluctuations which would act to obscure the psi signal from casual observation.

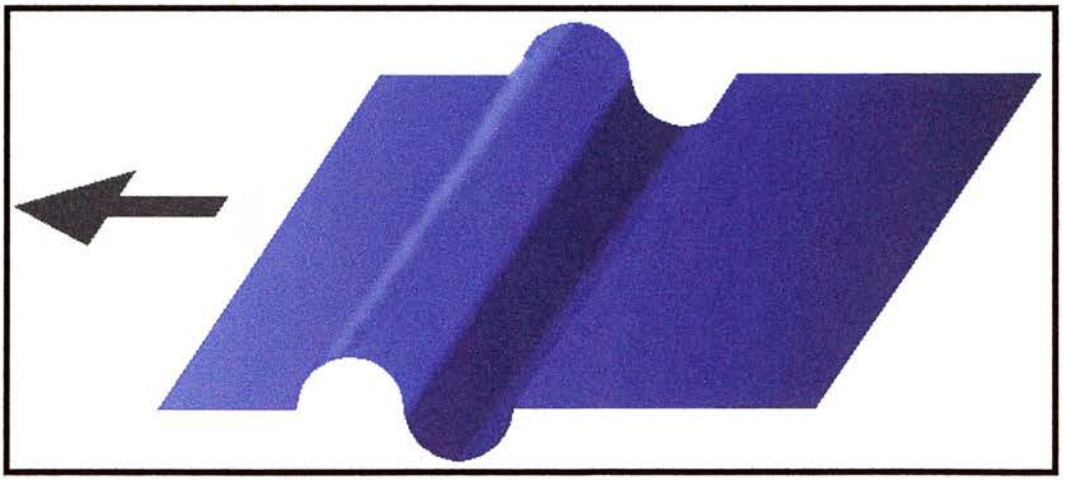

Figure IVb. Schematic of single psi signal

As only one psi signal was present in the simulated space at any instant of time, this might represent a weak wave that did not correspond to any control or special timing on the part of the psi source. The simulated REG data are given in table IVc for the single perturbation, and in table IVd for the double perturbation.

Table IVc.: Data from simulated REG with periodic single psi perturbation

	Bit		Byte	
	Mean	Variance	Mean	Variance
	0.478	0.252	136.680	5759.286
	0.488	0.252	122.120	5408.664
	0.478	0.252	124.160	4514.044
	0.453	0.250	128.760	5447.487
	0.532	0.252	134.600	7252.965
	0.493	0.252	139.600	6379.590
	0.493	0.252	126.400	5188.540
	0.527	0.252	159.800	4017.502
	0.478	0.252	114.480	4863.746
	0.522	0.252	138.080	5537.080
Mean	0.494	0.252	132.468	5436.89
Standard Deviation	0.024	0.0006	11.840	869.378

As can be seen, the effect of a psi signal in both cases is to increase the mean bit, byte, and variance values. Compared to the baseline simulated REG (see table IVb), a Wilcoxon test for the single psi perturbation gives a z of 0.204 (p=0.42 1-t) for the difference in mean number of bits, and a z of 1.604 (p=0.55, 1-t) for the difference in variances. For the double psi perturbation, a Wilcoxon test gives a z of 0.946 (p=0.17 1-t) for the difference in mean number of bits, and a z of 0.255 (p=0.40, 1-t) for the difference in variances. It is also interesting to note that the perturbation model considered by the decision augmentation theorists included only the mean shift; they did not consider a change in variance. The model which they say would be associated with DAT, shows a small mean shift plus a change in the variance (May et al, 1995), which is what the *perturbation* model used above also shows.

Table IVd.: Data from simulated REG with periodic double psi perturbation

	Bit		Byte	
	Mean	Variance	Mean	Variance
	0.542	0.251	126.480	5905.393
	0.527	0.252	138.720	7807.428
	0.443	0.249	106.520	5776.365
	0.542	0.251	155.480	4586.011
	0.478	0.252	144.200	5426.568
	0.498	0.252	124.680	6737.856
	0.463	0.251	102.360	5381.055
	0.473	0.252	141.360	6394.600
	0.512	0.252	114.760	4832.434
	0.493	0.252	134.520	5020.661
Mean	0.497	0.251	128.908	5786.837
Standard Deviation	0.032	0.0009	16.287	927.637

So, we would expect a real life psi-influenced system (in the absence of a specific intention) to exhibit an increased number of events, along with a slight decrease in variance. If the analysis were of the associated bytes, this would show as an increased mean. Is this what has been found?

The REG database of the PEAR laboratory's 200-bit sample psychokinesis studies (Nelson et al, 1984), consisting of 569,450 trials showed a mean shift from an empirical baseline of +0.0038 bits for high aim trials, and -0.040 bits for low aim trials[2]. This compares to the simulation's mean shift of +0.005 (single cycle) and +0.008 (double cycle). The magnitude of the simulated effects was thus roughly the same order of magnitude for the PEAR high-aim data, and an order of magnitude larger than the low-aim data. Unfortunately, it is not possible at this time to define a difference in terms of the proposed psi signal for different intentions. It seems likely that a high-aim would be closer to the above simulation as, in terms of the proposed model, this would involve increasing the zero-point field fluctuations. The modelled psi signal may be seen as doing this. A low-aim would require a decrease

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[2] These studies included an intention on the part of the psi agent to bias the REG output in a desired direction, whereas the simulation above considered only a non-specific perturbation.

in the fluctuations, which might require a greater degree of control, either in timing or in the structure of a psi signal.

Even though the simulation was based on a very simple model that could not be anywhere near as complex as a real life situation, there does still seem to be some correspondence in the magnitude of effects seen, which could imply that the model is a useful starting point to help further our understanding of psi.

This exercise was intended merely to demonstrate that the basic premises of a psi signal could indeed correspond to real life data, but it might also be developed, possibly by adding in specific frequency ranges, at a later date in an attempt to predict some testable parameters in a psi experiment.

A typical psi target system

If psi does indeed act through a mechanism similar in principle to the one described above, then we should find that some target systems would be more sensitive than others to a psychokinetic influence (i.e. would be more perturbed by a psi signal). The majority of current PK experiments now use random event generators (REGs) based on electronic noise in semiconductor devices. To explain how this works, it will be necessary to briefly look at the physics underlying electrical conductivity. For more details, the reader is referred to any standard physics text (e.g. Halliday and Resnick, 1988).

Any atom consists of a nucleus and associated electrons. These electrons have certain discrete energies - rather than the classical picture of electrons as 'orbiting billiard balls', quantum theory visualises the electrons as having properties akin to standing waves. Such waves are what makes musical instruments work: there are only certain wavelengths of vibrating air that can exist within the confines of the musical instrument, these wavelengths relating to the range of musical notes the instrument can produce. In an atom, the electron can be viewed as being a wave, and the atomic forces act to confine the length of that wave to certain values, each value having an associated discrete energy. When two or more atoms interact, as occurs in any solid material, the resulting system will have closely spaced *bands* of

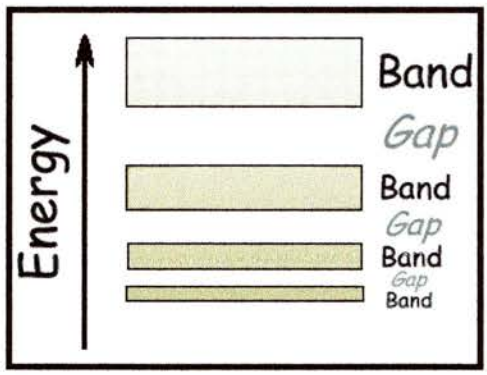

Figure IVc: Schematic of energy levels

energy levels with intervening gaps, due to the Pauli exclusion principle saying that no two electrons can occupy exactly the same energy state. Electrons can have energies corresponding to the bands, but cannot have energies which correspond to the gaps (see figure IVc).

Now, for a material that is classed as a *conductor* (e.g. metals), all of the lower bands are completely full of electrons. The maximum energy of these electrons (Emax) corresponds to an energy level which is lower than that of the upper band. This means that the highest energy electrons could gain a bit more energy and move up in to an unbounded state. Such electrons are then free to move and, under the influence of an externally applied electric potential - a voltage - can drift along the material , what we call an electrical current (see figure IVd, left).

An *insulator* (e.g. plastics), on the other hand, has its maximum electron energy corresponding to the top of a band, leaving no chance for the electrons to move. As well as this, the gap above the band is normally too great for the electrons to be able to 'jump'. The electrons are thus locked into place and will not be able to move when a voltage is applied, unless the voltage is so large that enough energy becomes available, in which case the insulating properties break down (see figure IVd, right).

A *semiconductor*, as the name implies, has properties that are between a conductor and an insulator. The energy level structure is similar to that of an insulator, with the maximum electron energy corresponding to the top of an energy band, but the gap above this is much smaller, requiring less energy for an electron to jump across. Normally, this energy may be so small that the small amount of energy provided by random electromagnetic (usually in the thermal range, although there are visible range-reactive semiconductors, called *photoconductive* or *photoelectric* cells) fluctuations is enough to allow some electrons to jump. The maximum energy band is termed the *valence* band, and the upper, free band is the *conduction* band (see figure IVd, middle).

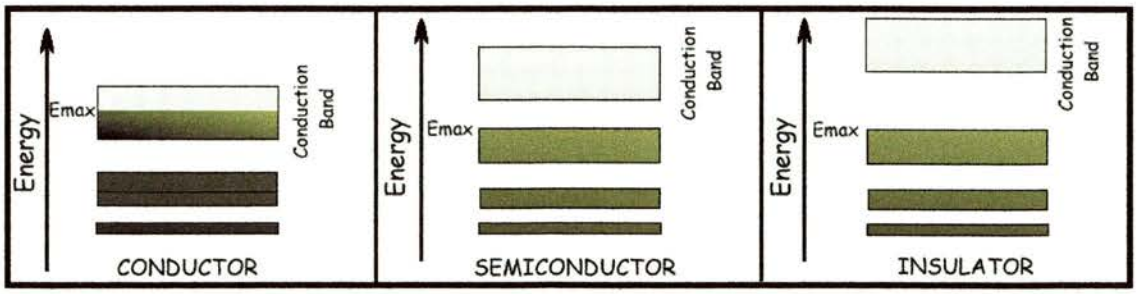

Figure IVd: Energy levels for different materials

The use of semiconductor devices in psi research is due to their way of showing *noise*. Noise is a term given to any unwanted signal in a system, due either to external sources (e.g. the whistling sounds on radios due to lightning strikes or solar events) or internal sources (e.g. thermal agitation due to the temperature of the device). As psi means 'the unknown quantity', psi research is concerned with those events not due to conventional sources, so we have tended to concentrate on internal noise that a psi agent should not be able to influence by any conventional means. Electronic noise is a phenomenon found in all electronic devices. It is due to the non-zero temperature of the system (thermal noise), plus to the fluctuations of the zero-point field (Fraser, 1983). Both types of noise are electromagnetic in origin, and both have similar statistical properties. This noise will exist even in the absence of an applied current, as electrons in the valence band are given the required extra energy by interacting with the vibration of the semiconductor lattice - any material which is at a non-zero temperature can be visualised as a lattice of vibrating atoms, these vibrations being greater the more the temperature increases. Zero-point energy may be seen as a fundamental, baseline vibration that would exist even at a temperature of absolute zero (where, classically, the atoms would have zero energy) (Milonni. 1994). As will be discussed in chapter V, the properties of cell membranes are very similar to those of semiconductors, giving an associated level of cellular noise. In the framework of the proposed model, this offers a common theme for some aspects of PK and ESP - both could be considered to be the result of a psi signal modifying the noise in semiconductor type materials.

One standard REG model (available from Professor Dick Bierman, University of Amsterdam) used primarily in PK protocol psi research is a serial port device based on two NAND gated Zener diodes. In this, each diode is sampled and, if its current exceeds a threshold value, then this is considered to be an event, and is coded as a binary 1 . If the threshold is not exceeded, then it is coded as a binary 0. The two diode binary digits (one **bi**nary dig**it** ≡ 1 bit) are then passed through a

logic gate called a NAND gate. This is a NOT gate followed by an AND gate, and is governed by the rules shown in table IVe.

Table IVe: Logic gate operations

INPUT		AND	NOT	OUTPUT
Diode A	Diode B	Gate	Gate	
0	0	1	0	0
1	0	0	1	1
0	1	0	1	1
1	1	1	0	0

Thus, the REG will only output an event if the 2 diodes give *different* results. This was done to guard against any possible biasing of the REG by external influences, decreasing the likelihood of a direct correlation of an REG event with environmental conditions. For the type of psi signal proposed, this may actually interfere with successful detection, resulting in lower psi effect sizes.

Eight sequential events may be taken and combined to give an 8-bit (1 byte) binary number, ranging from 00000000 to 11111111 (0 to 255 in decimal form). This is often the format used when looking at variance effects, as the variance in bytes will reflect the variance of binary events.

So, it was decided to look at a system that might more accurately reflect the detection of an energetic psi signal. If such a signal existed, it was thought that it may also show some degree of distance attenuation if the right properties were looked at. That is, although there has been little indication that psi has any distance parameters, this has been mainly looking at an effect versus no effect cut-off. If psi relies on the content of the signal rather than the strength, then we would expect to find a psi signal over a wide range of distances (at least up to the diameter of the Earth, approximately 12756 km), but the effects would show some variation with distance. It was predicted that the variance would increase with distance, as the signal became more distorted either due to interference or to a spreading out effect. It was also predicted that the effect would decrease with distance.

Experiment: Laser Distance Web Study

The primary aim of the experiment was to look at whether a PK effect would show a dependence on the influencer's distance from the target system. A target system was chosen to maximise the potential for PK to occur, based on the proposal that psi acts to alter zero-point field fluctuations but also allowing for the views of other researchers.

The target system chosen consisted of a laser where the beam was split into two parts of approximately equal intensity, using a half silvered mirror. In such a system, the laser light emitted from a laser diode may be seen as being composed of photons - the quanta of light. These photons will each have the same amount of energy, and be emitted in a beam with very little divergence. If they are incident on a half-silvered mirror, they have an equal probability of being reflected from the mirrored surface or being transmitted through it. A light sensitive detector placed in the path of one of the beams would then measure a constant number of photons incident per second, this number being roughly half the amount of photons emitted by the laser. The number of emitted photons is normally assumed to be a constant, but will show fluctuations based on the stability of the supplied power and on the amount of noise within the semiconductor (based on the ambient temperature and zero-point field fluctuations). The number of those photons which actually reach the sensor will be determined by the amount of scattering and absorption by air molecules, plus an approximately 50% transmission loss due to the half-silvered mirror. There would also be variations relating to the position of the beam on the photodetector surface, caused by air currents and physical vibrations.

The mirror was included as it might provide a further site of interaction for any PK effect. If PK were the result of an observational 'wave-function collapse' process, as has been suggested by several authors (e.g. see Walker, 1984), then this site would represent an area where the wave-function of each individual photon entered a superposition state of photon transmitted /photon reflected, the transmission mechanism being a quantum tunnelling effect. If a conscious observation of the system could select, or at least bias, the final measured outcome, then this would allow such an effect to occur with a clear focus point for the observer (Euan Squires, personal communication). If, on the other hand, the PK process was related to the fluctuations of the zero-point field, then, as well as the semiconductor properties of the laser and photodetector, the mirror represented a further site for where quantum noise could enter the system (Youn et al, 1993).

Additionally, a mixture of short and long data sampling periods were used. A comparison of any PK effects in the different sample lengths would allow a test of some of the ideas of Decision Augmentation Theory (DAT), as described in chapter II.

METHOD

Apparatus

The laser was a 100 milli-Watt semiconductor junction-diode device, operating at a wavelength of 650 nanometres. The photodetector was also a semiconductor device, giving an electrical output linearly related to the intensity of light (the number of photons) incident upon it, though also having a component due to thermal noise and zero-point field fluctuations. The laser was situated in a light-proof box with the laser beam split into two beams with approximately equal intensity (A and B in figure IVe). Beam B was absorbed by the box wall. Beam A was detected by a photodiode connected to an analogue to digital computer interface, which output a value related to the intensity of the incident beam. The whole assembly was seated in a box of polystyrene packaging material, this having been found to be most effective in reducing all but the most localised vibrations. As the system was only running when the room it was in was not otherwise being used, this seemed to be sufficient to avoid contamination due to physical vibration. No data was used from participants who were in the same building as the laser system, to avoid any possibility of manipulation of the system, subconsciously or otherwise. Finally, the laser system was connected to the computer via an analogue to digital interface having a sample rate of 25 Hz. Once initiated by the user, the computer would take a one hundred byte sample to act as a baseline, followed immediately by either one hundred or one thousand contiguous samples, the sample length being based on a pseudo-random decision. Although only one participant (the ostensible influencer) at a time could actually cause data from the laser system to be sampled, the average time a participant would have to wait before they could make their attempt was typically only a few seconds, virtually indistinguishable from the normal delays found with internet connections.

The participant interface consisted of a web page written in hypertext mark-up language (HTML) and utilising the form submission protocol to initiate the data recording program. This program was written in Visual Basic, using freeware common-gateway interface (CGI) Visual Basic code (Denny, 1978) , and connected to the web using the win-HTTPD PC server software. All software was run on a 486/66 PC under the Microsoft Windows 3.1 operating system. This made use of the World Wide Web (WWW), a graphical user interface (GUI) system for transferring information over the telephone-linked global network of computers known as the Internet. The web page was located at the University of Nevada's Consciousness Research Laboratory (CRL) website, <http://eeyore.lv-

hrc.nevada.edu/~cogno/cogno.html>. Such a system enabled people from around the world to take part in the experiment at any time of day or night, at their own pace, and needing no more knowledge than the use of a piece of software known as a web browser, readily available to anyone with access to a computer with an Internet connection. It would also allow for a much wider range of distances to be looked at than any more formal experimental arrangement, and was essentially automated, requiring no experimenter input once it had been set-up.

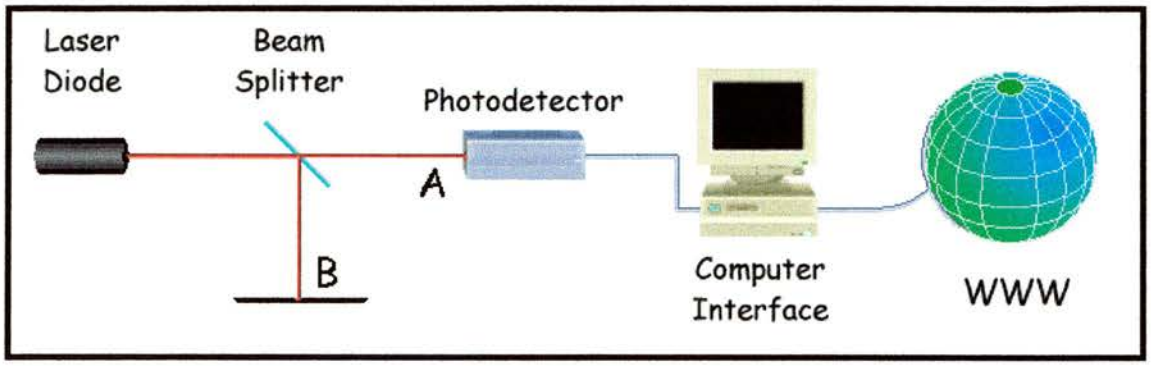

Figure IVe: Schematic layout of laser target system

Procedure

Upon first accessing the page, the user was presented with a page giving a brief description of the experimental setup and instructions for the PK task. The instructions told them that they were attempting to alter the output of the laser simply by concentrating on doing so. Users were told they could use any strategy they wished. There was also a schematic diagram of the laser for them to concentrate on. When ready, they entered their approximate latitude and their time-zone by selecting it from a pull-down menu of available options. If they did not know this information, they were asked to enter the name of their location so that the author could later work out the proper coordinates. They were then told to use the mouse to click on a button at the bottom of the page, and that this action would immediately initiate the data recording. Once this button had been clicked, the web browser reported it was accessing data, still displaying the schematic diagram for the user to concentrate on.

On completion of data recording, a new web page was automatically displayed. This page showed two schematic bar graphs, similar in appearance to the sound level LED displays seen on some hi-fi systems. The first showed the standard deviation of the laser system for the samples taken, the second the deviation in intensity from an initial baseline value. The higher the two values, the

more segments of the bar were 'lit up'. Underneath this was a brief explanatory paragraph, explaining the meaning of the graphs and giving some indication of how likely this was to have occurred by chance. If either the standard deviation or the baseline deviation were above a particular value, a further input box appeared asking the user to detail what particular mental strategy they used while attempting to influence the system.

Finally, the user was thanked and, after a few seconds, returned to the online experiments menu. The statistical results were automatically recorded to the computer's hard disk along with the IP address (Internet Protocol Address - a fixed, unique number assigned to every computer connected to an external network) and the location data. Due to the limitations of this particular setup, it was not practical to save the raw data for each user, but only the end statistical results. That these analyses were accurate was thoroughly checked during initial testing.

HYPOTHESES

Primary predictions were that:

H1a. The measured laser output would show a greater absolute deviation during the experimental attempts than in the control data.
H1b. The measured laser output would show different variances for the experimental attempts when compared to the control data.
H2. The magnitude of the absolute deviation would be inversely related to the distance of the influencer from the target.

H1a and H1b predict that there will be a PK effect to measure. H2 predicts a distance dependency of any PK effect.

Secondary predictions were:

H3. The variance would increase with influencer distance.
H4a. High geomagnetic field activity would correlate with high absolute deviations of the laser output
H4b. High geomagnetic field activity would correlate with high variance of the laser output.
H5. Shorter sample length would show greater absolute baseline deviations

H3 predicts that the distance of the influencer from the target system would adversely affect any PK effect. H4a and H4b predict that the often reported (e.g. Dalton and Stevens, 1996) correlation of psi with geomagnetic field conditions would be found. H5 is predicted by DAT as a selection model of PK would show a greater effect for shorter sample lengths, the normal operation of the laser system being more likely to contain periods of naturally occurring disproportionately high or low activity.

ANALYSIS OF RESULTS

The total number of trials (excluding any accesses from within the lab environs) was 194. Of these, 161 were useable, the other 33 having been improperly recorded due to a brief period of technical problems after the author had returned to the UK [3] . All users had provided sufficient information (latitude and time-zone) for their approximate geographical location to be determined. Variance was calculated from the squared standard deviation. The absolute baseline deviation was used as the direction of any deviation was unimportant for these analyses. The units of the values quoted are unsure as they represent the raw values output by the A/D converter. The influencer's distance from the target system was roughly calculated from their given time zone and latitude. These were used to give an approximate spherical coordinate on the surface of the Earth. The most direct circumferential distance could then be calculated between their coordinates and that of the target system.

Table IVf: Descriptive Statistics of Laser output

	Control Data			Experimental Data		
	N	Mean of Variances	Mean of Absolute Baseline Deviations	N	Mean of Variances	Mean of Absolute Baseline Deviations
All Data	41	0.419	0.144	161	0.466	0.405
100	19	0.130	0.020	77	0.227	0.377
1000	22	0.669	0.251	84	0.684	0.431

[3] Thanks are due to Jannine M. Rebman for fixing the problem.

A summary of the results is given in table IVf. Control data was taken prior to the start of the experimental data collection but under the same conditions.

Overall, it can be seen that the experimental data was generally greater in magnitude than the control data, indicating that there were differences in the laser system's operation during the influence attempts.

Table IVg: Mann-Whitney nonparametric comparison of control and experimental data

	Mean for Control	Mean for Experiment	Mann-Whitney U	Equivalent z	p
AbsDevn	0.144	0.405	1902	4.186	< 0.001 (1-t)
Variance	0.419	0.466	2696	1.809	0.08 (2-t)

A Mann-Whitney nonparametric test was performed to compare the experimental and control data, this being used as the distribution of the data was not normal. Results are given in table IVg. As predicted, the mean absolute deviation was significantly greater for the influence sessions than in the control data. H1a is therefore supported. There were differences in the variances of control and experimental data as predicted, but this was not significant. H1b is therefore not supported. Although no direction was predicted for this difference, it is interesting to note that the variance was increased for the experimental data (table IVf), an effect similar to that found in the REG simulation when a psi signal was present.

Table IVh: Regression coefficients of laser output against distance

	Experimental Data		Mock Distance Data	
	R	R^2	R	R^2
Abs. Dev^n	0.091	0.008	0.168	0.028
Variance	0.242	0.059	0.129	0.017

Table IVh shows the linear regression coefficients for the laser output against influencer distance. For this regression, a weighting scheme was employed to try and offset the very uneven distribution of results (as shown in figure IVf). A mean value for the absolute deviation and for the variance was calculated for each

distance, weighted by a factor w, where w equalled the number of values contributing towards the average and divided by the total number of data-points for all distances.

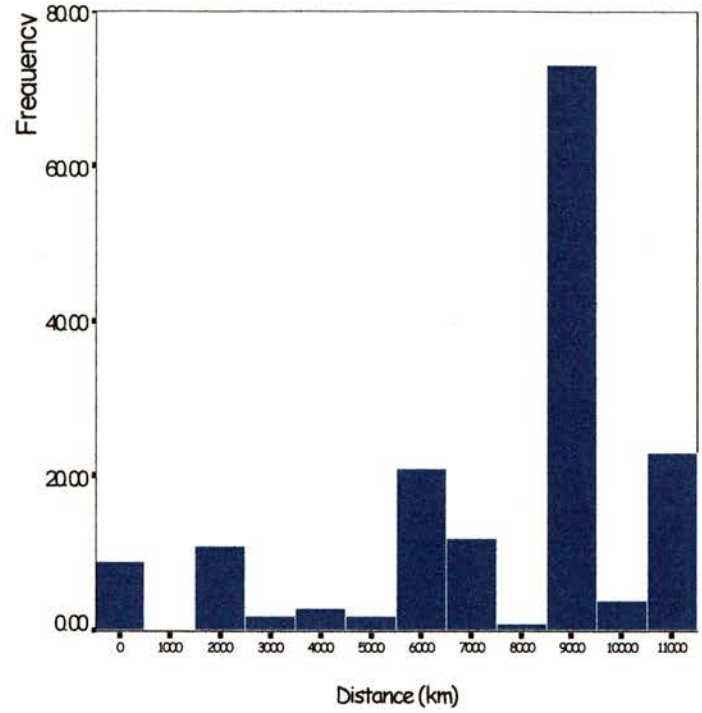

Figure IVf. Distribution of results by distance

No significant relationships were found for the experimental data, with the laser deviations and variances showing a small tendency to increase with distance rather than decrease. The R^2 value, indicating the amount of variance accounted for by the calculated regression equation, shows a less than 1% and 6% accountability for the laser deviations and variances respectively. To see whether there might still be a valid but very small effect, the control data set had a distance was randomly assigned to each datum. The range of distances used was the same as in the experimental data. The results of this are also shown in table IVh, labelled 'mock distance data'. In this case, the regression lines were a better fit for the randomly assigned data than for the actual data, though still no significantly. Clearly there was no simple relationship between a PK effect and influencer distance. H2 and H3 were therefore not supported.

Next, the activity of the geomagnetic field (GMF) was looked at in relation to the effects found. Table IVi shows the laser output data correlated against the value of the ap index (a daily measure of GMF activity). Analyses were performed for the entire control and experimental data sets, and for each of those data sets split by sample length.

As predicted, the GMF activity did significantly correlate with the absolute deviations for all cases of the experimental data. The effect was stronger for the longer sample lengths. This could be due to an actual influence effect of the geomagnetic field on the laser system, or a modifying effect on a secondary

influence (such as a PK effect), that increased with the duration of the sampling period. H4a was therefore supported.

For the variance, increased geomagnetic field activity appeared to be associated with an increase in variance. This was not significant for the two-tailed prediction made for the experimental data as a whole, although it was close. The main effect was on the longer sample lengths, which did reach significance. For the control data, where it was assumed that there was no PK effect operating, a correlation with the geomagnetic field was again found for both the deviation and the variance, implying that the geomagnetic field might be having a direct effect on the target system rather than a mediating effect on any possible PK influence. Thus H4b was partially supported, for longer sample lengths only.

Table IVi: Spearman r correlations of laser output with geomagnetic activity

	N	Variance Correlation		Absolute Deviation Correlation	
		r	*equiv. z*	r	*equiv. z*
Experimental Data	160	0.138	*1.740*	0.336	***4.237***
sample length 100	84	0.041	*0.374*	0.185	***1.685***
sample length 1000	76	0.266	***2.304***	0.426	***3.689***
All Control Data	41	0.460	***2.910***	0.284	***1.80***
sample length 100	19	0.243	*1.031*	0.086	*0.365*
sample length 1000	22	0.500	***2.291***	0.333	*1.526*

N.B. equivalent z scores were calculated for ease of comparison between different sample sizes using the approximate method of $z = r \sqrt{(n-1)}$

Finally, a comparison was made between the means of the absolute deviations for the short and long sample lengths, testing some of the ideas of selection versus influence models. The results are given in table IVj.

Table IVj: Mann-Whitney nonparametric comparison of different sample lengths for experimental data

	Mean for 100	Mean for 1000	Mann-Whitney U	Equivalent Z	p
AbsDevn	0.377	0.431	2833.5	1.356	0.088 (1-t)

The deviations seen in the 1000 byte samples were non-significantly greater than in the 100 byte sample, opposite to the DAT prediction. H5 was thus not supported.

No comparison was made for the variances, as these would always be greater for a longer sample length irrespective of any possible PK effect.

DISCUSSION

Significant differences were found between control and experimental data for the laser output, based both on deviations from a baseline value and on overall variance. This was interpreted as providing evidence for the predicted PK effect by a remote influencer. However, no linear relationship was found between laser output and the distance of the influencer. The largest individual effects were seen for those distances where most attempts were made, though this did not necessarily indicate repeat attempts by a particular influencer. Although a few influencers did contribute up to eight repeat attempts, most contributed less than three. The lack of any distance relationship may have been partly due to the non-uniform contributions at each distance, although a weighting scheme was used in an attempt to compensate for this. The method of calculating distance from the target was also very approximate, though it seems unlikely this would have completely obscured a distance relationship if such existed. The possibility remains that stronger PK effects might be found at close distances, with the large distances considered contributing only weak, noisy effects. Future studies of this type should use a greater concentration of results for close distances, and attempt to ensure a more uniform contribution of influence attempts over the range of distances used.

Correlations were found suggesting a relationship between geomagnetic field activity and the output of the laser, which showed a greater deviation and higher variability when geomagnetic field activity was high. As this effect was also seen in the control data, this might suggest an effect of the geomagnetic field on the laser system directly rather than on any supposed PK influence mechanism. If this is indeed the case, it has major implications for some of the supposed relationships between the geomagnetic field and psi. The typical assumption made by psi researchers (e.g. Persinger, 1989; Dalton and Stevens, 1996) being that any effect was on the psi agent, or on the psi - target system interaction.

This study did not support a selection model such as DAT. A comparison of laser deviation data between the short and long sample lengths showed no significant differences.

In more general terms, the experiment showed that the Web can be a viable medium for PK type experiments, where there is an external interfaced target.

Although the experiment had to be terminated earlier than expected, there was a good response both in the number of and the information provided by the participants. The only unusable responses were due to problems at the lab in which the system was situated and not due to omissions on the parts of participants. Any such data collection technique will obviously suffer from a higher level of noise, with some participants not paying particular attention to their attempt to have an influence effect, but this will be offset by the greater number of possible participants and the greater range of locations.

There were however several problems with the set up used. Simply taking an initial sample of one hundred bytes at the time of sampling as the baseline was not the best way of finding a baseline, with the resulting need to compare the experimental data with an earlier control period. A better solution, unfortunately not possible with the equipment available at the time, would be to take control data while the participant was reading the instruction screen, immediately followed by the influence data. Even so, it is difficult to see how the method used could have given spurious results. It would also have been interesting to have had some form of real time feedback during the influence period, rather than just the end result. This would not necessarily have improved effect sizes, but would, according to some participant feedback, have made the task more absorbing. Again, this was not possible at the time but may be possible in future studies with the recent advances in real time web interfacing techniques.

Summary

This chapter considered the rationale for considering psi to be an electromagnetic based signal. Such a signal would be generated by electrodynamic events in biological and non-biological systems, these events being part of the normal functioning of the system. It was also suggested that such a signal might be viewed as modifying the fluctuations of the electromagnetic zero-point field, and a simple computer simulation of PK was constructed to demonstrate this idea. Data from a simulated REG was compared to empirical data, with the results not ruling out this proposal as being a way of visualising psi. A more detailed description of the operation of a typical REG used in psi research was then made. Finally, an experiment designed to investigate some physical variables related to psi was described. Results showed a difference between control and influence datasets, with a possible dependence on geomagnetic activity found.

V. Emissive and receptive psi

What is being signalled?

To start with, it is important to look at exactly what information might be available in a psi signal of the nature described. Classically, signal theories of psi applied to ESP have used the analogy of a radio signal, sent out by a transmitter (Tx) and picked up by a receiver (Rx), as shown in figure Va. The psi signal contains encoded information about the target modulated onto a carrier wave. Such a signal might be affected by the quality of the encoding or the decoding process (possibly relating to the attention of agent or receiver, or to any irrelevant associations they may have concerned with the target stimulus), and external noise (from the environment), as well as psychological filters applied by the receiver.

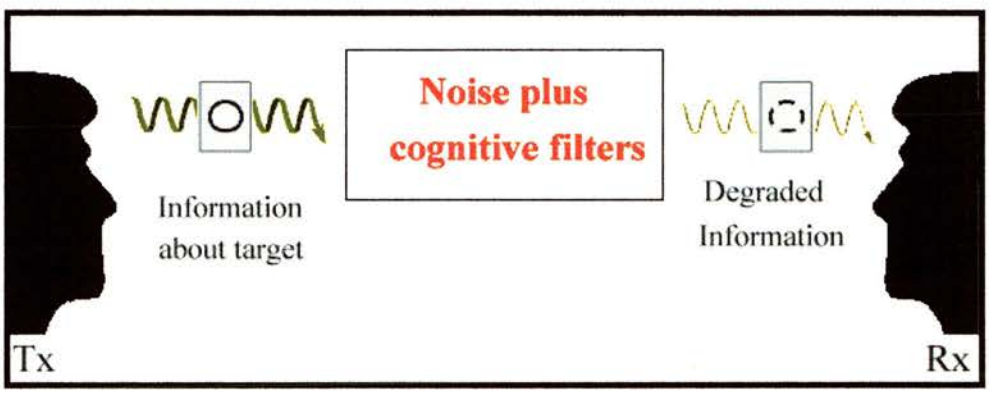

Figure Va: Schematic of Radio model of psi

If this were the case, then, for psi to be as elusive as it has proved to be, we must conclude that there are severe problems either with the transmitter or the receiver, or due to intervening noise, or a combination of these. Indeed, this has been the approach taken by several researchers in trying to improve psi functioning (the Ganzfeld technique used in ESP studies is based on a noise reduction model - see chapter VIII for a discussion on sources of noise for details). Even so, it has still proved to be difficult to reliably enhance psi functioning. This could mean that the techniques thus far developed are for some reason inadequate, or that psi is so weak that the noise will almost always degrade a signal. Alternatively, it could mean that the whole psi-as-radio analogy is inappropriate. Many authors have taken this to mean the whole psi-as-signal approach is incorrect, but another possibility is that the signal model is correct, but that a psi-signal is not of the

proposed type. Perhaps the information transmitted is about the way in which the transmitter reacts upon perceiving the target stimulus (see figure Vb). That is, upon detecting the original target stimulus, the transmitter produces a specific pattern of physiological activity. This activity releases energy into the environment as a 'psi signal'.

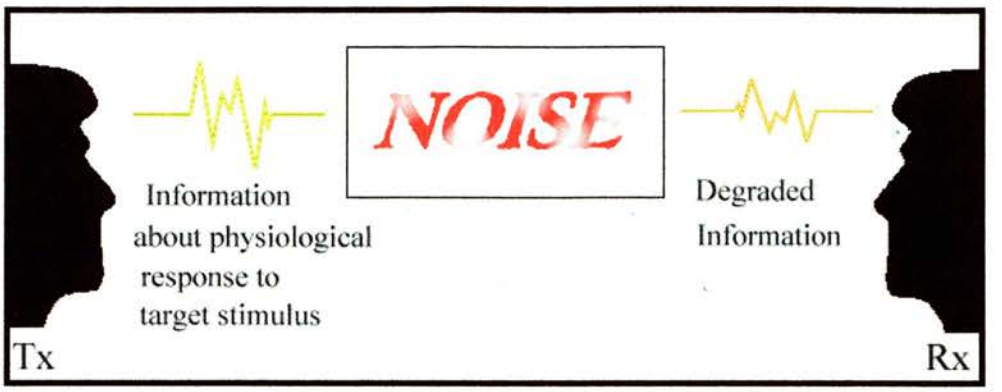

Figure Vb: Schematic of proposed model of psi with biological target system

It should be noted that this description may equally well be applied to non-organic systems. For a case of clairvoyance, the target system may itself be emitting a patterned signal, the patterning relating to its inherent activity, or to the way in which it affects its local environment. An analogy would be the way in which an object moving in water will cause ripples, or will modify existing ripples if it is static.

For a microelectronic random event generator (REG) in a PK setup (see figure Vc.), the psi signal contains information about how the REG's activity changes in response to environmental conditions. The receiver's physiological activity is then modified by this signal and this modification correlated with some form of feedback in a learning process. The feedback is an explicit source of information about the activity which produced a psi signal that acts to confirm and to provide further information about the nature of the received signal. The difference in this case is that the 'target stimulus' would be either the specific environmental conditions affecting the REGs activity (during the learning phase, where information relating to the REG's activity, in the form of a patterned signal, is interacting with the receiver's physiology) or the energetic perturbations initiated by the receiver's brain (in the influence phase, where the receiver now attempts to recreate the patterned signals they earlier received).

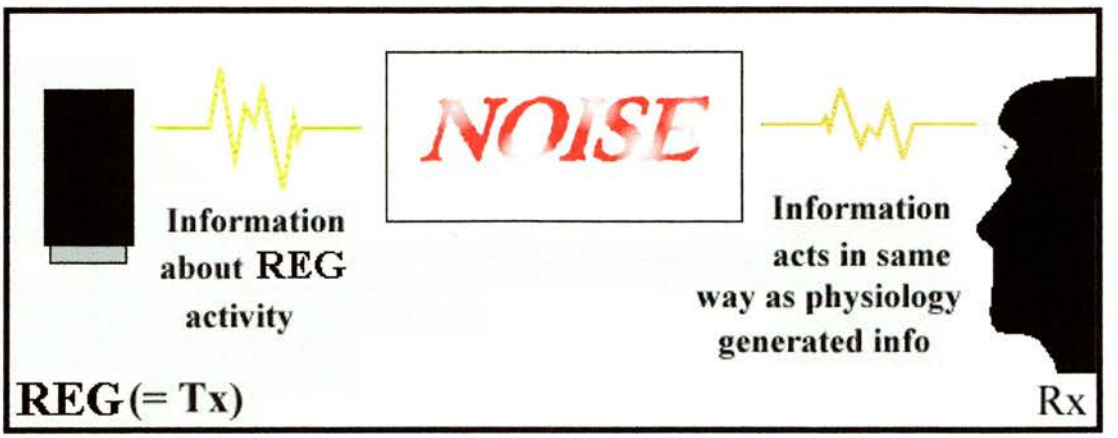

Figure Vc: Schematic of Radio model of psi with non-biological target system

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Emissive Psi, ψ_E

So, if this is the case, we need to look at the processes which could be responsible for producing a psi signal. In the case of human or animal psi, this is thought to be related to physiological functioning but, as mentioned above, it is envisioned that PK is also related to the same type of psi signal. We therefore also need to look at non-biological physical processes which have similar properties to biological processes, in an attempt to see how the interaction between signal and psi sensitive system might take place.

PHYSICS OF THE BIOLOGICAL CELL

Considering a biological system, the basic unit is the cell. All cells are classified as being either eukaryotes - cells which have a distinct nucleus containing information-carrying chromosomes - and prokaryotes - cells which do not have a nucleus but which carry genetic information in a single strand of DNA. All organisms apart from bacteria and blue-green algae, which are prokaryotic, are based around eukaryote cells. As organisms become more complex, the cells have become more specialised (e.g. neurons are highly specialised) but they still share the same basic structure and properties. A theory of psi based on the properties of cell membranes will thus be generally applicable to *all* organisms on this level- a definite advantage considering the apparent wide range of living systems successfully used in psi research.

As the primary energy transducers in an organism, the properties of the cell membrane are important. The basic structure of the cell is far from the randomly

mixed bag of enzymes and metabolites that is often presented in biology classes. Instead there is increasing evidence that it is highly structured on many levels, possibly even down as far as individual protein molecules (Clegg, 1984). Some researchers have presented evidence that many biological molecules possess properties of liquid crystals at physiological temperatures (Ho and Saunders, 1994; Wallace, 1995), and that they can undergo coherent excitations akin to the operation of a laser (Mei, 1994). Even in terms of classical physics, membranes have properties similar to the p-n semiconductors detailed in chapter III (Ho, 1993).

Semiconductor devices can react to a variety of external stimuli by generating an electrical current (flow of electrons). Possible stimuli include heat (thermoelectricity), light (photoelectricity) and mechanical deformations (piezoelectricity). The reaction is often reversible i.e. the application of an electrical current causes heat, light or mechanical deformation. An example of a semiconductor device would be the solar cell, which generates electricity as it absorbs photons in the visible light range, and the LED (light emitting diode) which emits monochromatic light when an electrical current is applied to it. They can also act as electromagnetic oscillators (especially at microwave frequencies), or be used to make solid-state lasers. Even in the absence of any external current or stimuli, they exhibit a baseline activity, or noise, due to thermal and zero-point fluctuations (Fraser, 1983).

Liquid crystals are most commonly seen in displays on electronic and computer devices (e.g. a digital watch screen is a liquid crystal display, or LCD) as their most useful property is to easily become aligned with electromagnetic fields. As cell membranes are known to have such properties and are also known to play a major role in the determination of cell organisation (Ho and Saunders, 1994), the role of electromagnetic fields as the organising principle has been put forward by several researchers (Ho, Ross and Bolton, 1992; Pethig, 1994). An obvious interest has been for possible pathological aspects of external electromagnetic fields, from power lines and other artificial sources. Neural cells in particular have been studied for their liquid crystal properties, with some researches suggesting that these properties may be intricately linked to the way in which information is encoded and stored in our brain (Wallace, 1994).

Systems exhibiting properties of liquid crystals are also noted for being highly labile (having the greatest possible degrees of freedom for their configuration), combining a highly ordered state with maximum mobility and

responsibility to external stimuli. A result of such properties can be to show signs of coherent (defined as having the same frequency and phase, or a fixed phase difference) behaviour, as has been suggested by Frölich (1987) as being a primary mechanism underlying unified behaviour and conscious experience. Coherence is responsible for the specific properties of laser light as compared to 'normal' (non-coherent) light.

Lability is worth considering in more detail as the term has often been mentioned in psi research as being an important factor for success. Braud (1980) considers a relationship between lability, which he defines as "the ease with which a system can change from one state to another", and the dynamicism of a system. He cites the REGs often used as being highly labile systems, although he does not go further to make clear why he thinks the *physical* constraints of a target system should affect the way in which psi works when he does not conceive psi as a physical phenomenon. In physics, a labile system is unstable with respect to an applied perturbation, be it external or internal i.e. it will react quickly and responsively to the presence of a patterned signal. If lability is indeed an accurate descriptive term for psi-responsive systems, then this would tend to imply that psi acted in a manner similar to a patterned signal, as this thesis proposes.

EMISSIVE ACTIVITY OF THE BIOLOGICAL CELL

For individual cells in all organisms, the whole cell is capable of emitting photons (quanta of electromagnetic radiation), due to its semiconductor properties, over a wide range of frequencies (1 to 4 x 10^{15} Hz) in the ultraviolet and visible ranges (Mei, 1994; Ho, 1993). For assemblies of cells, at least in the case of neurons, there is detectable electromagnetic activity that characterises their collective activity. This is used to measure brain activity by devices such as the electroencephalograph (EEG) and SQUID (Superconducting Quantum Interference Device - an extremely sensitive detector of magnetic fields) magnetoencephalograph (MEG). EEG measurements show activity that appears to be related to specific mental states and which can be traced to fairly large scale neuronal assemblies (e.g. the thalamus, or other specific parts of the cortex). Emitted frequencies have been measured by an EEG in ranges between direct current (DC), equivalent to zero frequency, and around 100 Hz. The usual frequency ranges are the gamma range (above 30 Hz), the beta range (15-30 Hz), alpha (8 to 14 Hz), theta (4 to 7 Hz), and delta (0.5 to 3 Hz). There also seems to be a peak of global activity at around 40 Hz

relating to a possible cortical-thalamus synchronising activity loop (Ioannides, 1994), and further undefined activity in the 35 - 70 Hz range (Penrose, 1994).

MEG measurements have a better resolution and, due to the relative permeability of the skull to magnetic fields, may contain more information about deeper cortical structures than do those of the EEG. They show that the fine-scale structure of neuronal activity is highly complex. Such measurements also show global synchronising activity between 40 and 60 Hz. It should be noted that it is not clear if these frequencies are the actual operating frequencies of the neuronal sub-assemblies or whether they represent envelopes of interacting frequencies akin to the beat frequencies that give musical instruments their timbre.

As the physical properties of neurons are not significantly different from those of other cells, we can conclude that other cell groups will also exhibit electromagnetic radiation characterising their collective activity.

EMISSIVE ACTIVITY OF NON-BIOLOGICAL SYSTEMS

The most commonly used non-biological targets in psi research are electronic noise REGs, radioactive decay detectors, pseudo-random algorithms and a variety of non-electronic physical systems that exhibit random properties, such as Nelson et al's (1988) random mechanical cascade, or Cox's (1974) ball-rolling machine . Each of these will be considered in turn to see what sort of emissive signal they could produce under this model, such a signal being vital for the initial learning process (detailed in chapter VI) that would be required for an organism to learn to control psi. Note that only the emissive activity that would be related to feedback is considered as only this would be useable under the proposed model. There will of course be other activity, but this is considered to be noise in the system.

Radioactive decay detector: the nucleus of the atom of a radioactive sample can be seen as a region surrounded by a barrier of electrical potential, with the radioactive decay particle trapped in this well. Although the decay particle has not got enough energy in classical terms to get past this barrier, it can spontaneously 'tunnel' through the barrier - a quantum phenomenon explained as being due to the de-localised nature of the particle's wave-function whereby the particle has a small but finite probability of being outside the barrier. According to the quantum electrodynamical and stochastic electrodynamical models of physics, this tunnelling phenomenon can be viewed in terms of the zero-point field, where the

probability of the atomic nucleus releasing a decay particle is partly related to the fluctuations of the field. In terms of information about the target system in a psi system, it seems unlikely that the radioactive decay itself will emit a psi signal. However, the psi agent (during the learning phase) may possibly be able to detect the conditions of the field that brought about the decay, or (more likely) will be able to detect the electromagnetic wave brought about by the radiation detector's activity when it detects the decay. A typical set-up used in a PK experiment would cause a single DC pulse of electricity at 5 V (the common operating voltage for a computer serial port) to pass along the wire from the detector to the computer, initiating an electromagnetic wave to propagate outwards and interact with the psi agent.

The electronic noise REG: as was mentioned in the last chapter, the most common REGs used in psi research are based on semiconductor material. Such material would not on its own emit a psi signal, but it will again have associated electrical activity due to its computer, or other recording device, connection. Again, for every generated event, there will be a pulse of DC current at 5V. This activity is likely to be at a much higher rate than the radioactive decay detector (the background radiation decay-product detection rate is typically less than 2 Hz), so would most likely have to be considered as a series of electromagnetic wave-fronts with random spacing at rates of up to 7600 Hz (a typical sample rate for a computer interface REG). As each of these events will be related in part to the current conditions of the background field, the agent in the learning phase might be able to gain sufficient information about the REG's activity to learn to produce an optimal perturbing signal.

Macroscopic systems with statistical distributions: such systems are far more difficult to explain in terms of emissive activity. However, many of the REGs used in psi research utilise electronic recording mechanisms to determine statistical distributions, so it may be that these may offer the potential for an emissive signal similar to the ones mentioned above. For example, the PEAR lab's random mechanical cascade (Nelson et al, 1988) uses an opto-electronic counter to record the presence of a ball in a particular bin. This means that, as a ball passes into a bin, it will interrupt a beam of light, causing an electronic pulse to be sent to the counting mechanism. The authors use 9000 balls for a run which lasts 4 minutes, which gives a rate of approximately 200 Hz. Assuming the balls are fed in sequentially, this would give an electromagnetic wave-front of pulses, the position

of which would depend on which counter was active, at a maximum rate of 200 Hz, much less than the electronic REG rate.

THE INFORMATION CONTENT OF THE SIGNAL

How much information could an emitted signal theoretically contain? To simplify matters a bit, we will assume that the information contained within the original emitted signal is the same as that in the received signal (i.e. there is no attenuation inherent in whatever processes transfer the information from the source system to the transmitting medium). Although this is unlikely to be true in any real life situation, it should still enable us to predict how much information could be contained in a signal, allowing us to speculate as to the upper possible limits of psi communication. Once we have such a limit, we can move on to consider the effects of limitations of transfer mechanisms or noise.

On a cellular level, Popp et al (1994) claim cells interact with one another through the exchange of electromagnetic waves in the range of 200nm to 800nm wavelength. Effects can be as simple as a synchronisation between cell activity, where the activity of two cells alters so that the timing of cellular events is similar. Where measurements of activity are taken for a number of cells, there is also a considerable decrease in the variance of the synchronised activity. That is, not only have the cells become time locked in their activity, the normal variance in that activity has decreased (recall that cells normally show a random level of ion channel gating).

More complex effects include interaction effects where the overall electromagnetic wave-form (the 'signature") from two cell groups combine and interfere. Should one group's wave-form be able to destructively interfere (i.e. cancel out) that of the other, then this could serve as a form of identification of an identical grouping. The higher the deviation from completely destructive interference, the more different are the cell groups. Popp et al (1994) suggest that this effect may have been shown to occur in cell groupings from individual enzymes, which are attracted to specific substrates from a distance, to cellular cultures or even entire organisms such as daphnia.

On a neuronal level, that the single electromagnetic output of a neuron is much too small to be detected by a MEG or EEG measuring device implies that the neurons must undergo widespread coherent activity. However the way in which EEG and MEG signals are averaged over a large number of signals (necessary because of variability due to the properties of the conducting medium, activity in

irrelevant organs, and an intrinsic variability in brain responses over time) mean that any aspect of fine scale information tends to be lost.

There has nevertheless been some research which gives us some indication of the sort of complexity produced by the brain during its activity. McNaughton and Wilson (1994) report on recordings of neural discharge patterns in rats. From this record, they could predict its movements with a fair degree of accuracy. This implies that normal physiological activity is associated with patterns of neural activity that are specific enough to provide precise information about the organism's actions. If a psi signal is generated by such activity in the manner proposed, then, for a given moment in time, a psi signal could contain information about the sum total of the organism's activity at that time. Stocklin (1994) also suggests that normal brain activity makes use of standing electromagnetic waves, both generating and being influenced by this wave in a dynamic process. He proposes a variety of ways in which the interaction of such waves could be involved in a wide variety of brain functions, including processing of sensory information and memory consolidation.

It seems that there is a great deal of information naturally being broadcast from every living system, and from a great many non-living systems, which would be available to a receptive system sensitive to it. A sensitive receiving system might therefore be able to gain information ranging from individual cell activity up to more complex behaviour of the organism as a whole. If a psi signal is an electromagnetic wave, then all this information could theoretically be available in a psi interaction. It should also be made clear that none of this information requires the interaction of a conscious mind to be broadcast. Everything that has been considered is purely the result of purely physical processes interacting with other physical processes. Just as we tend to be unaware that every television program, every radio broadcast, information about weather systems, transport systems and a myriad other human-related activities is being continually broadcast away from our planet into space, we also ignore the fact that every aspect of our ongoing cell activity has been broadcast to the world around us in a variety of different ways. The information is there - we have only to find ways of using it.

Receptive Psi, ψ_R

Having discussed how the signal might be generated at the source, we now turn to the effects that such a signal could have on a receiving system. As psi

effects have been observed in biological systems - plant, animal and simpler organisms such as single cells - as well as in a range of non-biological systems, all of these must have some common properties to be susceptible to an electromagnetic psi signal. Special attention will be paid to the human organism as the psi experiences of this are the main reason for the existence of psi research!

BIOLOGICAL SYSTEMS

The human body, like any physical object, is continually interacting with ambient energy fields in its environment. At one extreme are those fields we can consciously perceive - the infra-red (heat) and visual (light) parts of the electromagnetic spectrum, the energy density of waves in air (sound); at the other are those that we can detect only indirectly, such as background radiation fields or the ultraviolet electromagnetic spectrum. Those in the latter category are usually only consciously perceivable by secondary effects - genetic alteration and burning in the cases given. Interest in the effects of such energy fields has led to an increase in research, especially into electromagnetic fields (e.g. Hawkins, 1989; Plagenhoef, 1992; Kuster, 1995), with research pointing to a wider range of interactions than had previously been considered. Although still at an early stage, the general consensus is that "...weak electromagnetic fields can have a profound effect on a large variety of biological systems." (Pilla and Markov,1994). Some of the strongest research concerns the driving of the brain's global electrical activity by externally imposed electromagnetic fields. Bell et al (1992; 1994) showed that, in both humans and animals, the characteristics of the electromagnetic field are important in the interaction process. If the frequency modulation of the field covers the range found in biological systems (specifically, 1-40 Hz, plus some higher frequency peaks, in humans), then the brain exhibits electrical activity in the same frequency range as the driving field, even for weak fields approximating geomagnetic field strength. Given that a field with such low energy can have a relatively large-scale (i.e. affecting the global activity of the brain) measurable effect, it seems reasonable to suppose that weaker fields might have smaller but still behaviourally significant effects, especially as the brain has shown high sensitivity to small changes (Skarda and Freeman, 1987).

A more recent finding still is that weak static magnetic fields appear to modify some aspects of retinal operation, with decreased fields altering perceptual functions such as the critical threshold for flicker fusion (Warnke, 1994). An interesting aside for Ganzfeld ESP research, which uses a dim, diffused red light to

create visual homogeneity, is that the production of enzymes related to melatonin production can be inhibited by the presence of weak magnetic fields, but only when in the presence of weak red light. Perhaps the Ganzfeld state used in ESP research (e.g. Dalton, 1994) works not only for its noise reduction properties, but also (quite unintentionally) for its more direct sensitivity enhancing properties.

It is also important for the proposed model to note that *all* biological cells, plant or animal, have a stochastic component to the gating of the cell's ion channel. This is based partly on thermal and partly on zero-point field fluctuations (Hille, 1984). The membrane of a cell is in fact very similar in operation to the semiconductor junctions detailed in the previous chapter - a fact that will also be discussed later in a comparison with electronic random event generators. Although conventional biology teaching offers no explanation for this stochasticity, merely accepting that they are random, biophysicists do actually model these gating fluctuations as if they were due to external perturbations. That is, the standard scientific models are already theoretically predisposed towards the existence of an external signal that acts to perturb the resting state of the cell, a situation which can only be advantageous for the theorised approach to psi.

NON-BIOLOGICAL SYSTEMS

As the properties of a biological cell membrane are basically those of a semiconductor junction, it is these properties which are thought to be involved in the reception of a psi signal by a biological or non-biological electrodynamic system. However, as the interaction of two systems via the exchange of the psi signal is considered to be the process underlying several psi phenomena (as defined in chapter I), it would seem to be worthwhile to briefly consider possible alternative sites of interaction in non-biological systems that are also reported to be used as targets in psi experiments, which would not normally be considered to be electrodynamic. Two main possibilities come immediately to mind - the Van der Waals interaction force, and the mass-related properties of inertia and gravity

Van der Waals Forces

This force is experienced between polarizable objects (i.e. ones capable of holding an electrical charge). Although it is usually thought of as being an inter-molecular force, the macroscopic Casimir effect mentioned in chapter IV is considered to be an example of this force. The formulation of stochastic electrodynamics (SED) also extends this force to apply to other materials having

permeablity and dielectric properties (Boyer, 1980). If such a force depends on the state of the zero-point field, then a psi signal could conceivably act to alter this force slightly, allowing small changes in the statistical distributions of macroscopic systems such as PEAR's random mechanical cascade, or Cox's ball machine. The basic viewpoint of SED is that all systems are in equilibrium with the zero-point radiation, so anything which could act to alter that equilibrium in a specific manner might have measurable effects.

Inertia/Gravity

There is also the possibility that a perturbation in the zero-point field may be able to alter the inertia or the gravitational mass of an object. A recent, purely theoretical idea has been put forward by a number of researchers proposing that inertia - the tendency for a body to remain at rest or in a state of uniform motion unless acted upon by an outside force - may be related to the radiation pressure of the zero-point field (e.g. see Matthews, 1994 for a summary). Other work, originally by the Russian physicist Sakharov, and later on by Puthoff (1989b), suggest that gravity itself may also be a result of zero-point field interactions. A perturbation in the zero-point field may, we can speculate, ultimately be able to cause small shifts in the inertial or gravitational properties of a body. Although pure science fiction at the moment, it is interesting to speculate on a unification of electromagnetism and gravitation, and how such findings would alter the way we think about how living (and so electrodynamic) systems might be able to interact with their environment. We already have psi research suggesting that some fairly fundamental physical properties might be affected by a psi agent's intention - such as the damping rate of a linear pendulum (Nelson et al, 1994) or a change in diffraction patterns (Jeffers and Sloan, 1992), as well as the anecdotal reports of poltergeist phenomena - so perhaps we need an advance in physics before we will gain a better understanding of psychics!

BACK TO ORGANISMS

To recap, it is proposed that the psi signal interacts with the receiving system, modifying ongoing cellular, or non-biological equivalent, activity. This modification may or may not (probably not) be identical to the particular pattern of activity in the receiving system that would have been initiated by the target stimulus itself (in the case of telepathy or precognition) or by direct experience of that stimulus (in the case of clairvoyance or psychokinesis), and so will most

probably be misinterpreted (i.e. induce an inappropriate response with respect to the source activity), or even ignored.

However, in systems which are capable of using feedback processes, it is possible that the detection of such a signal could eventually, through a learning process on the part of the receiving system, come to be associated with a response which corresponds to the activity of the psi source. In this case, the signal itself when received by a thinking organism, will not be subjected to possible cognitive filters; only the *interpretation* of the signal will be. This feedback process will be discussed in chapter VII.

The interaction itself is hypothesised to occur when the spatiotemporal characteristics of the psi signal affects the stochastic gating of cells, or non-biological equivalent, thus modifying ongoing or creating new activity. In the case of a biological detection system, this proposal is not contradicted by any of the current research into biological sensitivity to low level electromagnetic fields, as there is not yet an accepted theory for the interaction effects observed.

In sentient organisms, this interaction acts to perturb ongoing thought processes, or possibly even to generate completely novel ones. The site of interaction is still proposed as being the background (stochastic) firing rate of individual cells, with the most complex forms of psi being due to the neural cells. For this reason, the following discussion will be restricted to the neural cells, although simpler interactions may well occur with all cells of all biological systems. Consider a network of cells at rest. Each will show a low level of essentially random firing. As the psi signal propagates through the region of space occupied by the cells, it will raise the average level of firing for those cells (compare with the simulation results in chapter IV). Thus some cells will reach their firing threshold, the exact number depending on the characteristics of the cells and on the precise structure of the psi signal. This increase in firing levels will act to increase the overall level of arousal in the organism, or the state of activation of a specific network of cells if there are signal-cell resonance or pattern specific effects.

On a conceptual level, this aspect of the model is similar to the ideas used within cognitive psychology. There, the cognitive system is biased towards the processing of external stimuli in accordance with the internally generated content of already activated neural network nodes i.e. the system will attempt to match the pattern created by the external stimulus to a pre-existing template to speed up processing. In the absence of an external sensory stimulus, the internal factors - expectancy, mental set, priming, etc. - will take on a primary role and may result in

the creation of pseudo stimuli, also known as day dreaming, imagination and fantasy! The proposed model has the psi signal acting as an external stimulus which bypasses the normal sensory channels and acts directly to modify the neural network's activation as though it were one of the internal factors. Thus psi is seen not so much as equivalent to a sensory channel (although it might be used as though it were one - see the later discussion) but as an externally imposed primer affecting subsequent interpretation of external sensory or internally generated stimuli. It could be said that the major effect of psi is to bias systems towards a particular outcome, be those systems biological or inanimate, brains or electronic machines. This priming effect could be as simple as an elevated level of global activation (compare with the electromagnetic sensitivity study findings, detailed later in this chapter) or result in specific responses. This latter idea is similar to one suggested by Klinger (1971) in his review of fantasy and dreaming, and since adopted by other researchers into the source of the bizarreness of such imagery (Reinsel et al, 1993), who postulate:

"..the existence of a single waking and sleeping baseline stream of ideation whose properties are modulated by fluctuations in the states of arousal... In the waking states, perceptual scanning and directed, operant activity must perforce be considered to interrupt the flow of fantasy."

In the framework of the proposed model, we would say that the properties of the baseline ideation are modulated by the psi signal induced fluctuations in the states of cellular excitation, and that perceptual scanning and directed, operant behaviour must be considered to interrupt the flow of psi-borne information. While the psi signal should still modify the ongoing activity no matter what that activity is, the problems involved in noticing this modification in the face of the stronger sensory stimulus would be much greater. As the bizarreness of waking thought is lost when 'reality' intrudes, so is the 'psi-ness'. There is also the further problem that the act of noticing the psi signal modification would in itself further modify the activity. While this is not a problem in fantasy, where there is no objective information content we wish to maintain, it would effectively destroy, or at the very least obscure, the psi borne information (a fuller consideration of this problem is given in chapter VIII).

Parameters of psi systems

So, if the above is indeed how a psi signal interacts with a system, this should enable predictions as to which systems could produce a psi signal. Somewhat surprisingly, the answer is that *all* electrodynamic systems are capable of this. Biological or non-biological, living or dead, any process which involves an electromagnetic component will produce a psi signal of some sort. Even non-dynamic systems will be capable of modifying the signal or the background field. In many ways, this is extremely helpful if we are to ever produce a comprehensive theory of psi as the many studies produced over the years have not yet found any areas in which psi does not seem to be able to manifest, but it doesn't make it easy for us to decide under which circumstances we are most likely to be able to demonstrate, and eventually utilise, psi. If on the other hand we look at the expected properties of the psi signal that different systems might produce, and at the properties of different receiving systems, we may be better able to determine the parameters under which we would notice psi in everyday life (and in lab experiments!). The easiest case to consider would be interactions between two biological systems. As both have certain fundamental commonalities, we might expect psi to occur most frequently between such systems. Thus DMILS (Bio-PK) would be more likely to be successful than ESP as the former would require a relatively simple interaction between two systems, whereas the latter would also require some greater degree of interpretation and processing of the information . ESP would be more likely to occur than PK, as, even though complex, it would still be occurring between two biological systems, whereas a PK effect could only occur where the properties of the source system had something in common with the receiving system. For example, if there are frequency effects in the psi signal, we might find that there are systems upon which we would not be able to exert PK as we would not have an overlapping frequency window. Unfortunately, until we have a better understanding of the signal itself, it is difficult to predict which target systems would be most sensitive with any greater detail than has been given. Pure clairvoyance situations which do not involve electrodynamic targets, i.e. ones where the target system passively acts to modify the background field rather than emitting a signal of its own, are even less easy to predict as there are as yet practically no theoretical guidelines in physics to relate the zero-point field modifications to the properties of different materials. We could suppose that the effect would be analogous to way in which humans can judge room size based on echoes, or the sonar senses of some animals - the physiological activity of an organism will

constantly emit psi signals that will be effectively reflected or absorbed by the materials around them - but it is currently impossible to say any more than this.

So how do we known if the basic premise is tenable? Part of the problem with testing a psi theory is that it is currently impossible to ensue that there will be a psi effect to test in any given experimental set-up. A failure to show an effect could show that the hypothesis under test is incorrect, or it could just show that something had been overlooked, that the participant was not in the ideal psychological state to produce a psi effect, or that some random factor just happened to interfere. Without a better idea of what psi is as a starting point, dealing with a (hopefully) psi producing system as complex as a human being is a daunting prospect. However, the general principles described - the cellular level modification and the physiology related nature of the signal need not necessarily be restricted to psi phenomena. Based on the proposed physics, we should also find that similar effects to those predicted by this model would also be found in cases of electromagnetic sensitivity as both include the psi-signal generating patterned electromagnetic wave component. Moreover, there has long been the suggestion of a possible link between electromagnetic phenomena and psi effects (Becker, 1992), either in that specific electromagnetic fields may be conducive to psi (Persinger, 1988), or that psi itself could be an electromagnetic phenomenon. Although the consensus appears to be that not all of the properties of psi could be fully explained by conventional electromagnetic effects, there do still seem to be sufficient parallels to suppose an interrelationship between the two. This being the case, it seems likely that a comparison of electromagnetic sensitivity and psi sensitivity may be a useful exercise, even if the link is only by analogy. A study was therefore performed looking at human sensitivity to electromagnetic fields, with analogies being drawn between the electromagnetic 'signal' and a psi signal.

Experiment: Human Electromagnetic Sensitivity

The obvious starting point for a psi-electromagnetism comparison is that the topic of electromagnetic sensitivity is a highly controversial one, with a familiar split between sceptics and advocates (Adair, 1991; Smith, 1994). The reason for this in the electromagnetic case is that an interaction effect is either very small, or very erratic, and lacks a generally accepted theory explaining the interaction. A very familiar situation to any parapsychologist. Secondly, except for the eyes, there have not yet been found a specific electromagnetic sensor in the human body. For now, I

am restricting the argument to human sensitivity as some animal species are known to have specific electromagnetic detection sites (e.g. Kirschvink, 1989; Zoeger et al, 1981). The psi ability of animals I won't even attempt to argue!). Some researchers point to the presence of magnetite particles in the brain, other to electromagnetic wavelength-sensitive pigments in the eye, and yet others argue for direct cellular effects (Ho et al, 1994), but there does not seem to be a single electromagnetic sensitive organ that can account for all the observed and suggested effects. Next, the repeatable demonstration of both psi and electromagnetic-sensing phenomena is somewhat erratic, being more successful if unconscious or physiological measures are taken rather than conscious responses. Some researchers argue that the effect would be too small to be able to register on a conscious level. (Delanoy and Sah, 1994; Bell et al, 1992). Lastly, there are the 'electromagnetic stars': people who are reportedly much more sensitive than the norm, as well as those who have the occasional (though much less well documented) electromagnetic influence on their environment (Smith and Best, 1990).

So, how might an electromagnetic interaction work, and could this help us understand psi? Perhaps what we are looking at is a global effect, one that affects the sensing system at many sites simultaneously. The basic unit of any living organism is the cell, and the outer membrane of a cell can be considered to be the primary energy transducer in the body, irrespective of that cell's specialised function. As a primary part of a cell's activity is electromagnetic in nature (Ho, 1993), this makes it a prime candidate for the site where electromagnetic detection could occur. Note that this idea is not new, having been suggested by several different researchers in varying forms. Thus, rather than a process analogous to conventional sensing, the effect of an electromagnetic field may be to act as a perturbation of the *entire* system (or at least an entire subsystem), showing up as a physiological, and maybe then as a psychological, modification.

Recalling the earlier similarity with psi with respect to the superiority of physiological over conscious measure (or at least, explicit measure- dowsing could be argued to be more of a subconscious than conscious measure), one wonders whether psi is a process that also acts at a cellular level, perturbing the system as a whole. If so, then the important factor for information transmission become not so much the 'focus' of the psi agent, but the structure of the signal and the compatibility of the receiving system.

So, for any perturbing signal operating at this level, the important human question becomes: what would be the *experience* of the sensing ? For a weak source field, it seems unlikely that any effect would be an obvious one, the 'signal' getting lost in the 'noise' of everyday, ongoing activity. Humans routinely screen out superfluous information from the conventional sensory channels, to better concentrate on the task at hand, so it would be unusual if this were not the case for other stimuli. However, if there were some degree of introspection, perhaps the changes would become noticeable - a technique used in many psi experiments, but seemingly not used in electromagnetic sensing experiments. Any such changes would, in our global perturbation scheme, show up as subtle modifications to normal processes, possibly ranging from a slight loss of concentration to 'strange' perceptual shifts, or even new perceptual creations. As this sort of signal essentially represents a shift from baseline for ongoing processes, it would also appear that attempting to analyse the shift as they occur would change the baseline which we were using as a comparison - the old "Oh look I'm meditating, wasn't I" effect. Successful sensing would therefore require some degree of passivity or dissociation, once again a characteristic of many psi experiments.(Parker, 1975).

It was decided to use a methodology wherein human participants would be tested for initial electromagnetic sensitivity, and then given some feedback training to see if this could be enhanced, with the aim of applying any successful strategies to future psi studies. A variety of responses were taken. Two of these responses were termed *explicit* as they required some conscious activity on the part of the participants. One was free-response, the other a dowsing (ideomotor action) response. A qualitative 'perturbed-thought' response was also taken in the initial session only. The third response was of unconscious, autonomic activity.

Three psycho-perceptual measures would also be used relating to various types of pattern recognition (temporal, spatial and rule-based). Measure one was related to temporal pattern-recognition, consisting of twenty trials of identifying the presence and placement of a four note random melody in an eight note random sequence (based on a standard music perception test - see Deutsch, 1969). Measure two was for spatial pattern-recognition, being a short version of Witkins Embedded Figures Test (Jackson, 1956). This is related to a psychoperceptual measure known as psychological differentiation, placing people on a continuum between being highly field dependent (FD) to highly field independent (FI). Psychological differentiation has been defined as "the capacity to overcome, or analyse, an embedding context in perceptual functioning" (Witkin et al, 1954). As

well as its pattern matching qualities, this test was of interest due to past research showing that it was correlated with background electrodermal activity (Hustmyer et al, 1964), with the systems showing more spontaneous bursts of activity taking longer in the identification task, but with those faster in the identification task being more reactive to stimuli. As the theoretical background for this study was supposing a cellular response to the perturbing signal, those people who had more reactive systems would be more likely to detect the signal. Measure three involved a rule-based pattern-matching task where participants had to deduce imposed rules from feedback to their choices, where the governing rule was periodically changed. This test included a period in the middle where there were random rules, the idea being that their degree of recovery once a stable rule was reintroduced would be a measure of their 'adaptive strategy' use. A 'take home' questionnaire was used, composed of the ambiguity tolerance AT-20 (MacDonald, 1970), private self-consciousness scale (Fenigstein et al, 1975) and an absorption scale (Tellegen, 1992).

A dowsing response, wherein the motions of a suspended bob supply simple responses to questions, was included to see whether it might represent an easy subconscious link as is often claimed in the dowsing literature (Eastwood, 1993). The claim is that subconscious ideomotor actions such as muscular tremors are amplified by means of the pendulum, giving essentially simple physiological feedback. In this study, the participant asked themselves the question 'Is there a field at the moment?', assigning specific movements of the pendulum to be either an affirmative or a negative answer. For example, a circular motion might be taken as a yes, whereas a linear, side-to-side motion might be a no. The assignment of these movements was left to the participant, who simply asked themselves 'show me a yes motion' and 'show me a no motion' at the beginning of the session. There was also a possible psychological value of it being used as a scapegoat to 'allow' the participants to be sensitive.

Participants' psi-related experiences and beliefs would be recorded, and they would take part in a couple of basic psi experiments: one looking for a psychokinetic effect, and one for extra-sensory perception. It was hoped that this would contribute towards the development of a profile of the electromagnetic-sensitive person, and that the successful strategies used could be adapted for use in future psi studies. The study would also, it is hoped, address the possibility of an electromagnetism-psi relationship.

METHOD

Apparatus

The basic set-up consisted of a pair of parallel coils 0.65 metres in radius and separated by the same distance (the Helmholtz condition). This ensured a reasonably homogeneous (to within a few percent) field in the centre region between the coils. The coils were constructed of wood, and wrapped with enamelled copper wire. For a detailed discussion of this type of apparatus, the reader is referred to Bell and Marino (1989). Figure Vd. gives a schematic of the coils, showing the position of a participant. The participant was seated in a padded, all plastic chair placed between the coils. The chair offered full back, head and arm support, but had no foot rests.

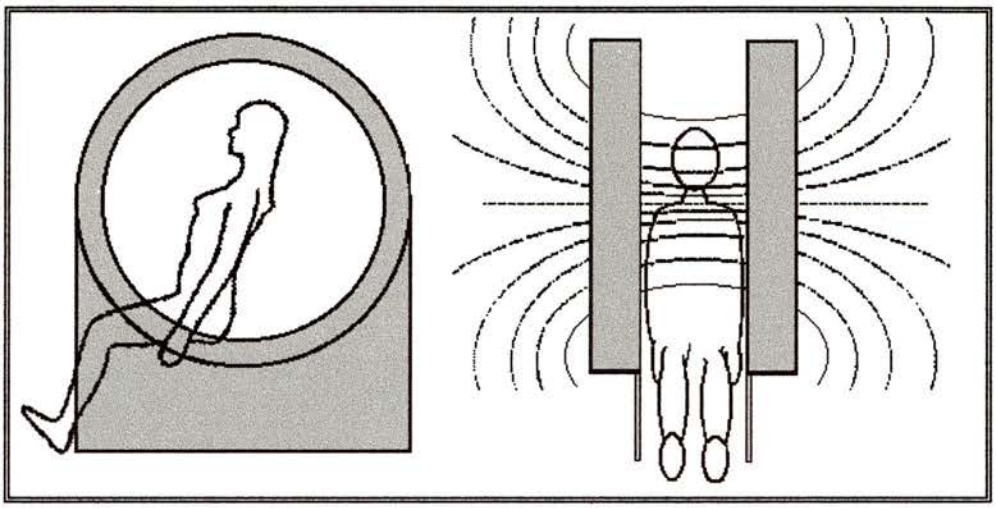

Figure Vd: Schematic diagram of Helmholtz coils and participant

The field was controlled by amplified output from a PC sound card, enabling easy generation of different types of wave-forms. The main restriction with this method was that signals could not be generated below 20 Hz as the sound card was intended primarily for audio-range frequencies and rapidly degraded the signal below this limit. Three types of field were used, their magnetic flux densities (a measure related to the strength of the field) being approximately 500 mG (see table Va). For the system used in this study, a field was produced by supplying a direct current, modulated at specific frequencies, to the coils. This field, applied in an East-West direction for periods of 5 seconds duration, was directly measured using a flux-gate magnetometer. The field intensity was chosen as being of the same order of magnitude as the geomagnetic field and thus not any stronger than would be encountered under normal circumstances. The field characteristics were not, however, chosen to emulate the geomagnetic field, but instead were within the

frequency range for activity of biological systems. When testing electromagnetic sensitivity, there was a computer-selected pseudo-random chance of there being a field or not, the type of field also being pseudo-randomly selected with equal probabilities. All random selections had equal probabilities of being selected each time, with no counterbalancing, as this might have enabled participant to improve their chances of being correct simply by counting how many of each of the types of field they had already experienced.

Table Va: Electromagnetic field characteristics

Field	Frequency (Hz)	Description
Type 1	20	A sinusoidal wave-form with a period of 0.05 seconds.
Type 2	40	A sinusoidal wave-form with a period of 0.025 seconds.
Type 3	20, 10	A 20 Hz sinusoidal wave modulated at 10 Hz to give a more complex wave-form

The study was conducted in a sound-attenuated room. No attempt was made to eliminate naturally occurring geomagnetic field fluctuations as it was reasoned that these would be part of any real-life sensing. As such, any organism sensitive to such fluctuations would presumably have learnt to filter them out as extraneous noise, as occurs with any other enduring stimulus. It may be that, if these naturally occurring fluctuations were removed, then the participants would be more sensitive to any artificially produced fields, but this would not have been an ecologically valid situation as the geomagnetic field permeates most environments that would be encountered in everyday life.

Audio feedback was given to tell participants when the field came on and went off. This consisted of an audio tone which had been modulated at a frequency matching that of the applied field. Thus the 20 Hz field tone was a 440 Hz (middle A) tone modulated at 20 Hz, resulting in a warbling sound. Each instance of field exposure was thus easily differentiable by audio tone alone. The feedback was played over stereo loudspeakers placed a few feet behind and to each side of the participant. During the testing sessions, the computer loudspeakers were turned off as they had a tendency to pick up the fields and emit a hissing noise.

Physiological measurements were taken with the Physiodata monitoring system model I410, with sensors for bipolar electrodermal (EDA) activity, peripheral blood flow and hand temperature. The electrodermal activity (EDA) electrodes consisted of two passive silver-chloride electrodes that were attached by means of velcro straps to the first and second fingers, in a bipolar placement. Blood-volume-

pulse was measured using a photelectric transducer, attached by velcro strap to the third finger. Temperature measurements used a thermistor, fixed with surgical tape to the centre back of the hand. The monitoring unit itself was interfaced to a high speed serial port on a 100 Hz Pentium PC. Data were sequentially sampled at 1024 Hz, and time-averaged samples saved to disk at 16 Hz.

A psychokinesis test was also attempted based on an attempt to influence the motion of a radio-control 'creature' whose movement was computer-controlled and based on the level of background radiation. This task consisted of the participant attempting to influence the movement of a small radio controlled 'creature', which movements were determined by changes in the background radiation in the room. A lowered count made the creature move forward, a higher count made it rotate.

Finally, there was a simple, forced-choice extrasensory perception task. This used a close friend as a 'sender' who attempted to communicate a random series of four possible emotional states. They were situated in a room approximately 10 metres from the participant. The participant was simultaneously shown a series of tachistoscopically presented images of a face lacking any specific features (the same image was presented each time) and asked to choose an associated emotional state.

Participants

The study used 18 unselected, volunteer participants, recruited from the university environs. 20 participants were planned initially, but one participant's session had to be aborted due to temporary equipment failure and he was unable to return for a repeat session in time, and another repeatedly postponed his session.

The recruitment messages informed them that the study would be looking at possible human sensitivity to electromagnetic fields, and that this would involve them being exposed to a variety of weak, artificially generated fields. participants were fully informed as to the nature of the study - the types of field to be used, the aims of the study and their role in it - and encouraged to ask any questions they might have. They then signed a consent form if they agreed to the three basic criteria of having had no personal or family history of epilepsy-related symptoms, understanding that the fields used would transiently affect their physiology, and knowing that they were free to stop or take a rest at any time during the study.

Procedure

On arrival at the parapsychology unit, the participant was given the psychoperceptual tasks, all of which were computer presented.

For initial sensitivity testing, the participant was seated in a semi-reclined chair so that their heads and upper torsos were within the homogeneous field region of the Helmholtz coils. Physiology electrodes were attached to the non-dominant hand. Connections were then tested via the computer program, asking the participants to take a deep breath to see that the system responded correctly. The participant was asked to relax with eyes closed while a type 1 field was applied 10 times, with 10-second intervals in between each exposure. They were then asked if they had noticed any sensations during field exposure.

Next, a test session was given, where the participant heard a 6-second countdown of quiet clicks emitted by the computer loudspeaker, followed by a silent 5-second period, followed by a 'response' signal. At this point they verbally gave a yes/no response as to whether a field had been present during the silent period. The participant was told verbally by the experimenter whether they were right or wrong immediately after their response. 20 trials were given in a test session.

The participant was then introduced to the idea of pendulum dowsing. They performed another test session using the dowsing response to determine the presence of a field.

Finally, they took part in a simple guided visualisation exercise, which started with a progressive relaxation exercise followed by an attempt to maintain a constant mental image. This image was of a pool of water in which they could see their reflected face, this being consistent with the 'descent into a cavern' relaxation exercise used. At the same time as this image was being maintained, a type 1 field with no audio feedback and of 5 seconds duration was repeating with 10-second rest intervals in between. The participant was encouraged to describe any changes in their mental image should they occur. They were then debriefed as part of the usual post-experiment tea-drinking session. A copy of the take home questionnaire was given as they left. Where possible, each participant was asked to complete three further sessions after the initial one. These sessions followed a similar format, with an emphasis on test sessions following feedback sessions, in an attempt to see if electromagnetic sensing could be improved. Session two consisted of a 10-trial feedback session for each type of field in turn, followed by a free-response test session and a dowsing test-session, both with immediate feedback. In the test session, the participant was additionally asked to identify the type of field if they

thought one was present. Session three consisted of a 10-trial feedback session for each field-type where the participant attempted to find a discrete dowsing response for each type. A dowsing test-session with immediate-feedback then followed. After this, the PK task was given, it being presented to the participant as an extension of 'environmental sensing' with an added reciprocal control element. Eight PK attempts were made, each lasting for the duration of 20 1-second data samples.

Session four consisted of further 10-trial feedback sessions for each field-type. The participant then undertook a free-response test session but one in which feedback was delayed until the end of the session. After this, they took part in the ESP task.

For all sessions, the experimenter was present in the room, situated approximately one metre to the side of the participant's seat. Only the experimenter could see the computer screen, and care was taken to ensure that there were no cues given to either experimenter or participant as to the type of field being used during test sessions.

PREDICTIONS

The predictions of the study were :

H1: Participants would exhibit some degree of electromagnetic sensitivity.

H2: There would be a difference in electromagnetic sensitivity between participants based on psychological measures of:

(a) field dependency.

(b) private self consciousness.

(c) adaptive strategy use.

(d) pattern matching

(e) temporal pattern matching ability.

(f) ambiguity tolerance.

(g) absorption.

H3: Electromagnetic sensitivity would show a positive correlation with:

(a) paranormal belief.

(b) reported paranormal experience.

H4: Electromagnetic sensitivity would positively correlate with

(a) scores in the ESP task.

(b) scores in the PK task.

For all of the hypotheses, 'sensitivity' was studied on two levels: explicit responses and physiological measurement.

RESULTS

18 people completed their initial sensitivity session, representing 1371 field exposure trials. Of these 18 participants, 16 returned for session 2, 15 returned for session 3, and a further 10 completed all 4 sessions. This gave a total of 93 test trials. None of the participants exhibited an amazing degree of sensitivity. Figure Ve shows a plot of the frequency N of the number of correct responses in each 20-trial test. for all 93 test trials. As this represented a yes/no binary answer, theory predicts a binomial distribution (the dotted line in figure Ve) centred on 10 correct responses. The actual distribution (the solid line in figure Ve) appears to show a deviation from the expected distribution, but this was not statistically significant. (A chi-squared goodness of fit test gave $\chi^2=16.08$, p=0.711, 92 df). H1 is therefore not supported on the basis of the explicit responses.

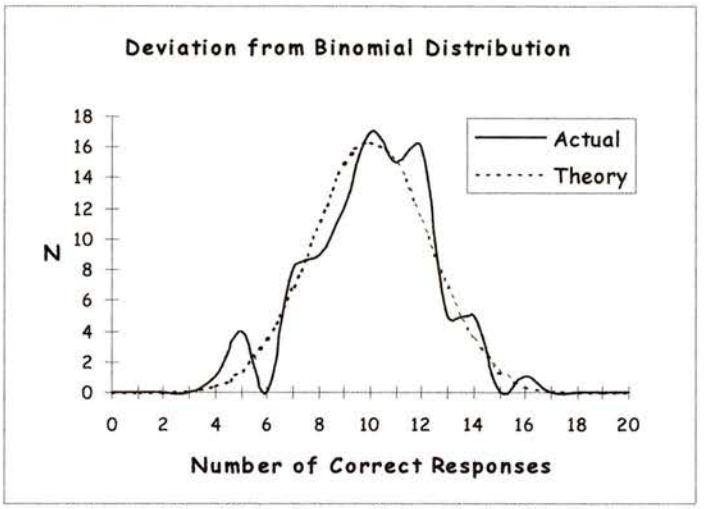

Figure Ve: Histogram of number of correct responses

The overall results do not indicate any learning effect (see table Vb, row 'All'), as participants actually got worse after their first feedback session

Table Vb: Mean number of correct explicit responses, and a t-test showing differences between field dependent (FD) and field independent (FI) participants

	Verbal Response 1	Verbal Response 2	Dowsing 1	Dowsing 2
All	10.60 ± 2.3	10.50 ± 1.75	10.13 ± 2.28	9.88 ± 2.96
F.D.	10.60± 2.72	10.75 ± 1.75	10.50± 2.76	9.13 ± 3.18
F.I.	10.50 ± 1.85	10.25 ± 1.75	9.75 ± 1.37	10.63 ± 2.72
t [FD:FI]	0.529	1.471	0.147	-2.089
df	15	14	15	14
p (2-t)	0.605	0.163	0.885	0.055

There is a small reversed effect related to field dependence. FD people were initially better at the free response, but got worse with dowsing. FI people showed an opposite effect. A t-test showed that the differences between the two groups were not significant, only the second dowsing session being even close to significance. H2a was thus not supported, based on explicit responses. However, the magnitude of the difference did increase between first and second sessions for both verbal and dowsing responses, which could imply some degree of learning.

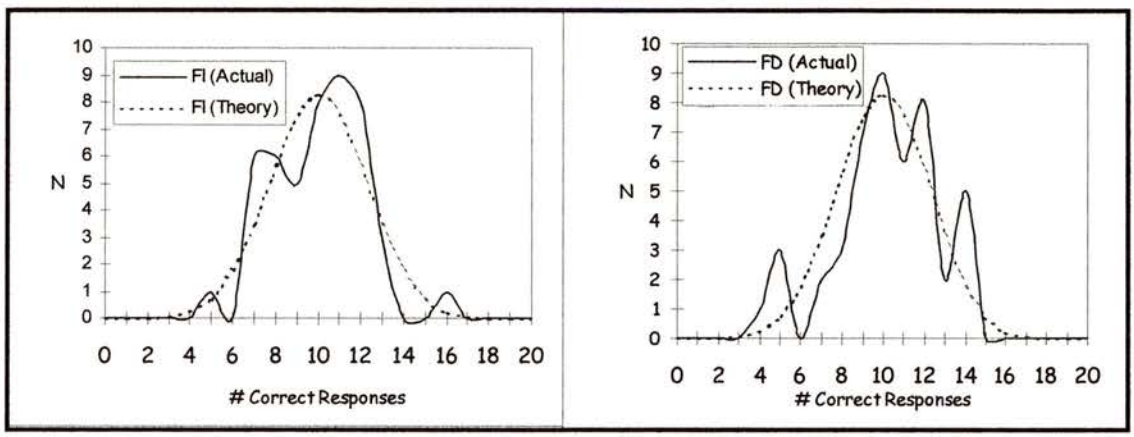

Figure Vf: Number of correct responses for field identification - deviation from theoretical distribution for field independent and dependent participants

Figure Vf shows the deviation from the theoretical binomial distribution for the overall explicit responses for all sessions. A Chi-squared goodness-of-fit analysis gave $\chi^2=11.51$ ($p=0.93$) for FI participants, and $\chi^2=23.25$ ($p=0.28$) for FD participants. Although non-significant, it does show that the FD people deviated more from the expected distribution. The difference based on field dependency can also be seen in table Vc, which correlated the embedded field test (EFT) scores with the electromagnetic responses. The mean EDA level and variance was consistently negatively correlated (though this was not significant) with the EFT scores, indicating that Field Independent people have higher EDA. This was true both for the unperturbed EDA (the no field case) and the perturbed (field) case, actually strengthening for the latter. Although again non-significant, the EFT score was consistently positively correlated with the verbal response measure, strengthening between sessions. There was little sign of any correlation for the initial dowsing response, but the second session showed a stronger, negative correlation. As this

was in the same direction as the physiological response, this could suggest that the dowsing response is based on a subconscious awareness of changes in physiological activity.

Table Vc: Spearman correlations for field responses and EFT

	Initial Sensitivity		After Training		Physiological Response	
	Free Response 1	Dowsing 1	Free Response 2	Dowsing 2	EDA Variability	Mean EDA
Embedded Figures Task	0.28 (N=17)	0.36 (N=17)	0.02 (N=16)	0.32 (N=16)	0.07 (N=11)	-0.31 (N=11)

For significance at the p=0.05 level, r_c=0.62, N=11; r_c=0.51, N=16; r_c=0.49, N=17.

Next, physiological measures were looked at, these readings being taken as representing unconscious responses. Although it is difficult to compare absolute EDA readings, as there will be individual differences and also differences depending on conditions at the time of each session, the mean EDA readings should still offer useful information. The area of interest for this study is in the relative differences in the EDA for each field type, which information should still be preserved in the mean values. The magnitude of the mean values should not be taken as indicative of a typical response, individual readings varying from as little as 0.15 to as much as 20.82 for the level of EDA.

Table Vd: Mean EDA level for field vs. no field [17 Ps contributing 1371 trials]

		Field Type 1	Field Type 2	Field Type 3	Field	No Field
Mean EDA	All	9.71	10.14	10.13	9.99	10.22
	F.D.	8.43	8.76	8.41	8.54	9.19
	F.I.	10.11	10.61	10.71	10.48	10.62

Table Ve: Mean EDA Variance for field vs. no field [17 Ps contributing 1371 trials]

		Field Type 1	Field Type 2	Field Type 3	Field	No Field
Mean Variance	All	0.495	0.488	0.806	0.596	1.646
	F.D.	0.274	0.161	0.219	0.218	1.413
	F.I.	0.694	0.744	1.256	0.898	2.070

As can be seen in tables Vd and Ve, the presence of any type of electromagnetic field was accompanied by an EDA response which was lower in magnitude and less variable, for all cases. A Wilcoxon non-parametric test of the mean EDA level for field versus no field gave $z = 0.827$ ($p = 0.408$, 2-tailed, non-significant). The same test of the mean EDA variance for field versus no field gave $z = 3.103$ ($p = 0.002$, 2-tailed, significant). This result was consistent for 15 out of the 17 cases. H1 was therefore supported on the basis of EDA variance. Although it differs in magnitude for FD and FI people, there are differences in EDA for the different field types. This implies that there would in principle have been sufficient somatic information for the percipient to have differentiated between field types.

To perform the correlations with psychological scales, it was necessary to devise a score that would reflect a deviation from pure guesswork when participants were trying to say whether a field was present or not. Thus the response deviation was calculated as | Actual Response Score - Chance Level Response |. The absolute deviation was taken as, for the purposes of the correlation, electromagnetic sensitivity would require only that a difference could be consistently sensed between the presence and absence of a field. That is, it did not matter whether participants scored above or below chance, the direction only indicating the label they applied to two distinct sensations.

Table Vf: Spearman correlations for field responses and psychological factors

	Initial Sensitivity		After Training		Physiological Response	
	Verbal Response 1	Dowsing Response 1	Verbal Response 2	Dowsing Response 2	Mean EDA Variability	Mean EDA Level
Private Self-Consciousness	0.00 (N=13)	-0.09 (N=13)	0.27 (N=13)	0.27 (N=13)	0.04 (N=12)	-0.37 (N=12)
Adaptive Strategy	0.03 (N=17)	-0.23 (N=17)	0.05 (N=17)	**0.55** (N=17)	-0.39 (N=15)	-0.33 (N=15)
Pattern Matching	0.01 (N=17)	-0.33 (N=17)	0.13 (N=16)	0.07 (N=16)	**-0.73** (N=15)	-0.43 (N=15)
Temporal Pattern Matching	-0.39 (N=18)	-0.05 (N=18)	0.42 (N=16)	0.11 (N=16)	0.14 (N=16)	-0.08 (N=16)
Ambiguity Tolerance	-0.09 (N=13)	0.25 (N=13)	-0.23 (N=13)	-0.15 (N=13)	0.56 (N=12)	0.43 (N=12)

Bold type indicates correlation has reached significance at the p=0.05 level (r_c=0.59, N=12; r_c=0.57, N=13; r_c=0.52, N=15; r_c=0.51, N=16; r_c=0.49, N=17; r_c=0.48, N=18). Note that this table represent 36 separate correlations and so, for the quoted significance level, we would expect to find 2 correlations by chance alone.

In all cases, the initial free-response and dowsing sessions were taken to indicate initial sensitivity, whereas session 2 would hopefully show if any learning

ability existed as participants had had a complete feedback session by then. Results are given in table Vf.

For explicit responses, no clear relationships were found for any of the measures (table Vf, columns 'Initial sensitivity' and 'After Training'), except that an adaptive strategy may be related to successful learning of dowsing (see table Vf). The correlation with private self-consciousness did increase after training, being the same for verbal and dowsing responses, and was in the predicted direction. H2b-f were therefore not supported, based on explicit responses. For physiological response measures (table Vf, columns marked 'Physiological response'), a significant negative correlation was found between pattern matching (rule-based) and physiological variability. A smaller, close to significance positive correlation was found between ambiguity tolerance and physiological variability. Of the hypotheses H2b-f, only H2d was supported, based on physiological measures.

Table Vg shows the correlations between the Absorption score and the various responses. The overall Absorption score did not correlate with the free-response initial sensitivity, but was negative (though non-significant) for the dowsing initial sensitivity and the second session. H2g was thus not supported for explicit or physiological responses. To explore the data further, the Absorption scale was split into its component six factors. These were "Responsiveness to engaging stimuli", "Synaesthesia", "Enhanced cognition", "Oblivious/dissociative involvement", "Vivid reminiscence" and "Enhanced awareness" (also in table Vg).

Table Vg: Spearman correlations for field responses and Absorption factors (N=12 for explicit response, N=8 for physiological measures)

	Initial Sensitivity		After Training		Physiological Measures	
	Verbal Response 1	Dowsing Response 1	Verbal Response 2	Dowsing Response 2	Mean EDA Variance	Mean EDA Level
Absorption	0.01	-0.37	-0.50	-0.24	-0.13	0.15
1: Stimulus	0.24	-0.10	-0.39	-0.13	-0.17	-0.14
2: Synaesth.	-0.46	-0.23	-0.34	-0.14	0.32	0.12
3: Enh. Cog.	0.47	-0.06	**-0.75**	0.02	-0.15	0.30
4: Dissocn.	-0.06	-0.32	-0.38	-0.24	0.11	0.20
5: Vivid Rem.	-0.20	**-0.59**	-0.43	-0.43	-0.07	0.16
6: En. Aware	-0.28	-0.20	-0.31	-0.28	0.12	-0.11

Bold type indicates correlation has reached significance at the p=0.05 level (r_c=0.59 for Explicit Measures, r_c=0.69 for physiological measures). Again, this table represents 42 individual correlations. As such, we would expect roughly 2 correlations to be significant by chance alone.

Factors 2, 4, 5 and 6 are directionally consistent, and factor 6 also strengthens from session 1 to 2. The negative correlation for factor 4 is particularly surprising as it was thought that a degree of dissociation would be beneficial to the sensing process. Factor 5 appears to be the most consistent result, implying that abilities related to 'vivid reminiscence' are not conducive to electromagnetic sensitivity. No significant correlations were found between absorption factors and physiological activity.

Next, the predicted relationships between electromagnetic sensing and psi were analysed. An emotive ESP score was calculated based on the number of correct responses to the forced-choice emotional state task. Unfortunately, no evidence of ESP was found. For the PK task, both the mean deviation from control count and the variance of the target system were looked at, these measures being the most commonly taken scores in PK tasks. Results of the PK task used are given in table Vh, comparing control to influence periods. A Wilcoxon signed rank's test comparing the control to influence mean count data gave a Z of -3.664 ($p<0.001$, 2-tailed), indicating the existence of a PK effect. For the variance comparison, the difference was not significant (Wilcoxon $Z=0.914$, $p=0.361$ 2-tailed).

Table Vh: PK 'scores' for control vs. influence periods

	N	Mean # Counts [σ]	Mean Variance[σ]
Control	27	2.9180 [2.6]	2.7706 [2.4]
Influence	27	2.6448 [2.4]	2.9919 [3.9]

Table Vi shows the correlations between electromagnetic field responses and psi factors. There was little consistency, although the after training explicit responses are close to being significantly correlated with psi belief, possibly indicating that belief aided learning (or that belief came about as a result of learning ability in other psi situations). Overall, H3a was not supported.

Reported experience of ESP showed a consistent negative correlation with all the electromagnetic sensitivity responses, reaching significance for the second dowsing response. As lowered EDA was found to be a reaction to the presence of any type of field, then it could be hypothesised that ESP experience was inhibited in those people with some sensitivity to electromagnetic fields. Reported experience of PK also showed a consistent negative correlation with all the electromagnetic sensitivity responses, reaching significance for the second verbal response.

However, the sizes of the correlations were small, so neither H3a nor H3b were supported.

The psi task scores did not show any consistency with electromagnetic sensitivity. The PK deviation score also showed no correlation with these two factors. However, the variability of the PK target system was consistently positively correlated with the verbal response measure, and consistently negatively correlated with dowsing. That is, successful verbal-response electromagnetic sensitives gave more variable activity in the PK target system, whereas successful dowsers gave less variability. This could indicate a link between PK ability and the most successful strategy used in electromagnetic sensitivity.

Table Vi: Spearman correlations for field responses and Psi factors

	Initial Sensitivity		After Training		Physiological Response	
	Verbal Response 1	Dowsing Response 1	Verbal Response 2	Dowsing Response 2	Mean EDA Variability	Mean EDA Level
Belief in Psi	-0.10 (N=12)	-0.45 (N=12)	-0.48 (N=12)	0.58 (N=12)	0.03 (N=11)	-0.16 (N=11)
ESP Experiences	-0.19 (N=12)	-0.55 (N=12)	-0.22 (N=12)	**-0.62** (N=12)	-0.18 (N=11)	-0.44 (N=11)
PK Experiences	-0.002 (N=12)	-0.42 (N=12)	**-0.64** (N=12)	-0.19 (N=12)	-0.08 (N=11)	-0.37 (N=11)
Emotive ESP	-0.37 (N=10)	-0.30 (N=10)	-0.07 (N=10)	0.22 (N=10)	-0.10 (N=9)	-0.04 (N=9)
PK Mean Deviation	0.10 (N=14)	-0.34 (N=14)	-0.40 (N=14)	0.10 (N=14)	0.18 (N=14)	-0.35 (N=14)
PK Variance	0.27 (N=14)	-0.23 (N=14)	0.28 (N=14)	**-0.72** (N=14)	0.07 (N=14)	-0.20 (N=14)

Bold type indicates correlation has reached significance at the p=0.05 level (r_c=0.74, N=8; r_c=0.65, N=10; r_c=0.62, N=11; r_c=0.59, N=12; r_c=0.54, N=14).

Post-hoc, but of interest in relation to the basic electromagnetic sensitivity question was that several participants spontaneously reported sensations when the field was on. Although this did not at the time appear to indicate a greater propensity to correctly identify the field in testing sessions, the reported symptoms were very similar for all participants. They included tingling in the hands and arms, an indefinable sensation in the left temple, often coming in waves, and a tingling feeling in the centre of the forehead. A Wilcoxon test was performed to see if the instances of symptom reporting was different for the training sessions, when participants knew when the field was present, and the testing sessions, when they

were not. The Wilcoxon z was 1.396 (non-significant, p=0.16), where more symptoms were reported in the training session (mean of 0.95 symptom reports per person) than in the testing sessions (mean of 0.65 symptom reports per person). This was true for both field dependent and independent people. Symptom reporting did not seem to correspond to an increased number of correct responses. Several of the participants also reported distortions in their maintained mental image, including the spontaneous creation of additional 'sensory' elements, during the guided visualisation period. These distortions were often timed to coincide with the start and stop points of the field exposures. Common reports were of 'wave-like' effects moving from left to right (which did in fact correspond to the direction in which the field was applied), a loss of concentration and clarity, and noises or lights in the visualised scene.

DISCUSSION

None of the participants were shown to be amazingly sensitive to the applied electromagnetic fields, but there were individual differences relating to field dependency, and a few indications that training could help to elicit a degree of awareness.

All showed a physiological response wherein the level of their electrodermal responses and the variability of electrodermal activity was lowered in the presence of *any* field. The change in the level of activity was *higher for* field dependent people than for field independent people. A change in overall EDA is normally taken to indicate a change in levels of situational arousal of the autonomic system, or of the responsiveness of an individual to stimuli (Cacioppo and Tassinary, 1995). For sensory presentation of a stimulus, this is taken to indicate that the stimulus has some significance to the perceiver. In cases where the stimulus is non-sensory in nature, such as appears to be the case with electromagnetic fields, it is conceivable that the effect might be a non-specific change in arousal that could then be projected onto a simultaneous sensory stimulus. For example, in this study, many of the participants reported the sensation of 'hand tingling' during feedback periods, even though this was not found to correspond to an increased awareness of the field in no-feedback sessions. Such a sensation is a fairly common one experienced when one is relaxed and attending to the hands so perhaps the field served to generate a non-specific feeling of 'significance' which was then applied to an unrelated sensation, causing participants to consider it important enough to mention. As an extension of this, perhaps some cases of ostensible hauntings are

actually due to the experient's electromagnetic sensitivity. When experiencing a site-specific electromagnetic field, a non-specific feeling of 'significance' is generated, which the experient then attempts to explain by seeking out conventional sensory cues. Should the site be a calm, peaceful, religious site, then the experience is one of 'the sacred'; should it be a dark, gloomy setting (or the experient a person of a nervous disposition!), then the experience is of a 'presence'. If this is the case, we would expect to find differences between people with varying degrees of psychological differentiation.

That overall EDA, based on both magnitude and variance, was *lowered* in the presence of any type of field was opposite to those results found by Braud and Dennis (1989) wherein EDA was higher during higher GMF activity. This could possibly be due to differences between the geomagnetic field and the fields used here. However, this finding could relate to the oft found relationship between low geomagnetic field activity and psi success (e.g. Dalton and Stevens, 1996), as higher geomagnetic field activity might be expected to disrupt normal physiological activity in sensitive people. If psi were due to a signal generated by physiological activity, an externally applied field could then disrupt psi.

For psychological measures, there were no obvious relationships between electromagnetic sensitivity based on either explicit or physiological responses. For the psychoperceptual measures, some indications of possible relationships were found. Field dependence appeared to be correlated with better explicit sensitivity, as well as with a lesser physiological variability than field independent people. This latter result disagrees with the result found by Hustmyer and Karnes (1964) wherein FD people were found to have *more* spontaneous EDA than FI people. However, it does tie in with earlier research reported by them, which found that FI people were more active, and more reactive to stimuli.

CONCLUSIONS

Although the study used a low number of participants, each contributed a large number of experimental trials. As such, the results may be taken as being fairly robust, and of use in the design of future psi and electromagnetic sensing studies. Of most interest are the indications in the physiological responses of a possible relationship between electromagnetism and psi, be it direct or by analogy. The failure of the psychological but the success of the psychoperceptual variables to reliably differentiate success could also offer indicators for future selection procedures of successful psi agents.

As discussed earlier, some properties of cells are shared by the semiconductor devices often used as target systems in psychokinesis studies, and it was suggested that the psi signal would have a similar basic effect on both. Neglecting the effects of any kind of patterning in the signal, and concentrating just on the presence or absence of a signal, it was suggested that the effect would be to increase the activity of the system on a cellular or equivalent level. That is, cells sensitive to the characteristics of the signal would fire, or otherwise become excited, more easily. The electromagnetic sensitivity study described found that the effect of any type of field on human physiology, based on electrodermal measures, was to show a suppression in the level of activity. In an exercise to see whether the semiconductor properties of cells were in fact the site of interaction in this effect, or whether there was a second order effect based on as yet unspecified unique properties of biological or psychophysiological systems, a further, similar study was performed.

Experiment: Non-Biological Electromagnetic Sensitivity

This study looked at the effects of electromagnetic fields on a typical Zener-diode based random event generator (REG). Conventionally, we would expect the REG to be unaffected by all but the strongest fields, whereas the thinking in this thesis would lead us to expect a difference in the variance of the REG when comparing different applied fields to the baseline condition of no applied field. As this thesis postulates that psi is an electromagnetic wave, evidence of an electromagnetic effect on the REG might help us to understand some of the reported PK effects on REGs.

Method

Apparatus

A computer controlled system was set up such that there was a random presentation of different types of electromagnetic fields applied via the same Helmholtz coils used in the human sensitivity study. Within the coils was placed a serial port REG based on two Zener diodes (see the chapter IV discussion on target systems for details of the REG operation), this being a typical REG used in many different psi studies.

Possible electromagnetic fields types were fields of 40 Hz, 20 Hz, or 10 Hz pure tone sinusoidal wave forms, white noise (a random mix of frequencies), or a period equivalent in terms of duration and computer activity but with no field generated (a 'silent' field). All wave forms were of 30 seconds duration, with a flux density of either 500 mG, 250 mG or 10 mG[4]. No attempt was made to shield against additional effects of the natural geomagnetic field. These values were later retrieved from the internet site[5] of the British Geological Survey geomagnetic monitoring station to be used in the statistical analysis. The k index was used, being a global measure of the largest geomagnetic field fluctuation in any one of the North-South, East-West or Vertical axes recorded at any one of 13 monitoring stations around the world.

Procedure

Once initiated, a complete experimental session lasted for 12 hours, this being 1440 trials each of thirty seconds duration at approximately 4 Hz (equivalent to 119 samples). Each sample was of 175 bits (so the expected number of mean events was 87.5). Sessions were started in the evening, and allowed to run unsupervised in a locked room overnight, or over the weekend, this arrangement minimising any possible effects due to the presence of people in the environs.

PREDICTIONS

If the electromagnetic waves (psi signals) did indeed interact with cells by modifying their semiconductor properties, then the semiconductor-based REG should show a similar increased activation effect when placed in an applied field. Such activation would result in a slightly decreased number of events (based on the simulation results in chapter IV) and a decrease in variance. The main predictions were thus:

H1: In an applied field, the REG output would show a decreased:

(a) number of events.

(b) variance.

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[4] 1mG is one-thousandth of a Gauss, the c.g.s. units of magnetic flux density. It corresponds to 10^{-7} Tesla in S.I. units.

[5] Available free for non-commercial use at <telnet://vaxa.nerc-murchison.ac.uk>, username is **GIFS**, password is **GMINFO**.

The effect of the geomagnetic field on the system, and an interaction between the GMF and the applied field was also looked for. As there has long been thought to be a relationship between success in psi and GMF activity, it was predicted that there would be a difference in mean events and variance depending on the field, but no direction was specified. ESP protocol research has often found that lower GMF activity is associated with success, whereas the few PK protocol looking at a possible relationship have been less consistent. Secondary predictions were thus:

H2: Irrespective of the experimentally applied electromagnetic field, geomagnetic field activity would show a relationship with the REG output based on:

(a) mean number of events

(b) variance

RESULTS

The following tables Vj-o give summaries of the results obtained over 10 sessions (299,880,000 binary events) spaced over a period of 1 month.

Table Vj: Mean of REG events and variance for 500 mG field, split by field type

	Mean Events	Mean Variance	N
No field	87.49	43.63	6487
Field	87.49	43.21	4848
20 Hz	87.50	43.38	1631
40 Hz	87.49	43.27	1629
White Noise	87.49	42.98	1588

Table Vj. shows results for the highest field flux density used. The mean number of events observed was not noticeably altered, but the variance of those events did show an overall decrease when an electromagnetic field was applied. A further breakdown shows that the white noise (a random mix of frequencies) showed the greatest decrease in variance.

Table Vk shows an analysis of variance (ANOVA) for the 500mG applied field. This showed no significant change in the number of mean events due to the presence of the applied fields but did show that the variance was significantly altered. The geomagnetic field alone did not appear to have an overall effect on

either the mean number of events or on the variance of those events, but there was a significant interaction between the applied field and the GMF in for the variance of the REG events.

Table Vk: Analysis of variance for 500 mG applied field and GMF effects

	Hypoth SS	Error SS	Hypoth MS	Error MS	F	p (F)
By Applied Field (df = 3, 11307)						
Mean Events	0.029	4159.629	0.010	0.368	0.026	0.994
Mean Variance	440.863	365699.946	146.954	32.343	4.544	**0.004**
By GMF (df = 6, 11307)						
Mean Events	0.927	4159.629	0.155	0.368	0.420	0.866
Mean Variance	168.140	365699.946	28.023	32.343	0.866	0.518
Interaction (df = 18, 11307)						
Mean Events	6.891	4159.629	0.383	0.368	1.041	0.409
Mean Variance	985.653	368699.946	54.758	32.343	1.693	**0.033**

Table Vl: Mean events and mean variance for 250 mG field, split by field type

	Mean Events	Mean Variance	N
No field	87.49	43.63	6487
Field	87.49	43.45	4921
20 Hz	87.47	43.34	1659
40 Hz	87.52	43.32	1590
White Noise	87.48	43.68	1672

For the 250 mG applied field, results are shown in table Vl. Again, the mean number of events was not noticeably altered for the field versus no field comparison, although there was a difference when the breakdown into different types of fields was considered. The variance of those events again showed an overall decrease when an electromagnetic field was applied, although this turned out to be true only for the two pure frequencies. The white noise this time showing an increase in variance.

Table Vm: Analysis of variance for 250 mG applied field and GMF effects

	Hypoth SS	Error SS	Hypoth MS	Error MS	F	p (F)
By Applied Field (df = 3, 11307)						
Mean Events	1.826	4229.763	0.609	0.372	1.638	0.179
Mean Variance	186.386	371547.137	62.129	32.649	1.903	0.127
By GMF (df = 6, 11380)						
Mean Events	1.256	4229.763	0.209	0.372	0.563	0.760
Mean Variance	39.033	371547.137	6.506	32.649	0.199	0.977
Interaction (df = 18, 11307)						
Mean Events	4.760	4229.763	0.264	0.372	0.711	0.803
Mean Variance	764.701	371547.137	42.483	32.649	1.301	0.175

The ANOVA for the 250 mG applied field is shown in table Vm. The change in the mean number of events due to the applied fields was not significant, nor were the changes in the mean variance due to the presence of the applied field significant.

Table Vn: Mean events and mean variance for 10 mG field, split by field type

	Mean Events	Mean Variance	N
No field	87.49	43.63	6487
Field	87.49	43.41	4839
20 Hz	87.47	43.76	1622
40 Hz	87.49	43.15	1647
White Noise	87.50	43.33	1570

Table Vn shows the results for the 10 mG applied field. Yet again, the mean number of events was not noticeably altered for the field versus no field comparison, and there was a slight difference for the breakdown into different types of fields. The mean variance showed the expected overall decrease when there was an applied field, but the breakdown by field type was not consistent, showing an increase for the lowest frequency, and a decrease for the mid-frequency and the white noise.

Table Vo: Analysis of variance for 10 mG applied field and GMF effects

	Hypoth SS	Error SS	Hypoth MS	Error MS	F	p (F)
By Applied Field (df = 3, 11298)						
Mean Events	2.202	4142.612	0.734	0.367	2.002	0.112
Mean Variance	259.592	367712.829	86.531	32.547	2.659	**0.047**
By GMF (df = 6, 11298)						
Mean Events	2.573	4142.612	0.429	0.367	1.170	0.319
Mean Variance	414.421	367712.829	69.070	32.547	2.122	**0.047**
Interaction (df = 18, 11298)						
Mean Events	7.973	4142.612	0.443	0.367	1.208	0.244
Mean Variance	711.136	367712.829	39.508	32.547	1.214	0.239

The ANOVA for the 10 mG applied field (table Vo) showed no significant change in the number of mean events but the mean variance was just significantly altered in the case of the applied field and for the GMF alone. No significant interaction effects were found, implying that the noted effects might be cancelling each other out?

Overall, the ANOVAs showed no significant effects on the mean number of events, either for the applied or the geomagnetic field . H1a and H2a were therefore not supported.

Several significant interactions were found for the mean variance. For the applied field some exploratory t-tests were performed to determine the direction of the effects. The results are given in table Vp. For the applied fields, the 500 mG and 10 mG fields showed significant effects in the predicted direction (the mean variance was lower in the presence of an applied field), and the mid-range field was very close to significance.

Table Vp: T-tests looking at Applied field vs. no field effects on variance

Variance of events with field of:	t	p(t) 1-tailed	Effect size (Fisher's Z)
500 mG	-3.843	0.00005	0.036
250 mG	-1.631	0.052	0.015
10 mG	-1.968	0.025	0.019

N.B. a negative t implies value under field is lower than under no field

To determine an overall effect, the t values were converted to standardised z-scores using Rosenthal's method (Mullen and Rosenthal, 1985) and combined to give an overall z of -4.296, with an associated probability value of less than 0.001 and effect size of 0.028. H1b was therefore supported.

For the geomagnetic field effects, the data were split into two groups - with a k index value above the mid point, the other below this - an a t-test performed. The results (see table Vq) show that the effect appears to become stronger as the applied field becomes weaker, actually reaching significance for the weakest applied field. This would tend to imply that any effect due to the geomagnetic field will be drowned out in the presence of other, stronger effects, but will show up when the other effects are very weak, as is likely to be the case with psi.

Table Vq: T-tests looking at low vs. high geomagnetic activity effects on variance

Variance of events with field of:	t	p(t) 2-tailed	Effect Size (Fisher's Z)
500 mG	0.208	0.835	0.002
250 mG	1.340	0.180	0.013
10 mG	2.522	0.012	0.024

N.B. a positive t implies value under low GMF is higher than under high GMF value

Table Vr: Mean events and mean variance for data sets, by geomagnetic field fluctuations

	500 mG data set			250 mG data set			10 mG data set		
GMF K Index	Mean Event	Mean Var	N	Mean Event	Mean Var	N	Mean Event	Mean Var	N
0.4	87.49	43.39	1569	87.49	43.49	1545	87.49	43.31	1570
1.0	87.51	43.41	769	87.48	43.46	809	87.48	43.27	792
1.2	87.48	43.49	1548	87.49	43.41	1544	87.47	43.43	1544
1.4	87.51	43.63	799	87.49	43.80	773	87.50	44.06	748
2.0	87.49	43.40	4346	87.50	43.60	4418	87.49	43.55	4413
2.8	87.49	43.10	743	87.49	43.19	748	87.52	43.16	751
3.4	87.50	43.69	1561	87.49	43.71	1571	87.50	43.90	1506

It is also interesting to note that the direction of the effect, that the overall mean variance is higher when the GMF activity is low, is similar to the findings of ESP research - that psi is more successful when the GMF is relatively inactive. The t values were again converted to standardised z-scores and combined to give an overall z of 2.350, with an associated probability value of 0.02 and effect size of 0.015. H2b is therefore also supported.

In an attempt to find out how the GMF affects the results, the mean variances under each of the measured GMF activity values were tabulated (see table Vr) and then plotted on a graph (see figure Vg).

It is apparent that there was no consistent effects on the mean number of events, as was indicated by the ANOVAs. However, it can be seen that the effect on the variance does appear to be consistent for all the densities of applied field, although the relationship is certainly not linear. This can be seen clearly in figure Vg, with the effect of the GMF being stronger for the weaker applied fields.

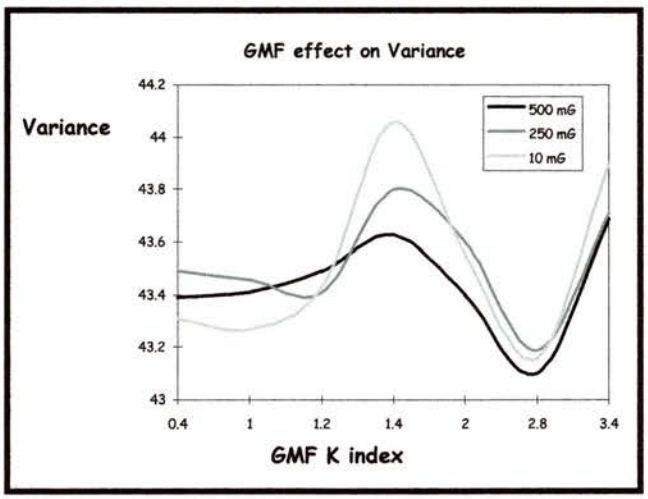

Figure Vg: Mean variance versus geomagnetic activity

DISCUSSION

The study described did not find any significant effects of the applied fields or of the naturally occurring geomagnetic field on the mean number of events produced by an electronic REG. This mean shift was also seemingly not dependent on the flux density of the field, which could indicate that the relevant physical assumptions used in the PK simulation (that the REG output is determined in part

by the zero-point field fluctuations) is correct, as it is thought that this field will be perturbed by applied fields of any flux density equally. Variance of REG output was lowered for the field versus no field case. However, the direction of the shift in variance had some as yet unknown relationship to the frequency of the applied field. For the proposed psi signal, we might therefore expect different PK effects on REGs based on the frequency characteristics of that signal. Consistent PK results would be obtained only if the psi signals in various trials were made as similar as possible. This might be possible if the psi agent(s) were trained to produce a specific pattern of brain activity (e.g. more global alpha) during influence attempts. The results suggest a non-linear decline in effect size with decreasing flux density, so for typical neural magnetic fields of 10^{-8} mG (i.e. 100 million times weaker!) we would expect a slightly decreased effect size from that found here.

A surprising finding was that the geomagnetic field alone was associated with changes in the target system. Although past psi research had suggested a relationship between the activity of the geomagnetic field and success in psi tasks, it has been generally assumed that this was an interaction effect. That is, the geomagnetic field was assumed to interfere with the psi agent or with the psi mechanism. However, results from this study suggest that the geomagnetic field may in itself affect the functioning of the REG. This effect was found to be stronger when the applied fields were weaker. As psi is proposed to be due to a very weak field, the geomagnetic effect would be noticeable in studies where measures were directly related to the REG output, though the effect is as likely to be on the target system as on the psi agent.

Moreover, it was suggested that systems with semiconductor properties, which include REGs and biological cells, will be sensitive to electromagnetic fields. As the described study into electromagnetic sensitivity found that humans reacted to the presence of an electromagnetic field by exhibiting a decreased variability of their physiological activity, a finding similar in effect to that reported here, this may offer support to the proposed semiconductor link.

To conclude, this study found an overall effect in which a random event generator showed a significant decrease in the mean variance of events when an electromagnetic field was applied. The direction of the effect appeared to have some relationship with the frequency characteristics of the applied field, although the nature of the relationship remains unclear. No overall change was found in the mean number of events generated under an applied field.

The first aim of this study was to investigate the possibility that the effects seen in psi experiments using REGs based on electronic noise could be due to an electromagnetic mechanism. It is concluded that this is viable. The second aim was to compare the effects of electromagnetic fields on a non-biological semiconductor system to the effects seen on a biological system in an earlier study. The variance of both the semiconductor-based target system's output and the human physiological activity was decreased when a field was present, providing support that the site of electromagnetic interaction with the human body is through the semiconductor properties of cells.

Summary

This chapter has looked at the characteristics of systems which might be capable of generating or receiving a psi signal similar to the type proposed in chapter IV. Both biological and non-biological systems were considered, with an emphasis placed on the properties of systems having neural cells, these being considered to be the systems in which the most complex aspects of psi would be found. It was considered that the psi signal contained information about the ongoing activity of the source system, rather than the classical encoded carrier wave model used in psi research in the past, and that the receiving system reacted to the presence of this system in a purely physical manner, psychological factors being involved only in the interpretation of the signal, not its basic effect.

In an attempt to test the proposed concepts, two studies were conducted utilising electromagnetic fields (thought to be equivalent to a simple psi signal) and looking at the effects of such a signal on a biological and a non-biological system. It was concluded that similar effects were found in both systems, supporting the idea that the semiconductor properties of each system were the sensitive aspects of that system.

VI. Psychophysiological characteristics

The previous chapters have considered general characteristics of psi, and attempted to apply them to a number of different systems, both biological and non-biological. Now we move on to consider those aspects of psi which may be unique to humans [6] but which, within the theoretical framework detailed in this thesis, would be expected to enable better use of psi. If the psi signal does interact with the human system on a physiological level, then it makes sense that the important aspects will be those dealing with the interaction between psychological state and physiological state. That is, what characteristics would make a human better at sensing changes in their physiology, and likewise in *making* changes, the former being necessary to bring about any degree of control in the generation of the psi signal. To make it clear, a distinction is being made between the *detection* of the psi signal - a purely physical process acting on the physiology of the receiver - and the *perception* of that signal detection, which will depend on psychological factors.

It is known that there are many bi-directional pathways between mental states and physiology (Murphy, 1992) - the acknowledgement of such pathways is the basis for the fields of psychneuroimmunology (the study of how mental experiences can affect, and be affected by the immune system), psychoendocrinology (the study of how chemical transmitters in the brain are related to mental experience), psychobiology (the study of the biological basis of mind), and some areas of perception research, which emphasise the effect of psychological factors on sensing processes - so we should find that there are areas of psychology which are concerned with such interactions. Hopefully, a consideration of these areas will offer some hints as to the characteristics which would be useful in selecting psi agents.

Somatic awareness

A starting point would be to look for those people who are better, for whatever reason, at monitoring their own physiological states. One area to

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[6] I realise that much of the discussion in this chapter might apply to some animal species, especially the higher mammals. However, animal psychology tends to be modelled on human concepts, and very little is known about how animal psychophysiological factors might differ from human ones. As such, I decided to concentrate purely on aspects of human functioning for now.

consider is that of body-image, a global construct of perceptions, thoughts and feelings about the body and the experience of the body.

Although this concept does not deal only with physiological states, these will be part of the overall perception. Cash and Pruzinsky (1990) state that "a person's body experience is not limited to the domain of body appearance/aesthetics but includes experiences of bodily sensation, function... and health/illness as well". Fisher (1990) notes that the body image label often subsumes other psychological terms, including sex-role definition and physical symptom perception.

Pennebaker and Brittingham (1982) point out that an important part of the perception of physical symptoms is the amount of *external* information that is available to the individual. All individuals, no matter how a psychological scale may classify them, will tend to increase the degree to which they monitor their internal state if there is a dearth of external stimuli. Any type of physiology based psi would thus be improved if the psi agent was in an environment where external stimuli were reduced to a minimum - exactly what occurs in the Ganzfeld state, which was introduced as part of a general noise reduction approach. In an experimental study, Pennebaker and Brittingham found they could increase somatic awareness simply by making participants spend some time concentrating on their breathing, the sound of which was amplified and played back to them over headphones as they were engaged in mildly strenuous activity. What is interesting is that the participants continued to be more aware of their body's activity for at least a couple of days after the feedback session. This implies that psi agents might be able to be trained to be more aware of their physiological states if they were given feedback related to the particular physiological process of interest before they attempted to use psi. Based on the 'low environmental arousal' idea, the authors also report supportive findings that people who live alone, have few social contacts, or who are dissatisfied with their work also report a greater number of, and a greater variety of, physical symptoms.

They also list three personality variables that appear to relate to this area: private self-consciousness, anxiety levels, and type-A coronary-prone behaviour pattern, Private self-consciousness, similar to introversion, is defined as a cognitive self-examination emphasising internal experiences (Fenigstein et al, 1975). Anxiety levels unsurprisingly show a correlation as many somatic symptoms are taken to be indicators of anxiety (such as 'butterflies in the stomach'). The main problem with this measure is that the reported symptoms are not always accurate - as anxiety

increases, symptoms are as likely to be exaggerated or imagined as they are to actually be experienced ! A type-A behaviour pattern is characterised by competitiveness, a high level of personal driving, and a feeling of the urgency of time. Such people report more physical symptoms than type-B when resting but less when involved in a task, implying that they become highly involved in information processing tasks whether internal *or* external. Type-A people also appear to exhibit a higher level of overall autonomic activity when resting. For the proposed model of psi, we would thus expect people showing high private self-consciousness and some degree of type-A behaviour might have a greater chance of performing well in a psi task.

In general terms, we can view a body image as being an amalgam of different perceptions: social, cognitive, interoceptive and exteroceptive. It is constantly updated in a feedback cycle where the individual redefines who and what they are in terms of their interactions with their environment, analogous to the comparator circuit in cybernetic feed-forward systems. Thus detection of psi processes, receptive or emissive, could be seen as being the differential between the individual's body image and the current perceptual feedback, when there are in fact no other factors to account for that difference.

Another term - interoception - is given to the specific perception of internal physiological state, covering the processing of information from specific sensors in internal organs to the more general kinaesthetic sense of body placement and movement. As interoception uses non-primary sense channels to gain information about the individual's physiological state, we might expect those people who were good at interoception to be better at psi. There aren't any psychological measures which can predict interoceptive ability, but the biofeedback literature necessarily covers this ability, as successful biofeedback is essentially an empirical measure of it. Individuals who are successful in learning to control their own physiological processes through biofeedback would necessarily be those who have superior interoceptive skills. Such a measure is not ideal, as there may be some individuals who are good at the interoception but fail to manage any degree of control. However, it should be possible to use biofeedback to train individuals to recognise their physiological state by alternating feedback with testing sessions. Such individuals who are successful would then be considered potentially superior for a psi task.

Perceptual differences

As the model proposes that psi involves the detection and subsequent processing of an electromagnetic signal, it is essentially a perceptual process, albeit one which is not mediated through the conventional sensory channels. As such, it may be useful to look at some general perceptual measures that are not specifically related to the primary sensory modes.

Mentioned as part of body image, sex-role definition has been studied by Sandra Bem, whose sex-role inventory (Bem, 1974) has become a standard psychological measure. The basic idea is that the individual will tend to characterise themselves as having stereotypical masculine (e.g. is aggressive, is willing to take risks) or feminine (e.g. is affectionate, is sympathetic) qualities based on the way they perceive themselves. This perception will be primarily based on the way the individual sees themselves as behaving, but there is also some indication that it reflects more fundamental cognitive differences. Hamilton (1995) found that self-perceived gender definition predicted visuo-spatial ability, something normally considered to have biological, sex related differences. Psi has traditionally been viewed as being more common in females. Although this could be due to reporting biases, perhaps a measure that classifies people as female-type perceivers would be a useful one.

Another wide ranging, though currently out of fashion, construct is that of field dependence (also called psychological differentiation). Defined simply as "the ease with which a person can see a given figure independently of the context in which it is presented", field independent people have "the capacity to overcome, or analyse, an embedding context in perceptual functioning" (Witkin et al, 1954). This construct has been shown to correlate with many other measures, ranging from locus of control to face recognition (Pizzamiglio and Zoccolotti, 1986) and represents a useful global construct that may be of use to psi research, covering as it does both cognitive and physiological aspects. The field independent-dependent dimension does not extend to all perceptual and cognitive situations, but is thought to manifest specifically when the task involves breaking an existing organisational structure and regrouping several of the components into a new structure. As such, it will also correlate with some of the rigidity and ambiguity tolerance measures used in belief research. As psi is proposed to require the perception of specific internal physiological states but with that perception taken out of context to see how it has been modified from normal functioning (i.e. the psi agent must not only perceive their physiological state, they must compare this to a memory of the

'normal' parameters of activity, and maybe then also compare this perception with other external perceptions of the feedback in a psi task), the ability to extract the 'figure' of interest (the modified or perturbed activity) from the 'ground' of noise (normal, unperturbed activity) might seem to be a useful skill for a psi agent to possess. There are also indications (Gackenbach, 1992) that field-independent individuals show a greater degree of global EEG coherence, a trait which may be useful in cases of emissive psi, as will be discussed later.

However, there are also problems with being field independent from a psi point of view. Tying in with the earlier mention of body image, field independent people show a more articulated body image, with a greater definition of their body's limits. This means that they have a clearer picture of how their body *should* be, so they could act to suppress any externally originated modifications. They also tend to have more specialised control and defence mechanisms, which could interfere with their interpretation of any information gained. On a purely physiological level, Hustmyer and Karnes (1964) found that the variability of the autonomic system, as measured by electrodermal activity while the person was at rest, was higher for field dependent people (also found in the electromagnetic sensing study detailed in the previous chapter). Hustmyer and Karnes related this variability to the idea of lability (also discussed in the last chapter), stating that field dependent people had more labile physiologies and so would be more responsive to any type of stimuli, internal or external, which would also include the proposed psi signal. Moreover, Bertini (1986) reported that field dependent people showed a greater proportion of sleep-like ideation, especially bizarre imagery, during the waking state, as well as a greater intrusion of wakefulness into sleep, than did field independent people. Recalling the comparison of Reinsel et al's (1992) formulation of bizarreness in dreams as being due to fluctuations in the states of physiological (specifically, neural physiology) arousal, we would expect field dependent people to show a greater number of fluctuations. As psi is proposed as being operative through such modulations, we might expect field dependence to predict a greater incidence of receptive psi under relaxed conditions.

Due to the different properties described above, the field dependence construct by itself would not be a good predictor of overall psi success, but it seems likely that it could be useful when coupled with other measures, or in very specific situations. Even so, a general prediction would be that field independent people would tend to be better at making use of a psi signal if they detected one, whereas field dependent people would be better at responding on a purely physiological level

to the signal, but might be worse at interpreting the signal information. Based on the typical psi experiment, field independent people should then show a slight superiority for success. For DMILS protocol experiments, where physiological measures are the psi measures, field dependent people should show a higher degree of success. The only exception might be for precognition-DMILS experiments, where the lability issue will be less important due to the psi signal evoking specific responses in the receiving system (which would be identical to the emitting system).

Controlling emissive psi

We now turn to the psychophysiological factors which might enable a psi agent to be the source of a psi signal, whether this is an intentional act or otherwise. We will first consider the case of an unregulated psi emitter, then the interactive case that is thought would have to be involved in any instance of controlled psi.

UNREGULATED PSI

The psi signal is proposed to be generated by normal physiological activity on a cellular level (or the equivalent level in a non-biological system). As such, we, and all electrodynamic systems, are constantly emitting information on this psi level. For humans, most of the time this signal will be incredibly complex and constantly varying, reflecting the ever changing activity of the brain and associated systems in action, and will have a seemingly random (and in most cases, negligible) effect on the emitter's surroundings. As such, the mental experience of the emitter would not differ from their everyday waking state experience. Only if there came about some degree of coherent activity, organised on a global scale, might the effects of the signal become independently noticeable, as such conditions would be expected to give a simpler but more identifiable signal (consider the difference in ease of recognising amid background noise a single weak but pure tone to that of the complex signal of someone whispering). In such cases, the emitter would be experiencing a more unified mental state, as is thought to be characteristic of meditative states and REM dreaming (e.g. Gackenbach, 1992), and possibly some

intense emotional states such as extreme anxiety (e.g. Pennebaker and Brittingham, 1982).

The most common forms of meditation involve some type of simple, repetitive activity, This can be the visualisation or study of a visual shape (like the religious mandalas), the repeated utterance of a certain sound (a mantra or prayer), the holding of a specific posture (as in yoga) or breathing exercises. Some practitioners may combine two or more forms, as with the Sufi dancers or the Zen breathing mantras (e.g. see Parker 1975 for a review of meditative practises and their possible links to psi). The common point is that all of these techniques produce what has been termed a 'hypometabolic' state - a decrease in the level of activity of a number of physiological responses: blood pressure, sweat gland activity, respiration rate, EEG frequencies, levels of lactate acid in the blood, and measures of body metabolism (Schwartz, 1975). The decreases found often exceed those found even in deep sleep. The overall effect is to reduce spontaneous activity in the system (lower the level of noise if you like) while increasing the level of coherence (unified activity on a global scale). Schwartz describes this as representing heightened cortical arousability but lowered limbic arousability, which would be experienced as an increase in perceptual awareness with a corresponding decrease in emotional arousal and stress. If we are looking at ways of controlling emissive psi, which would require the emission of a specific structured signal, generated by a particular pattern of physiological activity, then a calm, baseline state would surely be a good first step. We would thus expect individuals who practised some form of meditation to be better at emissive psi.

Obviously, once a baseline state has been achieved, the required pattern of activity still needs to be generated. Unfortunately, it is not known what measures would be correlated with the ability to do this. Possibly some degree of absorption would indicate an immersion in a specific activity, although there does not seem to be any literature supporting a link between a unified state and absorption scales. In the absence of any indicators, we will next turn to a different situation where, although there is not so much coherence, there is a good deal of strong activity - a state of high emotion.

Andreassi (1989) characterises the EEG of strong, excited emotions such as fear or extreme anxiety showing waves of higher amplitude than the normal waking state, with fast, mixed frequencies. The overall level of physiological arousal increases. Some researchers (e.g. Fair, 1988) suggest that the strongest emotional 'fight or flight' responses to times of extreme stress may act to overrule the higher

level cortical functions. In such situations, the brainstem floods the forebrain with massive electrical and neurochemical inputs, causing instinctive responses. The duration of this 'override' system is relatively short, but it acts on a level which, for reasons of speed of response, do not rely on the usual information processing pathways. As the emergency response is very strong and propagates throughout the brain, it seems conceivable that the associated emitted pattern of electromagnetic activity (which is proposed to generate the psi signal) would trigger a similar, though possibly weaker response in receptive systems that have the same hardwired response system. At the very least, a strong burst of activity should be enough to evoke a general psi response in any receptive systems, characterised by a change in arousal levels. If this is indeed the case, then we should also find that psi responses will be found in other cases of strong bursts of activity, which could be evoked under laboratory conditions by the use of surprising or startling stimuli to participants. An example might be a sudden loud noise at random intervals. Alternately, the signal might be amplified if a number of emissive systems (e.g. a group of people) were each stimulated simultaneously to give a burst of synchronised activity. The recent interest in REG output correlations to times of 'group coherent activity' might be showing just such a phenomenon. In these experiments (e.g. see Nelson et al, 1996) the output of events from a REG often shows shifts from theoretical baseline values in the same time period that a group, often unaware of the existence of the REG, experiences some form of cohesive behaviour. Examples of cohesive behaviour are meditation, reaching agreement in a debate, religious ritual and generic times of shared attention, as in when collectively watching a presentation. The point is that all these examples have as a common feature the existence of some sort of external synchronising signal given to the people involved, coupled with specific psychological states. Even on a very gross level, if ten people all react simultaneously to a shared event, there will be a short period of time when their physiologies will undergo a similar burst of activity, resulting in a sustained period of emission of an energetic signal. While this group signal will not necessarily be particularly coherent due to interference effects based on group separation and phase differences, it will represent the epicentre of turbulent activity. Imagine dropping a handful of small pebbles into a pond - the resulting waves will be messy but clearly distinguishable from the existing waves in the pond.

These ideas also fit in well with the anecdotal literature, which tends to suggest an association between an altered state of consciousness and psychic

phenomena and with times of extreme emotional or psychological stress, such as crisis telepathy or death-bed apparitions. For the former, one good example is that meditation adepts instruct their students to ignore the manifestations of ESP that they will find occur in intermediary stages of meditation as mere distractions. LeShan (1974) quotes a typical response from master to student who has experienced an unusual perception: "If you concentrate on your breathing, it will go away!". Perhaps this can be taken as an indication that the adepts recognise the misleading nature of unregulated psi. At the very least, it suggests that meditation practitioners acknowledge that the meditative state does increase sensitivity to psi-like perceptions.

Obviously there will also be other factors at work when psi manifests successfully - belief in certain states as being conducive to psi experiences and an intense need for something to occur are both powerful motivational factors that may enable the agent to use resources that they may not normally have access to - but the fact that reports of psi in the 'real' world are often associated with global, more coherent brain states would tend to lend support to this model's interpretation of how psi works.

REGULATED PSI

The utilisation of controlled, or at least regulated, psi is a more complex process under this model. To usefully utilise psi, the agent must involve themselves in a feedback loop of interactions between their own bodies and the system which they wish to exchange information with. That is, they must learn to associate the information that is gained from the detection of a psi signal with information from one or more sensory channels. In the case of influence of the target system, they must also learn to emit a similar signal to that which was originally emitted from the target system (all possible target systems being considered to emit a psi signal - see the section on emissive psi in chapter V for details). The experience of this process will be considered in depth in the next chapter. Here we will consider the psychophysiological factors which would make this process possible.

As with unregulated psi, a coherent meditative state is still likely to be of use in a case of regulated psi as it would cut down on the irrelevant activity which would interfere with the desired signal. However, we need to ask to what extent an individual can have conscious control of their own physiological functioning.

Schwartz (1975) asks whether cognitive processes could elicit or mediate some form of patterned physiological change. The advent of behaviourism led to the

idea that cognition was merely an epiphenomenon of underlying physiological activity, which made the question of mental control of somatic processes nonsensical. Current thought often maintains the implicit idea that cognition is reducible to physiology, but allows that the experience is often one in which mind appears to affect body. Whether mind is ultimately reducible to the physiological processes which underlie it, or whether it is a higher level emergent property is not strictly speaking important for this thesis - even if mind is reducible, the psychophysiological measures of interest will necessarily have this factor inherent in them (just because the explanation may be incorrect does not necessarily invalidate the prediction of a model). All that is of interest here is that the direction of action appears to be one of mind affecting body. Research into biofeedback has shown that trained participants can indeed show such an effect, often producing quite complex and specific physiological activity patterns, ranging from changing the temperature of a single finger, to producing differential firing patterns in the brain hemispheres (Schwartz, 1975)

Brown (1975) also discusses the effects of cognitive activity on physiological activity as part of an overall topic of 'biological awareness', citing examples where deeply hypnotised subjects appear capable of suppressing blood flow from surgical incisions, or control of heart rate by operant conditioning in animals. One study in monkeys found they were able, through a combination of conditioning and biofeedback processes, learn to control the activity of *single* cortical cells relating to muscular activity.

In a feedback based psi task then, it does not seem implausible to suggest that a psi agent may be able to learn to regulate their physiological activity based on feedback relating to the effects the emissions accompanying that activity have on a susceptible target system. What degree of control could be achieved would depend on the degree of susceptibility of the target system, the control the individual had over their own physiology, and the type of feedback used. As much of the feedback used in PK protocol experiments has been of a binary type, relating only to the final state of the target system rather than more specific characteristics of how the system is varying, perhaps it is not surprising we have such small effect sizes.

Controlling receptive psi

Overall Arousal

At the simplest level of interaction, we can consider the effect merely of the presence of a signal that acts non-specifically to increase the level of activity in the receiving system. Such activity in a living organism, it is assumed, could be interpreted as being an increase in the level of arousal of that organism's physiology, but one which was not associated with a causal sensory stimulus. Instead, it is thought (compare with the EMF study reasoning) that such arousal would result in a free floating sense of 'significance'. As organisms are biased towards matching internal stimuli with external events, the psi agent would then associate some other event or perception of, their environment with this sense of significance as though that event or perception were the causal factor. The choice of the event or perception would be governed primarily by timing - what was occurring in the environment at the time of the psi induced feeling of significance - and to some extent by preconceived beliefs and expectation on the part of the psi agent, who may be actively looking for evidence which would correspond to their notion of what would constitute a significant event in that place.

For example, if the psi agent were in a location known to be, or merely suggestive of being, a haunted house, they might be looking for evidence to support this idea. If, either by interaction with another organism, or through the effects of environmental fields acting in the same manner as a biologically created psi signal (e.g. a patterned electromagnetic field), the feeling of significance was induced, such as person might be more inclined to notice a shadow, or a sound, or to imagine a personality that they thick would be associated with the characteristics of that place. This perception would then be given the 'significant' label, providing subjective evidence that the location was indeed haunted. A sceptic in the same location, on the other hand, would (assuming for the moment that there is no inherent difference in sensitivity between sceptics and advocates) apply the significant label to perceptions which would be indicative of a sceptical interpretation - the squeaky floorboard or creaking door - once again providing subjective evidence for a preconceived belief. Both people would be correct in parts of their interpretation: the advocate in that they were detecting an objective phenomenon, the sceptic in that there was nothing 'supernatural' about the location.

Another example would be a psi based extension of the cold-reading technique. The psychic would start out by giving their client some general information, gradually becoming more specific as they noted their clients subtle reactions to part of that information. However, the client themselves would also be emitting psi signals containing basic information about physiological responses to the psychic's reading, which may give additional cues to the psychic about which areas are significant to their client even in the absence of the visible somatic responses normally used in cold reading. The psi signal may only act to heighten the arousal levels of the psychic, but this may be enough to give the non-specific 'significance' feeling to be attached to the current part of the reading.

So what characteristics of the psi receiver would be useful for enhancing this process? As before, it seems likely that a stable baseline state would make it easier for the receiver to notice the change in arousal levels. If the receiver were physically relaxed, there would be less interference from somatic sources and they would be more likely to notice externally induced alterations. This could be achieved by making use of progressive relaxation exercises, such as are currently used in many psi experiments (see Dalton, 1994 for an example). However, there would also be a need for a mental activity baseline. As described earlier, meditative practises may serve to provide a more unified state of mental activity, as well as bringing about a state of physiological relaxation, so practitioners of this may well be better able to calm themselves sufficiently to improve their chances of perceiving a detected signal. Even so, there may be a problem with simply assuming that meditators will automatically be better at using psi ability. The meditative technique often involves an attempt to ignore thought processes other than the particular process which is the focus point (e.g. the pronunciation of the mantra, or the perception of the mandala). Thus, although the meditation induced state will be a more sensitive state for detection of the signal, it is unlikely that it will be better for the perception of that signal, as the meditator will be attempting to ignore that perception. This ignoring may even act to suppress the modification as the meditator tries to return his system to the desired baseline state. The meditative technique may then be used as an initial preparation to increase psi sensitivity, but the continuation of the process may actually block psi. A related point of interest would be that any mental technique like meditation which attempts to bring about a controlled physiological state may be useful as a way of preventing sensitivity to psi - a topic which has recently shown an increase in interest, possibly due to the increased awareness of possible psi influence effects on human physiology and a

desire to find ways of blocking this (Watt et al, 1997). An exception might be those meditative techniques which involve a passive observation of thought processes rather than an attempt to stabilise them. One example would be the 'meditation of the bubble' or the Tibetan 'thoughts are logs' discipline, both of which involve viewing thoughts that occur during meditation as passing, transient objects to be acknowledged and then released without further associated thought (LeShan, 1974). Such an approach would be ideal for psi as it is envisaged, coupling a quietened mental and physiological state with a passive self-observation of mental processes.

In non-meditator participants, a useful predictor of success in purely arousal tasks would be field dependence, which was associated with a greater physiological lability and therefore increased sensitivity to external perturbations. Field independence has also been found to indicate a greater degree of EEG coherence, a greater ability for concept learning, higher creativity, and better visuo-spatial performance in females (Pizzamiglio and Zoccolotti, 1986). Interestingly, field independence has been found to decrease with age, is higher in females than males and is higher in paranoid schizophrenics than in a 'normal' population. That females and children are, on average, reportedly more believing of, and have more experiences of, psi, and that paranoid schizophrenics often report that they are being influenced or affected by other people (for a summary, see Nash, 1966) , may conceivably support the idea that field independent people experience a greater degree of psi, and related phenomena.

SPECIFIC INFORMATION

Now a simple change in arousal might be enough to show an interaction effect indicative of psi, and may have limited use in an evolutionary sense if it gave the organism a hint that there was something in its environment which may pose a threat, but the proposed model, and years of psi studies, imply that psi may be used to provide higher level, more specific information. What characteristics in humans would enable this information to be perceived and made use of? To gain a better understanding of this, it may be worthwhile going back to the basic concept of perception and how the psi signal might affect it.

Considering the effect that the proposed direct stimulation of *neuronal* activity might have on the percipient's experience, it was suggested in chapter V. that the psi percipient would experience distortions of pre-existing neuronal processes. On an experiential level, these would show as distortions to ongoing

perceptions or cognitive functions. On a physiological level, this could operate as priming or interference effect, making the percipient more likely or better able to react to specific sensory stimuli, possibly showing as an increased reaction time or a recognition response (this latter idea being tested experimentally, detailed at the end of this chapter).

In cases of perceptual distortion, for this to be noticeable, the psi signal would have to be perturbing a fairly weak original perception - if the sensory stimuli creating this perception were too strong, the percipient's system might reach an upper threshold (ceiling effect). Alternatively, if the psi signal were strong enough, or the receiving system sensitive enough, then there may even be the creation of novel perceptions or sensations. Whichever of the two occur, it seemed reasonable to assume that the governing factors that enable the effect of the psi signal to move on from being merely detected to being perceived will be based, at least in part, in the abilities of the percipient to self-monitor their own internal processes, be they physiological or psychological. To better conceptualise what this involves, we will return to the systems approach of chapter II.

It has been suggested by some systems theorists (e.g. Katakis, 1990) that, to adequately deal with any given situation, an organism must achieve a balance between internal and external complexity. For a human, this means that the individual's cognitive models of the environment and the communication of information between them must be sufficiently complex to process the amount of information received from the environment. To achieve this balance, the individual has two options: either increase internal complexity or cut down on the amount of environmental information. While the former option is possible, it is probably more economical to do the latter; the level at which internal complexity is frozen in favour of a filtering of external information will determine certain characteristics of that individual.

Now, any case of perception, sensation or even simple detection (conventional or psi), can be conceptualised as the transferral of information (patterned energy) across some defined boundary between the external (environment) and internal (brain/mind) systems. In terms of the model under consideration, the information is the coming to awareness of the psi signal, and the boundary is between the psi agent's physiology and their psychology. From the viewpoint of the perceiving system, it is proposed that the least number of factors involved in this information transfer is three:

Factor one represents how much information-energy can pass through the channels per unit time (i.e. how wide are the gaps). Labelled *external-internal information flow,* this assumes that there is a certain limit to the amount of information a human can make sense of in any given situation, this limit varying from individual to individual. There must ultimately be a physical limit to the absolute amount of energy that can be received through an information channel (the detection limit), but there will also be a perceptual 'processing' limit. Whether the latter is innate or learnt (and thus open to change) is not clear. This leads to the conclusion that the individual, within their own specific limits, could either perceive detailed (high-resolution) information about a well defined area of the environment, or they could get more general (low-resolution) information about a much wider area. Obviously, there would be a range in between these two extremes, representing different balances of detail and scope within the available information limit. It seems likely that this would be related to attention.

This factor also deals with the ability of that individual to assimilate the information into an internal pattern of elements and their interrelationships. This ability would enable the individual to concentrate on the important factors governing a situation, ignoring irrelevancies, and see how they influence one another (a priming effect?). It seems likely that this factor would be more related to cognitive rather than perceptual processes, possibly linked to how efficiently the individual organises their memory of the event. This factor may be of primary importance in deciding how stereotype-prone the individual is: the fewer pattern elements/interrelationships that the individual could handle, the more likely they would be to utilise stereotypes (which are cognitively far more efficient than more complex models allowing for individual differences).

Factor two is taken to be the number of discrete channels of information (i.e. 'gaps' in the boundary). Many channels mean a large amount of information, each channel able to contribute to the overall percept. In real terms, these channels will have both physical (relevant sensory transduction mechanisms) and psychological (perceptual biases, cognitive capacity, etc.) parameters. The label *perceptual mode* will be used for this factor, even though there will be both sensation and perception involved.

The number of physical channels (through the Environment-Physiology boundary in figure IIb.) will be based on the available signal transducers, which will in turn depend on the form of energy that contains the relevant information e.g.

sound information may be transduced by the auditory channel, or by dermal pressure sensors, whereas the psi signal is proposed as being transduced via cell membranes. The number of psychological channels (through the Physiological-Psychological boundary in figure IIb.) will depend on the degree of perceptual filtering. This relates to the degree to which the individual actively scans their environment for confirmatory or expected stimuli, rather than passively accepting all input. Disconfirmatory stimuli would either be neglected, possibly even unconsciously, or it's importance de-emphasised through a process such as cognitive dissonance (e.g. see Gross, 1992). The extremes would be a highly specific perceptual mode, where the individual is far more likely to perceive according to their expectations, literally not perceiving information which does not fit into a pre-selected template, to a more global mode, where the information is perceived first and analysis carried out later.

Factor three considers what structure is imposed on the information-energy inside the system and how rigid that structure is. Labelled *internal complexity,* this factor refers to the individual's ability to synthesise information into a coherent framework. The higher the complexity, the more detailed will be that individual's models of aspects of their environment; the greater the interrelationships between models, the more unified will be that individual's model of their environment as a whole and the more able they will be to transfer skills and concepts from one situation to another. This factor will be reflected in psychological concepts such as learning style and absorption. It is thought that this factor could also be represented by the individual's use of analogy or metaphor (including symbolism). As it is concerned with the synthesis of information, it must also deal with temporal as well as spatial information, and so will have some relationship with memory.

Taking the extremes of each factor - low to high information flow, specific to global perceptual mode, and low to high internal complexity - we obtain a possible eight different perceptual types (see figure VIa. - the diagrams have only one boundary here as they can reflect either conventional sensory channels between psychology and environment, or the psi channels which require information transfer between physiology and psychology). The possible types are thus:

Type 1: Low Information flow, Specific Perceptual Mode, Low Internal Complexity
Type 2: Low Information flow, Specific Perceptual Mode, High Internal Complexity
Type 3: Low Information flow, Global Perceptual Mode, Low Internal Complexity

Type 4: Low Information flow, Global Perceptual Mode, High Internal Complexity

Type 5: High Information flow, Specific Perceptual Mode, Low Internal Complexity

Type 6: High Information flow, Specific Perceptual Mode, High Internal Complexity

Type 7: High Information flow, Global Perceptual Mode, Low Internal Complexity

Type 8: High Information flow, Global Perceptual Mode, High Internal Complexity

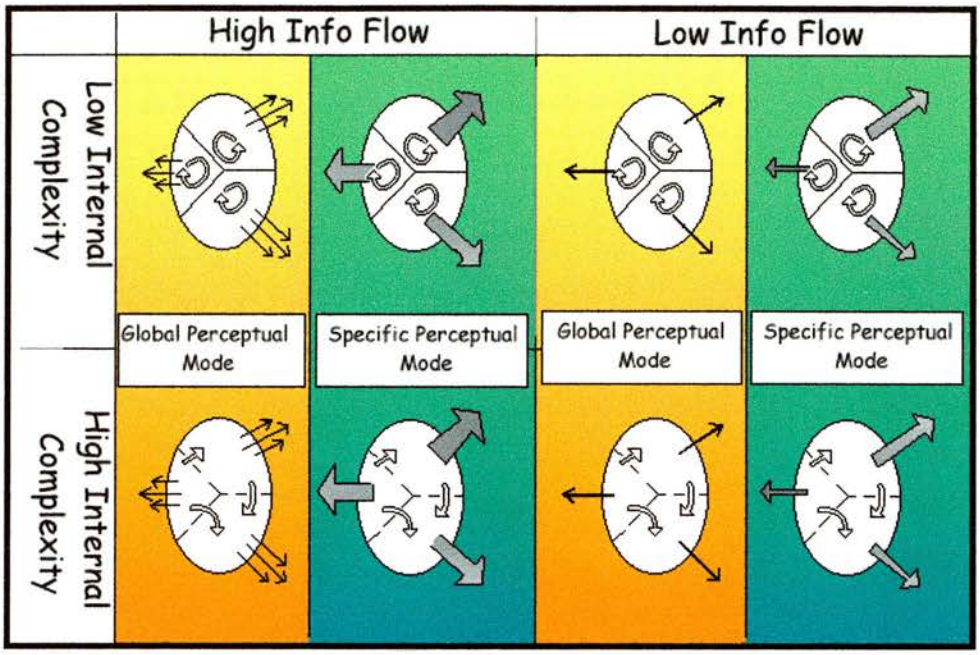

Figure VIa: Perceptual Types

To better visualise these, they can be plotted on a three-dimensional graph using (Information Flow) x (Perceptual Mode) x (Degree of internal complexity) as the x, y, and z axes, as shown in figure VIb. Although the factors are arbitrary and based purely on one way of conceptualising a generalised perceptual procedure, and it is not yet known how, or even if, they may be measured directly, it is hoped it may be a useful way of thinking about existing psychometric scales when attempting to predict which people will be successful in a psi task.

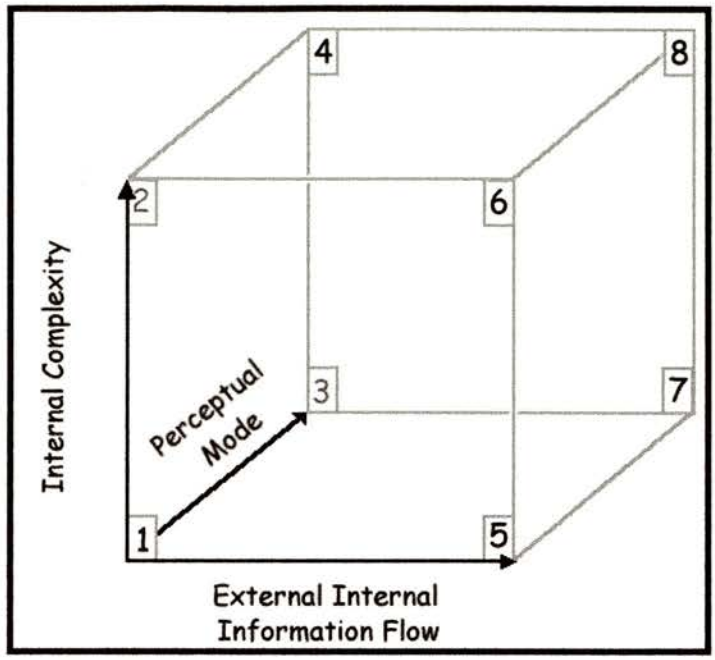

Figure VIb. Location of perceptual types on graph representation of the three factors of perception

Factor one, the external-internal information flow, would again relate to both physical and psychological measures of information processing rates. For example, in conventional perception, the rate of information transfer for sight is far higher than that for touch, for a variety of reasons including the density of transduction organs and neural connections, the way in which information is encoded in the relevant signal, and the way in which the human brain deals with the information. For psi perception, there will be constraints based on the type of information we are trying to transfer depending on the structure of the signal, but the fundamental type of channel is proposed to be a cellular level one. The important aspect of the rate of information transfer will thus relate to the level of introspection that the psi agent undergoes. This factor will then be related to measures such as absorption (Tellegen, 1992), which would relate to the amount of noise in the available channels, and also to other measures, probably best measured empirically, showing rates of information processing. Examples might be reaction time and simple problem solving ability.

Factor two, the perceptual mode, would relate to physical abilities and the cognitive factors which govern them, of the percipient (determined empirically) in the case of the number of discrete sensory channels, but will be related to physiological and associated measures for psi channels. Useful scales for psi success predictions might include: Private Self-consciousness (Fenigstein et al, 1975) which could be seen as self monitoring of a number of different internal and external channels; physiological lability, which would determine the extent to which the psi signal could provide information (the resolution of the signal); and field independence (Bertini et al, 1986), as the ability to separate information from its

embedding context would presumably increase if that information were already broken down in to discrete channels rather than in a global perception. Essentially this factor would relate to the conventional psychology classifications of an analytic perceiver versus a holistic perceiver, but also with the physical constraints of the perceiving system taken into consideration.

Factor three, the degree of internal complexity, would relate to the synthesis of different mode information and to measures of cognitive organisation. Examples might include: learning style, such as use of an adaptive versus a fixed strategy; perceptual and psychological measures of synaesthesia (Cytowic, 1994; Tellegen, 1992), which might indicate an ability to synthesise information across different sensory channels; Ambiguity Tolerance, defined as a willingness to accept a state of affairs capable of alternate interpretations, or of alternate outcomes (MacDonald, 1970), which would indicate a good ability to manipulate information once gained; again, field independence, which ability would presumably increase if the perceived information could be broken down into its component parts and selectively reassembled into a new format at will; and use of stereotypes, as these represent cognitive 'shortcuts' which may indicate a need to classify information into rigid categories to ease processing loads (Gross, 1992).

Using this approach, we may predict that a good psi agent would be of perceptual types 2, 4, 6 or 8, these having the best information processing capabilities. Types 4 and 8 would, having a global perceiving style, be better at general deduction of psi information in a spontaneous, general arousal situation, merely noting any psi-induced modifications to their physiologies. Types 2 and 6, being better able to narrow down their focus to within specified constraints, would be better in a feedback learning situation. Taking the psychological scales mentioned above, we can thus predict that an ideal DMILS participant would be one with a labile physiology, high in Private Self-Consciousness, and field independent. A good telepathy participant would also have a labile physiology, but would be low in Private Self-Consciousness, field dependent, high in absorption, would benefit from using an adaptive learning strategy, and would show good problem solving ability.

Comparing these predictions to the electromagnetic sensing study (which, it is suggested, would utilise similar perceptual abilities to those used in telepathy), the successful (based on physiological responses to the field) participants were indeed field dependent, and used an adaptive strategy to successfully solve simple

problems. Though non-significant, there were also indications that absorption and ambiguity tolerance were also higher.

To test the idea of a physiological response to a psi signal containing information about the physiological activity of the source system, and to relate this to some related psychoperceptual measures, an experiment was conducted.

Experiment: Techno-Dowsing

Assuming psi to be the result of an actual patterned signal related to physiological functioning, a DMILS scenario was used with the idea that the target system might conceivably react to this signal as though it were an internally generated signal. As this situation is thought to be most likely when the target system and the signal generation system were one and the same, the protocol was modified to involve a precognitive element. Essentially, precognition is being treated as though it were a case of telepathy. The only difference is that the sender is the receiver at some future time.

If the psi signals originate in the brain, then the best approach would be to have each of the target stimuli cause as discrete a pattern of brain activity as possible. To describe such discrete patterns, neuropsychology uses the idea of an *engram* - the neural representation of a given idea, as represented by specific patterns of stimulated neurons or neuron groups in the higher centres of progressive processing. Once encoded, engrams are thought to be represented redundantly throughout the entire brain, although the actual structure of a specific engram will be unique. It has been suggested (Kissin, 1986) that there are three different classes of engrams:

Veridical - which represent the direct perception of sensory data

Iconic - which represent formalised abstractions of the veridical engram (e.g. a line drawing)

Symbolic - an engram which encompasses a whole class of veridical engrams, with an associative structure (including language).

The first type would be location and sensory mode specific, the last two would become more global, involving networks of veridical engrams. As each engram is associated with a specific pattern of electrical (amongst other types) activity in the brain, this seems a good way of classifying signal structure. If the engram structure can be represented externally as a patterned signal, then this

signal may be able to excite the brain it interacts with, reproducing a similar (if degraded) pattern of activity as that which produced it. Now, neurons have the peculiar property of becoming more sensitive to a stimulus if that stimulus is maintained (Greenfield, 1995). This occurs when stimulus presentation causes a search of engrams in memory, priming the neurons associated with each stored engram If an engram is found that matches the preperceptual input, the neuronal activity underlying that engram is enhanced (Kissen, 1986). If the reception of a psi signal also served to prime engram-associated neurons in the receiver's brain, then this could give a weak recognition response. If this is the case, the psi information would be experienced as a (probably degraded) perceptual experience. It may also be more likely to occur in conditions of sensory deprivation (e.g. ganzfeld, meditation, day dreaming) where the brain is looking for input. Psi-signal detection might also be influenced by expectation and mental set.

Minimising internal sources of interference

- *Remove expectation and set bias.* If recognition is influenced by expectation and set, then these could interfere with the detection of a weak psi signal. By taking physiological measures rather than conscious responses, it was hoped that such cognitive biases would be circumvented. Furthermore, any information that could allow the participant to guess the experimental rationale was minimised. Participants were aware that the laboratory conducted parapsychological research, but were not initially told the nature of the experiment.
- *Reduction of somatic noise.* If participants are thought to be detecting weak energetic signals through modification of somatic processes, then reducing the amount of activity in the somatic systems should act to increase the signal to noise ratio. Fortunately, participants are required to stay as still as possible during physiological recording, providing a feasible explanation for a relaxed state.

Varying the originating engram structure (the precognitive target stimulus)

If an energetic signal does underlie psi perception, then the best results would be expected from a strong signal. Such signals, in this experiment, would have to be seen as being generated by the brain physiology of the participant at a future time, and then propagating through time to interact with the present time receiver's brain. This represents a case of true precognition i.e. one where there is an interaction between two systems in a temporal direction which is reversed with

respect to our normal experience of time. If the signal originates through physiological activity of the source brain, then any target stimulus that gave large-scale, clear physiological responses would generate the strongest signals. Variables were therefore chosen to give the most discrete engrams in response to presentation of the target stimulus. These variables were *Engram class* (Veridical, Iconic or Symbolic as discussed above), *Emotional valence* (positive, neutral or negative), and *Face bias* (face present versus not present).

Emotional Valence was chosen as the affective qualities of a percept are thought (Davidson, 1983) to give hemispheric asymmetries in activity, with positive emotions giving more left hemisphere activity from the frontal lobes, negative emotions giving more right hemisphere activity in the frontal lobes, and neutral emotions showing no significant hemispherical differentiation. *Face Bias* was chosen as humans have a strong cognitive bias for efficient processing of faces (Purcell & Stewart, 1986). Classifying the stimuli in terms of having faces or not having faces should then give strong differences in neural activity. The images which were used as target pool pictures were thus classified in the (3 x 3 x 2) grid shown in figure VIc.

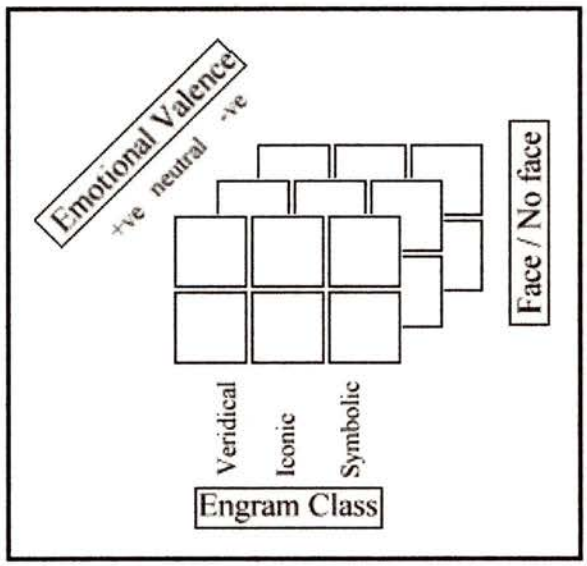

Figure VIc: target pool classification scheme

Identifying a response

To see if the participant is detecting a psi signal, we must first find out how the physiology of the signal source reacts when a recognisable perception is encountered. These reactions could then be used to create a template of recognition responses. It was decided that the physiological response patterns needed would be a conscious recognition response, a vague (or weak) recognition response (V) and a null-recognition response (N). By presenting the participants with a series of images, each one chosen to evoke one of these three basic responses, the patterns of physiological activity for each basic response could be found.

That same participant could then be shown further images, each chosen to evoke one of the engram combinations (the boxes in the figure VIc. grid). If their physiological responses were again recorded, it should be possible to determine which images give the strongest or the most consistent response. The common engrams associated with such images would then be the ones chosen as being significant to the participant. If it is assumed that this significance were due to psi-signal induced priming effect, a prediction could be made as to the precognitive target.

Psychological Measures

Two psychological measures thought to relate to perceptual style were used - the shortened version of the Embedded Figures Test (Witkin et al, 1954), and the Bem Sex-Role Inventory (Bem, 1974). The former measures the individual's ability to perceive a stimulus independently of the context within which it is presented, called *field independence.* The latter measures self-perceived gender trait possession. Although past studies have found sex differences in different areas of perceptual ability (e.g. males are traditionally better at spatial tasks, females at verbal ones), it had been noted that there was also considerable variation within, and a considerable overlap in distribution between, sexes, suggesting a psychological as well as a biological difference. Studies (e.g. Hamilton, 1995) have found that there is an association between psychological androgyny (defined by Bem as being the difference between a person's self-perceived masculine and feminine score, normalised with respect to the standard deviations of their masculine and feminine scores) and perceptual ability. As this study is postulating an emotion-inducing signal, it was decided that those participants exhibiting female sex-typing would be more successful in detecting the stimulus (i.e. would show a stronger or more consistent physiological response).

METHOD

Apparatus: Physiological Recording

Physiological data was recorded using the I-410 physiological monitoring system (Physiological Data Systems, USA). This is a system which interfaces with a standard IBM compatible personal computer, and is essentially an analogue-to-digital signal converter. It has several channels for data acquisition, allowing different combinations of physiological measurements through the use of plug in modular sensors and electrodes. The system opto-isolates the participant from the main's supply for safety reasons. For this study, the measures taken were:

PPG - a measure of peripheral blood flow, dependent on blood pressure and heart rate.

EDA - Electrodermal activity, based on the skin conductance response.

BL/BR, AL/AR, TL/TR - Electroencephalographic (EEG) activity for frontal lobe left and right hemispheres, for Beta (15-30 Hz), Alpha (8-14 Hz) and Theta (4-7 Hz) frequency bands.

PPG was measured using a photoplethysmograph attached to the ring finger of the non-dominant hand. EDA was measured using an electrode attached to the index finger of the non-dominant hand. EEG measures were taken by monopolar recording, with two scalp electrodes at positions F3 and F4 (International 10-20 Electrode System - see Stern et al, 1980) and a reference lead attached to the surface of the mastoid process behind the left ear. All electrodes were silver/silver-chloride, and the sites were cleaned and prepared with a commercial skin abrading solution prior to electrode application. The controlling software performed a real-time fast Fourier transform on the EEG data to calculate the relative strengths of the three frequency bands used before saving to hard disk.

Apparatus: Response Calibration Images

These were the images that would be used to obtain physiological responses for the recognition template construction. Two images were chosen for each engram class (refer back to figure VIc). It was hoped this would give representative overall response patterns. Images chosen to evoke a conscious recognition response were:

A photograph of the laboratory building (Veridical)
The Experimenter (Veridical)
Drawing of computer (Iconic)
Drawing of a car (Iconic)
The name of the participant (Symbolic)
A map of the USA (Symbolic)

Images to evoke a null-recognition response were:

A photograph of an Edinburgh building (Veridical)
An unknown person (Veridical)
Drawing of a mechanical component (Iconic)
A strange-looking plant (Iconic)

A fictional nonsense name (Symbolic)

A map of Venus (Symbolic)

The last category was the most difficult as the images had to be recognisable yet not something that would be immediately obvious as being known. In the end, it was decided to use images that related to things that the participants would be unlikely to have had personal experience of. Images for a vague recognition response were thus:

Photograph of a pyramid (Veridical)

Photograph of a lesser film star (Veridical)

Drawing of platypus (Iconic)

Drawing of satellite (Iconic)

The word 'Human' (Symbolic)

A map of New Zealand (Symbolic)

Apparatus: Images relating to the precognitive target

These were the images that would be used to obtain physiological responses for the precognitive target prediction. These images, in their pre-randomised order of presentation were:

1) Woman: a photograph of an emotionless woman.
2) Buddha: a stylised statue of the Buddha.
3) Dali-Vis: Dali's 'Visage of War'. Skulls within skulls and death motif.
4) Onedollar: a reproduction of a US one-dollar bill.
5) Roger: cartoon character Roger Rabbit.
6) Cross: a stone cross gravestone with a Raven sitting on.
7) Fire: stylised drawing of a forest fire.
8) Timezone: colour coded outline world map with time zone markings,
9) House: a picture of a family house with trees around.
10) Rose: a soft-lit drawing of a red rose.
11) Akira: a gun-wielding cartoon manga character dripping blood.
12) Escher: drawing of 2 hands, each drawing the other.
13) Crow: photo of film character 'The Crow' in half shadow.
14) Shore: a seaside scene with sandcastle, bucket and spade.
15) Wface: outline drawing of a woman's emotionless face.
16) Kitten: photograph of cute kitten sitting in a flower bed.

17) Xmas: a Christmas tree with coloured lights in snow.

18) Mushroom: photograph of nuclear explosion mushroom cloud.

These images were each chosen to represent a combination of variables as in the figure VId.

	Positive	Neutral	Negative		Positive	Neutral	Negative
Veridical	Kitten	Woman	Crow		Shore	House	Cross
Iconic	Roger	Wface	Akira		Rose	Escher	Fire
Symbolic	Onedollar	Buddha	Dali-Vis		Xmas	Timezone	Mushroom
	Faces				**Non-Faces**		

Figure VId: classification of images

Apparatus: Images in the target pool

Eight images were constructed for the target pool, each one primarily representing one of the engram structures. To get the strongest possible physiological response at the time of the target viewing (which would be relate to the strength of the psi 'signal'), it was decided to present a collection of images. Each target image was thus a montage of smaller items, which could be drawings or photographs, and representing ranges of emotions. The criteria was that the overall appearance of the image would most consistently evoke the required engram structure. As an example, the 'symbolic' target image consisted of a drawing of some mythical creatures, a photo-realistic ankh, a photo of some dice, a light bulb symbol, a photo of the American flag, a drawing of some clasped hands and the word 'Religion' in black text. Thus, although the image contained elements of other engram structures (faces of the mythical beasts, emotional overtones depending on individual reactions, iconic and veridical aspects), the consistent theme should have been that the objects all had symbolic associations. The actual target was not selected until immediately before presentation to the participant. Selection was by means of the Quick BASIC internal pseudo-random algorithm. This is a standard and widely used algorithm which has been shown to give apparently random sequences (Dalton et al, 1994)

The images for all three stages were presented full-screen on a computer monitor using a Quick BASIC program written by the author. Images were presented for five seconds followed by five seconds of blank, black screen.

Apparatus: the neural network

A neural network was used to determine a template for each of the three basic responses - conscious recognition, vague-recognition and null-recognition. Such networks have been shown to be useful at 'learning' to find patterns in noisy or highly complex data. A commercial software product, *Brainmaker* (Lawrence and Petterson, 1992) was used. This is a back-propagation network which in this case used a sigmoid transfer function with a gain of 1 (giving an output which is a semi-linear, continuous, monotonic function of the input - see Lawrence and Lawrence, 1992). For training, 90% of the data was fed into the network. The remaining 10% of the data was used to test that it could make successful predictions based purely on physiological data. When making a prediction, the neural network produced output values between 0.000 and 1.000 images relating to the precognitive target. Higher values indicated a stronger pattern match between the image-related physiological data and the trained template. These values were then used to produce an average response strength for each of the engram structures in figure VId. A value for the strength of the total response (TR) to each engram was then calculated such that:

$$TR = V - R + N \quad \textit{where} \quad V = \textit{Vague Recognition Average Strength}$$
$$R = \textit{Recognition Average Strength}$$
$$N = \textit{Non-recognition Average Strength}$$

This value was decided beforehand as it was expected that a subconscious 'psi recognition' response would relate more to a vague recognition (V) response than to a conscious recognition response, possibly also showing a conscious non-recognition (N) response. Thus, a psi-recognition response would ideally show High V, Low R and High N. (V-R+N) should then give the highest value for a psi-recognition response.

Participants

20 volunteer participants were used, recruited by poster display and word of mouth on and around the university environs. No selection criteria were used.

Procedure

Participants arrived at the laboratory and were seated in a high-backed armchair in front of a computer monitor. They then carried out an on-screen

version of the embedded figures task and Bem sex-role inventory. Once they had completed the inventory, the meaning of their results for both tests were explained.

The physiology electrodes were then put in place, with an explanation of what each was measuring and a reassurance that these were perfectly safe and isolated from the mains supply. Participants were instructed to remain as still as possible, breathing as normal. They were then told that they would be shown a series of thirty-six pictures on the screen which they should watch with as much attention as possible. Reassurances were given that they would not be expected to remember any details afterwards, nor were there any other aspects of the experiments about which they had not been informed. The experimenter then retired behind a screen to start the physiological data collection and image display. Once finished, participants were thanked and debriefed.

Once all 20 participants data had been collected, all of the the physiological data from the first 18 images (the response calibration images) were combined and used to train a general neural network to distinguish the recognition, vague recognition and non-recognition response patterns.

PREDICTIONS

It was predicted that:

H1: A neural network could be trained that would identify the precognitive target based on a participant's physiological responses to target-related images.

H2: Female sex-typing would be related to successful prediction of the precognitive target.

H3: The EFT scores would correlate with success in the prediction of the precognitive target.

H1 is the primary hypothesis, affirming that there would be physiological responses that would enable a successful prediction of an undetermined future event. H2 investigates the anecdotal claim that a feminine personality is more likely to 'be psychic'. H3 stated that participants with high field independence would be better at perceiving the psi signals as they be less inclined to attempt to interpret those signals as being related to their current surroundings

RESULTS

The most accurate neural network, based on the combined data of all participants, was found to be correct only 21% of the time (15 facts correct out of 72). This was for a network with one hidden layer of 200 connections. As this was

still highly unreliable, it was decided to allow for a margin of error by looking for the top two total response strengths as indicators of the engram structures which corresponded to the psi target. If this procedure proved to be valid, this would reduce the possible target pool from eight to two, increasing the probability of a successful psi experiment from 12.5% to 50%.

The general response network results showing the response for engram structures corresponding to actual psi target are given in table VIa. As can be seen, eight out of the twenty sessions showed the correct engram structure to give one of the top two responses, as opposed to the five that would be expected by chance. H1 is therefore supported for the general case.

Table VIa: general response network results

(H= highest of 8, L= Lowest of 8)

Participant	All Network Output
1	**H**
2	4th L
3	**2nd H**
4	3rd L
5	2ndL
6	4th L
7	2nd L
8	**2nd H**
9	**2nd H**
10	**H**
11	3rd L
12	**2nd H**
13	L
14	3rd H
15	4th H
16	4th H
17	**2nd H**
18	4th H
19	L
20	**2nd H**
TOTAL CORRECT (2H and H)	**8**

Table VIb: individual response network results

(H= highest of 8, L= Lowest of 8)

Participant	3L-80 network Output
1	**2H**
2	3H
3	2L
4	**2H**
5	**H**
6	3L
7	3H
8	4H
9	2L
10	4H
11	**H**
12	**2H**
13	4H
14	4H
15	**2H**
16	**2H**
17	4L
18	4H
19	3H
20	**2H**
TOTAL CORRECT (2H and H)	**8**

The next step was to see if the usefulness of the procedure would be increased by creating an individual network for each participant, which would allow for any individual differences in physiological recognition responses. The main

problem with this procedure was that there were only 18 sets of physiology data inputs for each participant, which would result in a less generalisable network and very few training facts (recall that typically 10% of the data set is used to train a neural network for later use. In this case, this gave only two items of data!). As a result, the standard network of one hidden layer of eighty connections got none of the two training facts right in seventeen case and only one right in three cases. The individual response network results are given in table VIb

In this case, the networks again showed the correct engram structure to give one of the top two responses in eight out of the twenty sessions. However, as the individual networks were smaller, it was practical to try to train some more complex networks in the hope that they would be more accurate. For each participant's data, the number of layers was increased until the testing showed an increase in accuracy. Once the maximum number of possible layers had been reached, the network was reset to the basic configuration, but the number of connections doubled. Details of the seven individual networks for which this produced an increase in testing accuracy are given in table VIc.

Table VIc: Additionally trained individual network details

Ps	Layers	Connections
1	4	80
2	3	160
3	7	80
7	5	80
9	7	80
14	4	80
18	5	80

For these networks, the psi-session data showed the following results (see table Vid). Of these networks, only one (participant 1) had correctly predicted the psi-target engram structure for the original configuration network. Thus, if the best networks were used for each case, the total successfully predicted engram structures was eleven out of twenty. H1 is thus supported for the individual cases.

Table Vid: individual response network results

(H = highest of 8, L = Lowest of 8)

Participant	Best Network Output
1	**H**
3	**H**
4	3L
8	**H**
10	3L
15	**2H**
19	4L
TOTAL CORRECT (2H)	**4**

A post-hoc attempt was made to see if a network could be trained using only the EDA, PPG or EEG data on their own, training one network per individual. In no cases could a network be trained, suggesting that each measure on it's own did not provide enough specific information. This could be due to the low-resolution data recorded, or indicate that the effect was a very weak one. An attempt was also made to see if there were some physiological differences between those people for whom the neural network successfully reduced the psi target pool and those for whom it could not, it was decided to look at the variance of each of the physiological measures taken. It was hoped that this would provide a crude measure of the lability of their physiology. Table VIc shows the Spearman correlations for each of the physiology measures and whether the neural network was successful or not.

Table VIc: Spearman correlations for overall variance of data vs. success (coded : yes=1, no=0)

	ppg	eda	bl	br	al	ar	tl	tr
Success	-0.113	0.341	0.044	-0.044	0.200	0.026	0.009	-0.096

To be statistically significant at the p=0.05 level, Spearman's r would have had to have achieved a value of 0.450 (N=20) or above. None of the correlations reached significance.

For the measures of psychological androgyny, a t-test was performed to compare differences between the success and non-success groups.

Table VId: Androgeny Scores

Success	N	Mean	StdDev
Yes (1)	10	0.4□	2.2
No (0)	9	-0.80	2.1

t = 1.194 (df = 17), p = 0.125 (1-tailed)

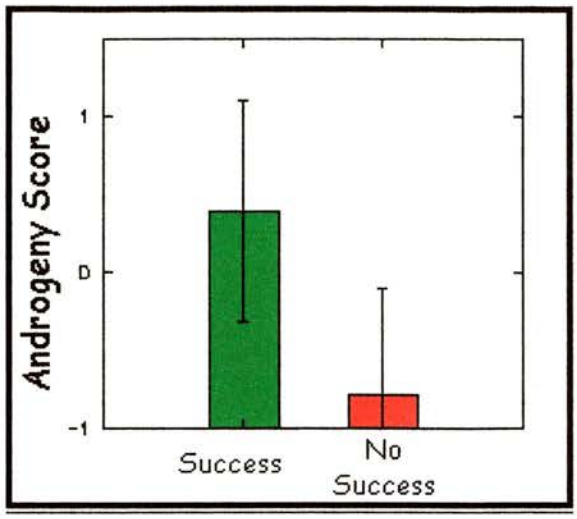

Figure VIe: Androgeny scores by sucess

Results were thus non-significant although in the predicted direction, suggesting that a feminine sex-typing (positive androgeny score) was superior either for psi performance, or at least for having the characteristics that enabled the neural network to make a successful prediction. The total N for this analysis was only 19 due to the corruption of recorded data for one of the participants, due to a spontaneous hard-disk access error. As the differences were not significant, H2 was therefore not supported.

For the measures of field independence, a t-test was again performed to compare differences between the success and non-success groups.

Table VIe: Field Independence Scores

Success	N	Mean	StdDev
Yes (1)	11	23.6	8.6
No (0)	9	35.2	27.5

t = -1.320 (df =18) , p = 0.102 (1-tailed). Results were again non-significant but in the predicted direction (a low EFT score meant good field-independence) This

suggests that field-independence was also superior either for psi performance, or at least for having the characteristics that enable the neural network to make a successful prediction. As the differences were not significant, H3 was also not supported.

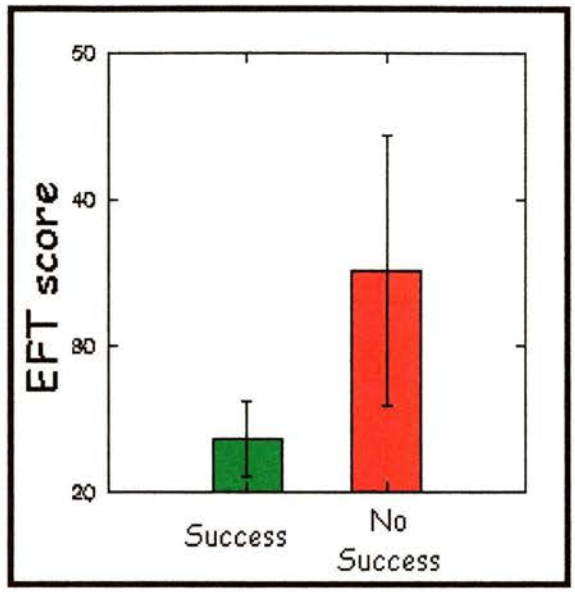

Figure VIf: EFT mean times (s) by success

DISCUSSION

The findings of this study seem to support the idea that there is, at least for some individuals, a discrete physiological response to a real-time perception related to a future perception. This is interpreted as being demonstrative of a low-level precognitive ability in humans. To some extent, the characteristics of this response may be generalisable to all individuals as an artificial neural network trained on all participants' data was able to reduce the possible target pool from eight to two in eight out of twenty cases. However, that there are individual differences was apparent as the individually trained networks were more successful, achieving a correct prediction in eleven out of twenty cases. In both cases, the expected number of correct predictions by chance alone would have been five out of twenty (Eight possible targets for twenty participants, with the top two physiological responses being taken as possible psi predictions). It is concluded that this approach is a worthwhile one, with the possibility of being a useful tool for (a) aiding in the training of psi abilities in a manner similar to biofeedback training and (b) helping to determine when psi is present.

Looking at the physiological data, there are possible indications that neural-network prediction success was achieved for individuals with low variance photoplethysmograph (PPG) readings, high variance electrodermal response (EDA) , and high variance of left-hemisphere alpha activity. However, a Spearman correlation did not show these findings to have reached a level of significance ($r = -0.113$, $r = 0.341$, $r = 0.200$ respectively). Part of the problem may have been that relatively low resolution physiological data was collected, samples being taken only

every second and with only one channel EEG. Future studies might benefit from taking more frequent samples.

For the psychological measures, the predicted superiority of individuals who were classed as showing significant feminine sex-typing was found ($t = 1.194$, $df = 17$, $p = 0.125$ 1-tailed) although it was non-significant. As the measure used - psychological androgyny - has been found to be related to perceptual ability, this is taken as being indicative that psi is in part a perceptual ability. For the measure of field independence, neural network prediction was successful for individuals who were rated as being field independent ($t = -1.320$, $df = 18$,, $p = 0.102$ 1-tailed). If this superiority is due to the individual's psi ability, it implies that the initial hypothesis that psi is related to the ability to recognise the presence of weak signals that are not part of the current perceptual environment is correct.

CONCLUSION

It is concluded that the use of artificial neural networks and physiological responses promises to be a useful tool in psi research, offering not just a training aid but a possible indicator of the presence or absence of psi within any given laboratory experiment. Although the psychological measures did not show significant differences in this study, they were in the predicted directions, indicating that future research with larger numbers of participants could benefit from taking psycho-perceptual measures into account when selecting participants.

Summary

It is proposed in general that higher order use of a psi signal may be seen as a third order perceptual process. That is, we can consider there to be three orders of 'receptive environmental interaction', where energy from the environment is transduced by an organism to gain information about the environment. A first order process would be basic detection, also commonly called sensation - a stimulus response to the energy transduction. Such processes have a primarily biological basis, and include sensations such as pain reflexes, sense of heat, responses to the presence of light, and simple pattern recognition (e.g. edge detection for orienting responses). The detection of a psi signal which lead only to a change in the state of arousal may also be included at this level. A second order process would be termed classical perception - the comparison of a sensation, or a collection of sensations to a stored template. The organism is attempting to model a

pattern of sensations into a whole, giving an overall perception of the immediate environment. Third order, then, is the realm of psi and other anomalous perceptions. It would be the comparison of a perception, or a collection of perceptions, to a learned template i.e. it is the 'perception of perception', modelling how perceptions should be. It is to be emphasised that psi differs from conventional perception in that it thought not to have a discrete sense organ but to act to modify the activity of cells of other systems, sensory or otherwise. As such it is 'perceived' as a modification of other perceptions rather than as a perception in itself. Hence it is three orders removed from the primary transduction of the psi signal by cell membranes.

VII. Mental experience of psi

Until this point, all of the discussion has focused on how the psi signal is detected by various systems, and ways in which individual characteristics might help or hinder this. No mention has been made of what many people consider to be a fundamental aspect of psi - the conscious experience of the phenomena. For the most part this omission has been deliberate as I wanted to make the point that a theory of psi need not involve consciousness as a necessary component of the system. As with many sensing abilities in humans, consciousness is not necessary for the detection, or even utilisation, of the fundamental signal-borne stimulus and, under this particular model, a psi effect may take place even between non-biological systems (e.g. phase-locking between two systems). However, much as it might appear otherwise, I am not advocating a reductionist approach to the psi experience. To talk about the experience itself is to move to a different level of description where the physical or physiological processes underlying the psi signal detection are not so applicable. Indeed, it is possible for people to have quite involved and complex experiences even in the absence of any objective phenomena at all, a fact that makes psi research that much more difficult if we rely on subjective reports !

In this chapter, there will be a consideration of how the psi process might appear from a subjective viewpoint, making reference to the proposed underlying processes, but not relying heavily on their specific. The final interpretation of the experience will depend on the specific beliefs of the individual and on other environmental factors, but all psi experiences that are the result of the detection and bringing to awareness of some form of psi signal should have some general features in common.

To start with, psi at the experiential level is considered in its most basic form to be a correlation of an aspect of the psi agent's internal state with some type of external feedback. It can be seen to be a form of environmental biofeedback, where a subjective state ultimately corresponds to an external change rather than a purely internal one, and feedback is of that external event. It's interesting to note that the model on this level has some surprising parallels with one of the earliest theories of psychology, the James-Lange theory of emotion. This argued that, as opposed to the conventional viewpoint that bodily or behavioural changes were caused by a subjective emotional experience, the emotion was an deductive

process based on the perception of bodily or behavioural change (Gross, 1992). That is, if we observed that we felt queasy, and were sweating and shaking, we would deduce that we were afraid and so would then feel that particular emotion, essentially a form of self attribution. Although this theory is now thought to be inadequate to explain all emotional experience, the basic premise appears to be true in some circumstances, most notably those where there is ambiguous information and strong external cues. The most famous study showing this was by Shachter and Singer (1962) where participants were given an injection of epinephrine, a drug which brings about physiological symptoms similar to those experienced in times of intense emotion, but told that it was a vitamin supplement. The participants were then, one at a time, placed in a room with confederates of the experimenter who acted in either a euphoric or an angry manner. While the control groups (no injection or placebo injection) and the group who were told to expect the symptoms did not report a matching emotional state, the experimental group who were not expecting the symptoms reported feeling the same as the confederates. That is, they experienced a level of arousal normally only felt during strong emotions, and so looked to their environment for cues for an interpretation of that arousal. In such cases, we can conclude that the perception of non-specific somatic sensations or behaviour coupled with perceived external cues can help to determine a subjective experience. It is this process which is thought to occur in determining how the psi signal will be experienced and utilised.

To make this clear, let us consider how a basic psychokinesis protocol experiment would be viewed within the proposed framework. In such a case we have a target system (the random event generator), the feedback (say, a computer graphics display) and the psi agent (the experimental participant). We start by assuming that the target system interacts energetically with its environment in some way, this environmental change then acting to modify the physiological, and eventually the psychological, state of the participant as discussed in previous chapters. (see figure VIIa.).

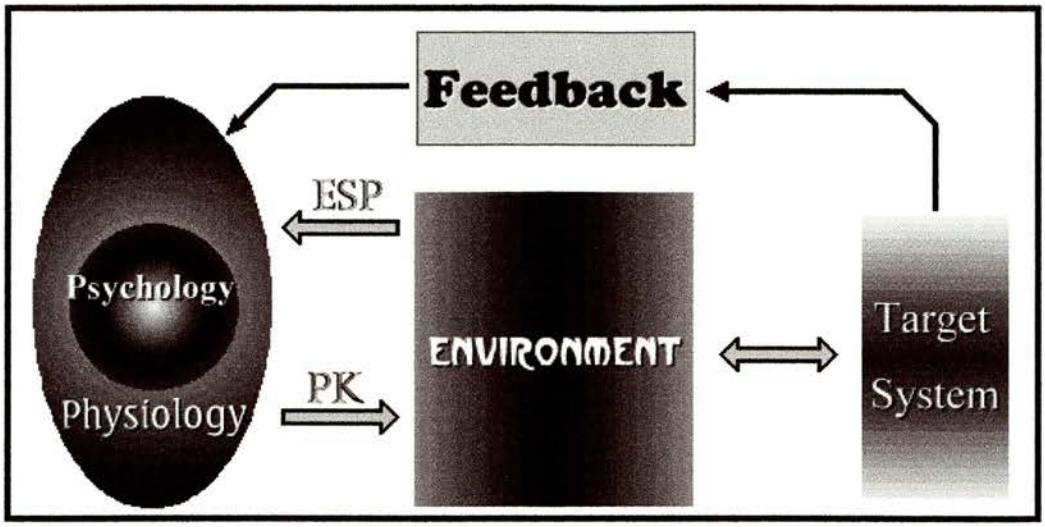

Figure VIIa: schematic diagram of typical psi experiment

As a simplified example, suppose that naturally occurring changes in the local environment produce the energetic conditions required to promote the decay of a radioactive particle (the detection of which is the basis for the hypothetical random event generator in our target system). This environmental change is such that it also weakly modifies neuronal activity in the participant's brain, leading to a state of arousal for the participant as they see a red light on the feedback display. This state of arousal may simply be noted as such, or may be assigned an emotional label based on other external or internal cues. Perhaps the participant was thinking about a holiday at the time they experienced the modification and so decided that they felt happy. With respect to the experimental situation, the participant, if they are monitoring their internal state as well as attending to the feedback, may then notice a correlation between 'happy' and 'red light'. Alternatively, also as discussed in earlier chapters, the operation of the target system may in itself be sufficient to cause change to the environment, which would then modify the participant's neuronal activity. This is what I have termed the *orientation* process, stage one of the psi experience. The psi agent must orient themselves to the characteristics of the target system under the particular environment and within their initial mental state, learning to recognise the relationship between their internal states and the external feedback.

When later trying to influence the same target system, the participant attempts to bring about a similar state of arousal (in this case termed 'happiness') as was experienced earlier .The assumption is made that, by recreating this 'happy' state, the associated physical processes in the participant's brain will to some extent approximate those which occurred in the original 'happy' state. That is, the

neuronal activity associated with being happy will produce a similar energetic pattern as that which originally promoted such activity (this is true of systems exhibiting semiconductor properties, such as cells membranes, and also of many enzymatic reactions in organisms). The emissive release of this energetic pattern could then modify the environment to a condition similar to that which originally promoted the decay of another radioactive particle for detection by the REG.

From the point of view of the participant, all they are aware of doing is noting, on some level, their emotional state at times when the target system is acting in the way in which they desire, and then attempting to stay in that emotional state in the hope that the target system will also continue to act in that way. In the absence of any scientific theory on the part of the participants, this sounds very much like magical thinking, so can we conclude that people will think like this when not specifically instructed to ? The American Psychiatric association defines *magical thinking* as characterising an individual who "believes that his or her thoughts, words, or actions might, or will in some manner cause or prevent a specific outcome in some way that defies the normal laws of cause and effect", and link it in with types of psychopathology . Zusne and Jones (1989) also note that the association goes on to admit the presence of non-pathological magical thinking in "primitive societies and children" but point out that it also occurs in 'normal' adults of all societies. As it stands, the definition sounds very much like what I am suggesting occurs in the orientation period, although I would not classify it as being either indicative of a mental disorder, immaturity or overly 'primitive' !

ESP as a precursor to PK

In this view, it would seem that for successful PK to occur there must first be an orientation period, allowing the psi-agent to form the internal stimulus-feedback correlations. It is proposed that this orientation period is essentially the process that has commonly been called extrasensory perception (ESP). This model then provides a continuum between the 'sensory' and the 'motor' aspects of psi phenomena, providing a more economical framework for exploring possible mechanisms. ESP can be viewed as the target system exerting a PK influence on the receptive system, thus giving the latter sufficient information about the target's system's activity for it to exert a reciprocal influence. As this reciprocal effect need not be based on a conscious decision, but instead could be subconscious or purely due to physiological or physical reactions, we might expect to find that all instances of psi had an interactive component. It is suggested that, where possible, the

monitoring of both target and receptive systems is undertaken, and synchronised activity within the two looked for.

At this experiential level, the proposed model has many similarities to Stanford's Psi Mediated Instrumental Response (PMIR) model mentioned earlier, although it should be noted that Stanford modified this model into the Conformance Behavioural model (Stanford, 1990), which replaced the scanning aspect of the PMIR with a more teleological approach due to worries about information overload in the scanner's processing centres. In the proposed model, however, the active scanning aspect is instead replaced by a passive detection approach - the psi-receptive organism is indeed 'drowning in and flooded with psi-mediated information of every kind' (Stanford, 1990) as there would be psi signals from many psi sources at any given point in time interacting with the organism's cellular structure. This does not require a huge amount of information processing in the normal, cognitive sense as the cognitive aspects only arise when some attempt is made to focus on a particular aspect of the available information. Information processing is still occurring with amazing complexity and on a large-scale, but on a cellular level. This is occurring continuously and is part of the whole range of cellular information processing that takes place as we interact with our environment; were we to attempt to apply cognitive processing to all this information - the feel of our clothes on our bodies, the background noise of people talking and cars driving past, the smells all around us - we would indeed suffer from information overload. Thankfully, our conscious experience of events appear undergo selective filtering, due to both physiological and psychological filters, requiring us to be aware only the surface layer of all this information!

Characteristics of the experience

So, would psi as envisioned have a teleological appearance from the point of view of the experiencer? The answer is yes, as the experiencer need not concern themselves on a conscious level with the precise mechanism by which they achieve their goals. If the effect is at its most basic level, where two systems essentially resonate with each other, the emissions of one driving the other into activity which more closely resembles its own, and vice versa, then there need be no conscious desire on the part of the psi agent. As discussed in the last chapter, it may be beneficial if they relax as much as possible, reducing 'noise' from internal sources and letting the external perturbations have a maximal effect on their physiologies,

but they need not attempt to cause or to direct the psi effect itself, any more than they need control the way their bodies will heat colder objects in their vicinity.

If some higher level interaction is to take place, then the internal-external correlation procedure needs to take place, the psi agent orienting themselves to the target system. Again, this need not be a conscious procedure and could occur naturally over a long period of time if they have a long term association with that system. An example of this could be the reason for the many anecdotal reports that telepathy is more likely to occur with as close friend or family member than it is with a friend. Carpenter (1977) review this area, reporting on studies showing that, in spontaneous cases, the most common psi agent-percipient relationships were mother and son or father and son, these combinations being more than twice as frequent as any other. Other experiments looking at dyadic interactions found better ESP success between intimate couples than casual friends, and even between a telepathic sender that the receiver had met beforehand as opposed to one they had not. If the orientation procedure described above is vital for any case of higher level psi, then a period of acquaintance between sender and receiver in an ESP task should improve results, the receiver having had time to learn to correlate the emissive signals sent out by the sender with their observed behaviour. The only situation in which this would not help to increase success would be in situation where the success measure is only a measure of arousal or simple physiological synchronisation. Thus a DMILS study would not show an increase in success if orientation was allowed to occur, whereas a telepathy experiment should. There will obviously be confounding psychological factors, wherein a previous meeting may make the receiver more at ease with the protocol, but it should be possible to circumvent such problems by indulging in a slight deception such as allowing the receiver to meet a false sender. Another exception would be in cases of true precognition, where the sender is assumed in some models to be the receiver at a future time. Should such instances occur, it seems fair to say that the receiver would already be intimately acquainted with the sender! If true precognition does occur, it would make testing many of the ideas outlined here very difficult under an ESP protocol as the receiver might act as a sender in any case where they receive eventual feedback about the target. Only if they were always kept blind to the experimental outcome would this not be a possible confound. As yet, I cannot think of any way in which to do this without either deceiving participants, or making them leave the experiment with no clear idea of how they performed - hardly a good way to encourage future participation.

Again, in this higher level case, the psi experiencer need not concern themselves consciously with the underlying processes. Once the external event-internal state correlation has been formed, it seems likely that the exact path by which this correlation was achieved will not be important, only the two end points featuring in the conscious decision to cause a psi effect. Just as we do not consciously activate all the intervening muscles when we wish to reach out and pick something up, concentrating instead on the end result, so too would the psi correlation become automatic. Returning to the simple example given at the start of this chapter, if we wish to make the red light appear on the feedback display, we would think about being happy. Recreating the correlated state would automatically recreate the physiological conditions required to generate a psi signal of the necessary characteristics. Thinking about those specific characteristics themselves would be more likely to interfere with the process - the same difference as would occur if we tried directly to recreate the hypometabolic state associated with meditation, or simply meditated.

This interference also leads into the commonly held notion that analytical thought is not conducive to psi, whereas a more passive state is. Analytical thought, being a process by which the elements of a situation are broken apart and looked at in more detail, is necessarily a interfering process. By intervening in a specific thought process, we have altered that thought process. If the information which we seek is contained in subtle alterations to the thought process, the analysing could essentially destroy that information. Only by taking a passive role, observing and recording the process as a whole, will the information be preserved (at least to a greater extent - there is really no such thing as a completely passive approach as we cannot in actuality be external to that which we observe).

Feedback considerations - is psi without feedback possible?

In psi terms, feedback may be considered to be the confirmation (either positive or negative) of the original psi-related hypothesis. For example, in an ESP experiment, the percipient describes internal imagery which they hope relates to the target image i.e. they make a prediction about the target's properties hopefully based on the reception of a psi signal, but probably also related to past experiences, extraneous cues, and so on. The process seems very similar to any form of perception where the stimulus is weak. When the percipient is later shown the actual target, they will compare the actual target properties with their prediction,

learning (hopefully!) in the process to better discriminate the relevant information from the noise. So the question is: what could constitute feedback? Initially, it was considered that the feedback was only the information provided to the percipient by the experimenter (or by some informed person in cases of spontaneous psi, but I will confine the description to lab cases, which are slightly simpler!) , plus whatever sensory cues might have inadvertently been present in the environment. A problem arose when some researchers showed that there were situations where psi appeared to work in the absence of feedback (e.g. Berger, 1986; Braud, 1975; Edge et al, 1984), implying that psi could work without sensory direction, and seemingly supporting the idea that psi was goal-oriented i.e. the psi agent need only will the desired outcome to come about and did not need any information other than that the goal existed.

However, feedback need not necessarily be so overt, and could be purely psi-based under the proposed model. To explain further, we need to consider each of the two general forms of psi that the model would allow.

Form one is the basic cellular response, relating to 'hardwired' processes, probably associated with fight-flight responses, basic emotions and other somatic needs such as hunger. As these are thought to be the result of an non-cognitive response to the psi signal, they could occur in the absence of feedback. PK effects related to the phenomena of phase-locking or resonance, or undirected perturbations (which could possibly involve some healing effects) could also work at this level.

Form two psi would be that utilising the learned correlatory response - basically a form one signal is detected but further cognitive processing allows a greater use. For this form, feedback would be essential as without it, no learning could occur. The feedback need not be complex, and could be as simple as a yes/no signal; the more abstract the psi-gained information, the more complex the feedback needs to be. The only exception to this would be in situations involving self-originated precognition, where fairly abstract information could be gained even in cases where the feedback to the percipient is minimal - in such a case, the mechanism could be a simple form one effect with identical transmitting and receiving systems.

For example, form one psi would be what occurs in staring experiments. No feedback is required for the staree, who can still show differing physiological responses during staring and non-staring periods (e.g. Braud et al, 1993). Here, the only experience had by the psi experiencer would be related to the final change in

their physiologies, though the reason that they ascribe to this will depend on other factors (see later section on cue-driven interpretations).

Another form one case could be a PK protocol which involved an unknown target (for a review see Stanford, 1977). In such cases, the target system's output is, unbeknown to the participants, linked to events in the experiment. For example, Schmidt found that participants could more quickly escape from performing an unpleasant task, the time at which they were allowed to stop being based on an REG's output, even when they did not know that this was the case. In the current framework, the participants *would* have been getting limited feedback, both from the REG activity and from the experimenter. Possibly this would have been enough for them to have biased the REG activity themselves, or with subconscious help from the experimenter. Again, the psi agent need not have any conscious awareness of this, noting only that when they feel *this* way, *that* happens.

Form two psi, on the other hand, would be the operating mechanism in a telepathy protocol. Here the receiver detects psi signals from the sender and, discounting precognitive mechanisms, attempts to decipher the target information through the correlatory connections between signals and sender responses they had previously noted. The better they know the sender, the more likely they are to have correctly correlated specific signals with the underlying psycho-physiological activity that produced them. Once these correlatory responses have been established, there is less need for explicit feedback, with the receiver able to infer certain things about the activity of the target system through reception of a psi signal. It is even conceivable that explicit feedback could be detrimental to success in that it would force the receiver to focus more on external perceptions and less on their internal state.

Another point to consider is that raised by PK studies involving prerecorded data. In such studies, usually used to test the predictions of the observational theories, data from a random source is automatically recorded by a computer system. At a later date, the as yet unobserved data is presented to the participant as if it were being collected real-time in the context of a PK task. Some results have apparently still shown a PK effect (Schmidt, 1985), implying that either the time of observation is the time of the PK influence , or that PK can act retroactively. Now, if the proposed model is correct, it would be impossible to collect unobserved data as the REG would be emitting a psi signal containing information about its activity. Anyone in the vicinity of the REG would be interacting with it on some level. If that person has had an opportunity to have previously learnt the necessary correlation

between this signal and the usual feedback, then they themselves could be perturbing the REG in real-time. If that person is the experimenter using the same REG as has been used in past experiments, they themselves would become the prime candidate for any results, and a possible source of interference in real-time experiments.

Metachoric Experience

The most extreme experience of receptive psi under this model would be rare cases where the signal was specific enough (and possibly strong enough) to perturb ongoing processes in the brain sufficiently for the psi agent to interpret it as being an actual, sensory perception. Imagine for example if a psi signal which the receptive agent associated (through a learned response) with 'mother' was received. They might then appear to 'see' the image of their mother superimposed upon whatever scene they were currently perceiving, the actual appearance of the mother image being expectation and past knowledge. In effect a hallucination but one which was triggered by the reception of an actual signal. Green and McCreery (1975) call such experiences 'metachoric' as they suggest that, rather than the apparitional person or object being hallucinatory, superimposed on a 'real' perception of the environment, the entire viewed scene is a hallucination. Although they suggest that such experiences occur only in a few case, such an assertion still seems unnecessarily extreme, especially in view of apparitional scenes, many of them described in Green and McCreery's book, where the percipient correctly sees details in their environment aside from the anomalous percept. Rather, I would suggest that the perception of the environment as a whole has been perturbed, often retaining many of its true features, but also having some induced ones. It need not even be so extreme as the mother example given above. The effect of the psi signal may be to create a percept akin to an after-images - an ambiguous shape caused by inhibition of certain retinal cells. This shape may then be *interpreted* as having some significance to the percipient. In all cases, whether for a high or low level psi experience, the most important factor is going to be the interpretation the percipient applies to the event. This will determine the attention given to and memory of the event, and their subsequent behaviour.

Cue-driven interpretation of ambiguous stimuli

So far, we have considered the use to which detection of a basic psi signal could be put, but we have considered only the case of true detection responses and correct correlations. There will also be cases where, by chance, the signal evokes activity unrelated to the psi-source but still perceptible by the receiver as a discrete psychological state, and where false correlations are made between the detection of a signal and an external cue.

If this is indeed the case, then we would find that people, rather than just having broad belief systems relating to paranormal experiences, might have more narrowly defined context specific beliefs. That is, their beliefs would not be general rules for all given situations, but would depend on a specific blend of sensory cues and expectations that were related to the particular location or situation. This blend would relate to their individual perceptions of the location, both present and past, to the specific physical parameters of that site - such as the geography and architecture - and to a variety of cognitive variables that related to how that person dealt with incoming information, sensory or otherwise.

So, a psi experience need not depend on the successful interpretation of a psi signal, but could be induced from the mere detection of the signal, irrespective of its information content. If a signal is successfully detected, then the percipient may become aware of this without being able to interpret the meaning of the signal. This could act to cause anxiety or could prompt the percipient to look to external cues to provide meaning to the psi stimulus. An example of this could be in some cases of 'hauntings' - if such sites have specific properties (possibly a particular configuration of electromagnetic field), then sensitive percipients might become aware of the results of their interaction with these properties. If the resulting stimuli are novel, then they may look to their environment for cues; which cues they choose will depend on individual factors (beliefs, expectations) as well as other random happenings (coincidental timing of events). If the percipient is in a dark, gloomy house, possibly having been told tales of similar haunted houses, the hypothetical electromagnetic stimulus may be interpreted as a 'presence'. Should they catch sight of a patch of light or a reflection out of the corner of their eye, this could become an 'apparition'. There may also be the possibility of the stimulus being less ambiguous and directly inducing an emotional state in the percipient. This could then become coupled to environmental cues in the same way. It was suggested (see Chapter V) that this was what may have been occurring in the case of electromagnetic sensitivity. The applied electromagnetic field acted to change

autonomic arousal, which was experienced as a general state of 'significance': that something was occurring of which the participant should take note. The participant then looked for sensory cues as a possible explanation for this feeling (e.g. the hand tingling sensation that often accompanies physical relaxation) and made a connection between the two: that the hand tingling was significant and was actually an indicator of the presence of the electromagnetic field. Obviously this experiment differed somewhat from a real life case in that participants were aware that they would be exposed to the electromagnetic field, and so were specifically looking for possible detection cues, but this may not be so far removed from a typical, for example, haunting case where the experient may have an expectation that something 'paranormal' will occur.

'Mythoperception'

It is worth considering just how far this process of subjective labelling of events could go. If psi is indeed experienced in this manner, then the human brain will undoubtedly do its best to make sense out of any psi perceptions in a methodical manner. As psi is thought to normally be a weak phenomena, then it seems likely that the cognitive processes involved in processing psi information will be similar to those involved in the processing of weak sensory stimuli. In subliminal perception studies, there is a strong symbolic component (Weinberger, 1992) where the conscious experience appears to relate to the semantic content of the stimulus, and associations with it, rather than directly to the stimulus itself, so perhaps we should expect similar findings in psi experiences. This is in fact the case, with several researchers highlighting similarities (Dixon, 198X; Watt, 1993; Ballard, 1980; Nash, 1979).

However, such studies deal with specific sensory stimuli to evoke the subliminal perception. In a psi experience, it is proposed that the experience will be evoked by a non-sensory stimulus which produces either a non-specific aroused, basic emotional, or, at best, a external cue correlated state. Any semantic association will therefore be based on a highly individual, and cue-dependent, initial semantic label. In plain English, an identical psi stimulus will produce differing responses each time depending on the available external cues, and on the individual involved. Thus two people in a 'haunted house' may both experience the same stimulus, but this could produce wildly different experiences in both of them. There may well be some broad commonalities between their experiences as both may have had similar expectation of what they might experience in such a

situation. Moreover, the same individual may not even have the same experience in an identical situation if their expectations are different as then the baseline against which they detect the psi stimulus will be different. This lack of continuity may well be why Rosalind Heywood, in her book *The Sixth Sense* (Heywood, 1959), said that the psychic should never trust a psi impression without some form of external confirmation. Without a great deal of control of one's psychological state, it may be impossible to make much use of external, purely psi based signals (the emphasis is placed on external psi signals, as essentially internally-generated signals, as were proposed to occur in cases of precognition, might act to activate specific neuronal states that were strong enough to be detectable in their own right and not merely for their perturbing effects).

In this picture of psi experience, it could be imagined that much of human legend and folklore, and possibly some aspects of religious experience, came about as site or situation specific responses to psi stimuli (I am including sites with electromagnetic anomalies as psi stimuli as I consider the underlying processes in the detection of both as being due to very similar, if not the same, processes). An individual notices a feeling when he is walking through a specific site, and also notices that there is something noticeable about that site (it has an unusual rock formation, or he is being watched by some wild animals, or it just very pretty!). He then makes the connection, either immediately or after repeated visits (depending on how intense the induced feeling is), that the feeling is caused by the noticeable factor at that site. Subsequent visits, if the stimulus remains, will tend to develop along the lines of the initial idea. Should he tell others of his interpretation of the feeling, they will then have a preset framework (i.e. an expectation) within which to explain any future experiences they have at that site. Human nature should then be enough to start the legend growing once it has been established.

To summarise: it is proposed that the most usual effect of a psi stimulus is to produce a non-specific psychological state due to a change in levels of physiological arousal. External sensory cues and/or expectations then serve to allow a meaning to be assigned to that stimulus. Subsequent exposure to the same stimulus may, if the external cues are consistent, be interpreted within a framework based around that original meaning. For that reason, and to reflect the author's proposal that it may underlie the generation of some aspects of folklore and legend, this process has been given the name of *mythoperception*: 'mytho-' from the Greek 'mithos', meaning "a theme embodying an idea", thus giving a term for 'themed perception'.

Is there any evidence that such a process may occur? If so, we would expect to find site-specific paranormal phenomena and other indications that psi occurs in relation to physical parameters of the site where the experience took place; that there would be commonalities between reported psi experiences in situations where external cues (situational or expectational) were present, and none where there were not; that even in cases with identical external cues and physical parameters, there would still be individual differences. This latter point is an important one as it addresses the counter-hypothesis that the psi experience is purely imagined, as opposed to an imaginatively enhanced detection, for an imagined event would tend to show a degree of consistency that is often lacking in real-life.

On an anecdotal level, poltergeist events and hauntings are often thought to start when there has been a change in the physical state of the site, such as building work (Gauld and Cornell, 1979). There have also been some academic research into physical properties of sites (e.g. Devereux, 1993) and how this may affect, both physically and psychologically, the experience of someone at that site. Persinger (1976) has looked at the possibility of seismic events being related to psi phenomena, especially piezoelectric fields, thunderstorm field interactions and local geomorphology, concluding that physical measurements should be made whenever possible while the phenomena is occurring, or as soon afterwards as is possible. He actually mentions what he calls "anthromorphic interpretations of... natural phenomena" but adds this to a list of complicating factors in psi experiences rather than including it as a key point as in the current model. Maccabee (1994) reports on measurement of strong magnetic fields around the location of a UFO sighting, saying that this could be taken either as evidence for the physical existence of the UFO, or as a causal factor giving a UFO experience. As a specific site gains in reputation as a UFO hot-spot, then subsequent visitors to that site may be more willing to ascribe any unusual sensations caused by the magnetic field to the presence of a UFO. Smith (1994) reports on unusual experiences relating to peak exposure sites in the path of military radar. He suggest that the radar beams might cause 'hot spots' of unusually high or specifically patterned electromagnetic radiation which may affect sensitive people, resulting in 'unexplained' sensations and experiences.

Psi as music

Assuming the above analysis of the cognitive processes which occur in a psi experience are correct, could there be information gained from the signal other than

the basic excitation pattern, possibly involving some higher cognitive processes other than semantic content? That is, if the signal does not correspond to a pattern of physiological activity within the receiver, and there are no external cues to aid the creation of a correlatory response, could the signal itself still be said to be conveying information to the receiver as part of the psi experience?

An interesting analogy which may help to answer this question is of the perception of music. If we take the psi induced perturbation of the cells to be the notes, then a specific pattern of excitation would correspond to the rhythm and the tone; basic emotional responses are musical phrases, and more abstract information is equivalent to an overall musical theme composed of multiple phrases. Like music, the psi signal is proposed to be a representation of something, especially an emotional state. The interpretation of the music will be dependent both on the form of the music but also on psychological and physiological differences in the individual. Different interpretations will be put on the music depending on the location (the acoustics of the site where the music is heard) and on the initial psychological state of the listener. There will be cases where the composer intended to convey awe and majesty, but the listener hears pomposity, or where the listener's appreciation of the music is guided by the situation in which they first heard it. So, in musical terms, the question becomes: if the form of the music itself does not evoke the composer's desired emotional state, and the music is of a style that is new to the listener so that they do not know what that type of music is intended to convey, nor is there anyone else listening to this music whose reactions can be used as a cue, what other useful information could there be in the music? To answer this, let us consider the processes involved in the perception of music (Roederer, 1995)

First of all, the external signal is converted to neural signals via transduction in the ear. This part is analogous to our psi-signal perturbation of cellular gating activity. For music, this conversion involves an analysis of both the *temporal* pattern of variation of the sound waves and of the *spatial* excitation pattern. Features that repeat through time - the successivity of events plus the order of those events - are related to the perception of the pitch of the music, whereas spatial features - the amplitude of the sound waves, the superposition of different frequencies, their angle of incidence - correspond to the perception of direction, distance, loudness and timbre (this last has been alternatively described as the *sound colour*). For psi, we are proposing a process which modifies the rate of gating (a temporal feature) and which can aid excitation of specific patterns of

activity (a spatial feature, possibly with a temporal components). The direction of the psi signal may possibly be gained from time delays or interference patterns in the signal structure; the loudness would relate to the intensity of the signal or to the intensity of the response; the timbre would relate to the complexity of the signal; the distance may be the only feature lacking as the (spatial) strength of a signal which modifies (temporal) gating features would be difficult to detect.

The music-related neural signals are conveyed to the primary cortical receiving areas, and then transferred to secondary and association areas, to the frontal lobes for further analysis, and then on to the rest of the brain. This final stage relates to the degree of success of prediction-making operations that expedite identification of the tone-message, and to the type of associations that the music has, which are evoked by a comparison with stored information on previous experiences. Roederer (1995) concludes that it is "...obvious that both innate neural mechanisms (primary processing operations) *and* cultural conditioning (stored messages and learned processing operations) must control our behavioural and aesthetic response to music.", a statement which closely parallels my division into form one (basic response to signal structure) and form two (correlatory response with external cues) participant experiences. To paraphrase Roederer: "both innate physiological mechanisms (primary detection operations) *and* cultural conditioning (expected responses and learned processing operations) must control our behavioural and aesthetic response to psi !"

So, for our psi signal, in the absence of a state-specific physiological response and where there are no external cues, what is left ? The answer lies in the actual structure of the psi signal and which characteristics of it that can be perceived. In the music analogy, we are left with attributes such as the sequence of temporal events, and the spatial patterns that relate to timbre, and so on. Could the same be true of psi ?

For temporal events in music, the spatial maxima (the peaks of the sound wave amplitude) are most distinct for lower harmonics, so lower frequencies (with respect to the possible detection rates of the ear) could give more discernible information. Higher frequencies give less time to discern the characteristics of the wave-form, and may start to blend into a continuous, featureless tone if they are too high. It seems likely that the same would be true of a psi signal. Cells must have a maximum rate of response, so there will be a range within which psi signals can be detected. As biological systems have similar cell morphology, psi signals which originate in a biological system are likely to be within a specific frequency

ranges (or show windows within a range). Successful detection of the signal and perception of the rate of detection could then provide a basic indicator about the nature of the originating system, living or otherwise. It may be true that specific species (or maybe different sexes !) have associated psi 'timbres', possibly allowing a 'my species' vs. 'not my species' distinction - something that, from an evolutionary point of view, could be a useful early warning sign. Perhaps a 'sense of presence' occurs for any non-specific signal that lies within a particular band of frequencies (possibly those corresponding to the EEG recorded frequencies) - we are most likely to recognise (and hum along to!) the 'music' of our own species, but can also appreciate the music of other living systems. Even with non-living systems, we may be able to get some idea of the basic rhythm.

Finally, even the presence of a specific psi 'tone', akin to the warning call of animals, may be a useful survival tool that bypasses normal consciousness and evokes an hard-wired response. Ho (1993) reports on research looking at swarm and flock responses, suggesting that an electromagnetic, or other non-audio energetic signal, propagates through the individuals to directly trigger a behavioural response. Although computer simulations have shown that flocking behaviour is possible purely by reacting to neighbouring individuals, other researchers have pointed out that this seems to require reaction times faster than sensory channels should allow for. A signal which acted directly on the nervous system would give sufficiently small reaction times.

It is also interesting that the psi-music analogy serves to bring up some further parallels. Roederer (1995) found that centres in the left hemisphere of the brain were active in detecting rhythm, and short-term melodic sound sequences, whereas the perception of a holistic melody (the music itself) was related to right hemisphere functions which process spatial integrations and long-term time representations (musical perception involves the analysis of spatial excitation patterns along the auditory receptor organ, caused by musical tones and tone superpositions, as well as the analysis of long-term time patterns of melodic lines). That is, the left was involved with basic detection, the right with higher, more abstract information. This processing bias could imply that the best utilisation of psi, in terms of abstract information gain, would be by people with right-hemisphere dominance - something that has been suggested by a number of authors. For example, Stanford (1977) reports on a number of studies which found better performance in musical or otherwise artistic people, who are thought to typically exhibit right hemisphere dominance, in ESP tasks involving real

information transfer. This has been replicated in some of the more recent Ganzfeld ESP studies (Dalton, 1997)

Poetic musical analogies aside, much of the above is based on the basic concept of the learned correlatory response, and its use in subsequent psi experiences. To look at this idea in more detail, a simple PK protocol study was carried out, comparing a group who were given the opportunity, and encouraged, to develop this response, with a group for whom an attempt was made to disrupt such a response.

Experiment: Orientation to target system in a PK protocol

PROCEDURE

Participants: All participants were self-selected volunteers recruited from posters placed around the University environs. All were randomly assigned by a computer-based pseudo-random algorithm to either the orientation or the null-orientation condition, such that both conditions had equal members.

It was decided before the study started to use 60 participants. This number was based on the reported effect size in the PK meta-analysis (Radin and Nelson, 1989) of 0.0003. For an effect of this magnitude, to reach a z-score of 1.645 (significance at the p=0.05 level), 7,516,736.11 bits need to be collected. This reduces to 52.2 sets of 144,000 bits. Rounding up to the most convenient value gives the chosen number of participants. Please note this is to 'ensure' an *overall* PK effect i.e. 144,000 bits were collected in each condition.

Equipment used: Random binary digits were generated using an serial interface RNG (available from Professor Dick Bierman, University of Amsterdam) based on two Zener diodes. The RNG was subjected to a number of randomness tests, both parametric and non-parametric, before use. Tests showed good random operation over a variety of run -lengths. The only exception was that a significant excess of runs (as detected by the non-parametric one-sample runs test) was occasionally generated only when samples of 50 bytes or less were taken. As the current study had a minimum sample size of 3600 bytes, the randomness of the device was sufficient.

The RNG was connected to an IBM compatible 486 computer with an EGA colour display. The feedback display used was generated on screen by a program written by the author in C++ and compiled to executable code. Once the program had been initiated, it could be interrupted only by knowing the combination of key presses and security code. If this was attempted unsuccessfully, an alarm was sounded and program operation suspended. There was no other way to interfere with its operation short of resetting the computer, which would then require the entering of a password before it started a new session.

Feedback Display: This consisted of a 24 cell by 24 cell matrix displayed on the computer screen. Figure 2 shows a schematic diagram of the screen appearance. The currently blank 'Influence matrix' - the area in which the RNG output will appear - is on the left; the Target pattern - a fixed, preset pattern - is on the right. The information bar presented prompts for initiating key presses, selected mode, and so on. The screen was predominantly a light grey colour with dark grey text.

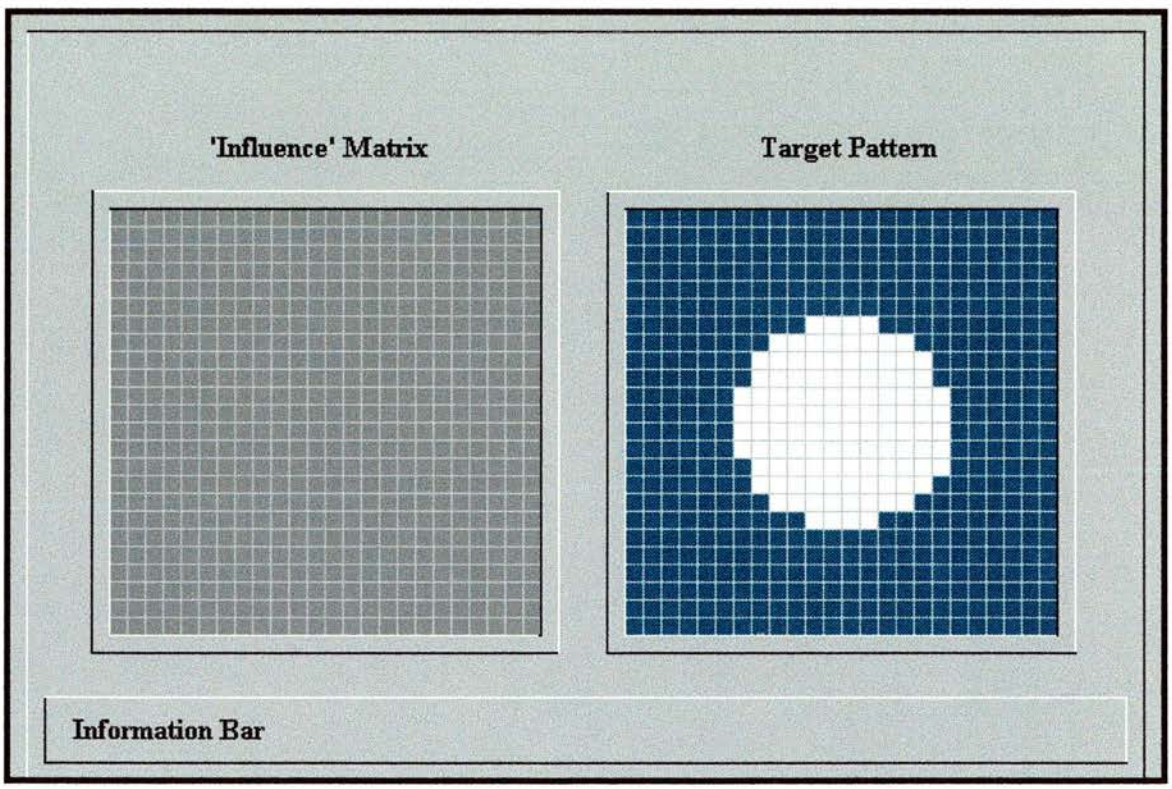

Figure VIIb: schematic diagram of feedback display

Binary events were used sequentially to determine the appearance of each cell. In binary mode, a '0' was displayed as a dark blue square, a '1' as a white square. The first bit generated determined the appearance of the cell in row 1, column 1, the next bit the appearance of cell (1,2), and so on up to cell (24,24). This provided real-time feedback, but would give feedback over time only if there were a large and consistent PK effect.. In cumulative mode, the cell colour depended on the length of runs - the more consecutive 0s, the darker blue the square; the more consecutive 1s, the brighter yellow. Purely binary variation (i.e. 101010) was displayed as a neutral grey colour. This mode thus gave the participant some indication of how much influence they were having over time, and led to a more dynamic display. The decision as to which display the participant would see first was randomly assigned, again with the condition that both cumulative-binary and binary-cumulative ordered groups contained equal numbers of participants. As the cumulative display gave some indication of success over time, it was predicted that this display would result in a higher degree of PK influence.

For both modes, the preset target pattern was displayed next to the feedback grid, participants being asked to attempt to recreate this pattern on the feedback grid by influencing the RNG output. This allows the possibility that, even if the number of 1s and 0s conforms to the expected chance values, a PK influence could still be seen by the participant through the appearance of the pattern (i.e. the distribution of the binary numbers), rather than having to wait for a battery of statistical analyses. Such an approach also makes use of the well known human capability of seeing patterns in randomness, whether they are actually there or not, This may serve to boost the participant's confidence. The preset pattern appeared either white on black or black on white, this being pseudo-randomly determined before each run.

HYPOTHESES

Feedback

H1a: Baseline deviation will be greater for the cumulative than for the binary display.

H1b: Pattern correspondence will be greater for the cumulative than for the binary display.

Orientation

H2a: Baseline deviation will be greater for the orientation than for the null-orientation condition.

H2b: Pattern correspondence will be greater for the orientation than for the non-orientation condition.

The existence of a significant PK effect should be apparent from the calculated z-scores used in the above comparisons, and will be reported. Any deviation from the control baseline, or any pattern correspondence, in the orientation periods will also be looked for. However, the purpose of the study is to test some aspects of the proposed model, rather than to attempt to add yet more proof to the already large PK database.

EXPERIMENTAL CONDITIONS

ORIENTATION VS. NULL-ORIENTATION: during the orientation period, participants in the orientation condition experienced the true random number generator (TRNG) in operation. Members of the null-orientation group experienced the pseudo-random (computer algorithm) number generation, only experiencing the TRNG during the PK attempt sessions. Both groups had 30 participants who had been randomly assigned.

BINARY VS. CUMULATIVE FEEDBACK DISPLAY: each participant will experienced an orientation period and a PK influence period with both of the displays. Half of the participants experienced the binary and half the cumulative display first.

METHOD

Before the participant's arrival, a 10-run control session of the RNG was initiated with an in-built delay to allow the experimenter time to leave the room. It was hoped this would minimise the possibility of experimenter PK Participants were then met at the Psychology department entrance and escorted to the room where the experiment was to take place. When ready, participants were seated in an upright, comfortable chair in front of the feedback display. The experimenter remained in the room, seated behind a screen. The procedure for the coming session was detailed and they were encouraged to ask questions about any aspect that was unclear. They then listened to a short seven minute progressive relaxation tape to reduce muscular tension. By promoting this inward-attentive state, such as

is used in ganzfeld ESP studies, any noise due to somatic processes may be reduced. It was hoped that this would allow any modifications or constraints within the participant's body that may correlate with the feedback to be noted as they watched the display. By asking for a self-report on any subjective impressions - mental images, feelings or sensations - any such correlations may be discovered, even if they are registered only on an unconscious level. In such a case, the generation of spontaneous feelings or symbolic imagery, as has been found in subliminal perception studies (Bornstein and Pittman, 1992) might be expected. No attempt was made to assess how confident participants were about the coming task, nor their general belief in the paranormal. Such questions, it was felt, might induce anxiety, either by implying difficulty or by emphasising the 'paranormal' nature of the task. During all of the periods, the participant's description of their internal-subjective state was noted on paper by the experimenter.

The experimenter started the no-feedback period (5 runs) having instructed the participant to report any subjective impressions or experiences. During this period, the matrix and target pattern appeared on screen, but no information about the RNG was displayed. Next, either the binary or cumulative feedback period was started (5 runs), the participant having been instructed to passively watch the display, again reporting any subjective impressions. At the end of this first feedback-orientation period, any reported impressions were discussed, especially if the participant had felt there were any correspondences between their impression and the display. If there were no correspondences, the experimenter attempted to discover what the dominant or most striking impressions were. If there were also none of these, the participant was encouraged to induce the same non-eventful state. In other words, no matter what the participant experienced, this was presented as being a positive result, although it was not sure whether a 'non-eventful' state could be recreated or whether such would be expected to have any effect in the influence session. When ready, the first influence session was started (5 runs), the participant instructed to recreate any internal states that s/he thought were related to the desired output. The orientation and influence periods were then repeated using the alternative display.

After the session had finished, data was archived and encrypted on floppy disk. The participant was debriefed as to the ideas behind the experiment and escorted out of the building. Meanwhile, another control run was performed. It should be noted that, being seated behind a screen, at no time could the experimenter see the screen while the display was active, and that he concentrated

as much as possible on performing an external task (e.g. writing down the mentation) rather than on his own internal state. By taking these precautions, it is hoped that any experimenter effect was minimised.

RESULTS

For the 'baseline deviation' - the number of 1s and 0s compared to the control period data - the absolute z-scores for deviation from control baseline were calculated for each period. For the 'pattern correspondence', the z-score for each cell with respect to the desired direction was calculated and combined to give a z-score for the entire matrix, for each period. All binomial probabilities in the statistical analysis used control period data to calculate exact probabilities. Although the RNG was extensively tested, and although the control run performed before each session was tested for any deviation from expected chance values, it was decided to that this technique would ensure that any non-random-bias in the RNG, however slight, would be compensated for. As the author is presenting a model which postulates an interaction between the RNG and its environment, it seemed sensible to allow for the possibility of varying environmental conditions altering the output.

Due to a series of computer failures during this study, one involving a complete hard disk failure in which the C++ program was corrupted (fortunately backups had been made of all the data), a small mistake was made in producing the replacement program wherein the number of participants already run in each condition was incorrect by 6. As a result, the end analysis found that there were actually 36 participants in the orientation group, and only 24 in the null-orientation group. It is unlikely that this would have a significant effect on the findings.

Raw data was reduced using a C++ computer program written by the author. All subsequent analyses were performed using the Systat statistical package (version 5.0).

Summary of Data:

No significant deviations from expectation were recorded for the pre-session control run data. In all cases, the calculated values given were statistically equivalent whether the empirical control or theoretical baseline values were used.

Table VIIa: Baseline deviation (z-scores)

	Orientation group (N=36)		Null-orientation group (N=24)	
	Binary	Cumulative	Binary	Cumulative
Maximum Absolute Deviation	3.34	2.98	2.13	2.24
Mean absolute deviation	0.969	0.784	1.129	0.757
Standard Deviation	0.837	0.732	0.537	0.695

Each influence period was composed of 5 consecutive attempts but, as the strategy for each of these attempts was the same, it was decided to combine the individual z-scores to give an overall score for the period. As can be seen from table 1, any overall PK effect (measured as any deviation from the RNG's baseline behaviour) was very small. In fact, the mean z-score for the binary-feedback orientation condition was actually slightly less than that for the null-orientation condition, and almost identical for the cumulative-feedback condition.

Table VIIb: Pattern correspondence

	Orientation group (N=36)		Null-orientation group (N=24)	
(z-score)	Binary	Cumulative	Binary	Cumulative
Best Match	3.15	1.95	2.55	2.34
Mean z-score	0.095	-0.465	0.017	0.335
Std. Dev.	1.176	1.280	1.290	1.226

The overall scores for pattern correspondence are again very small, being larger in the orientation group with the binary feedback, but smaller for the cumulative feedback. However, in the latter case, the negative score indicates a closer match to a negative image. That is, the RNG output appeared to conform to a reversed target pattern. (see discussion).

Distribution of z-scores

Figures VIIc-f show the distributions of the overall z-scores for each of the conditions (orientation vs. null orientation for each of the two feedback displays), for both the baseline deviation and the pattern correspondences. A smoothed curve showing an assumed normal distribution has been overlaid on each histogram to make any skew more apparent.

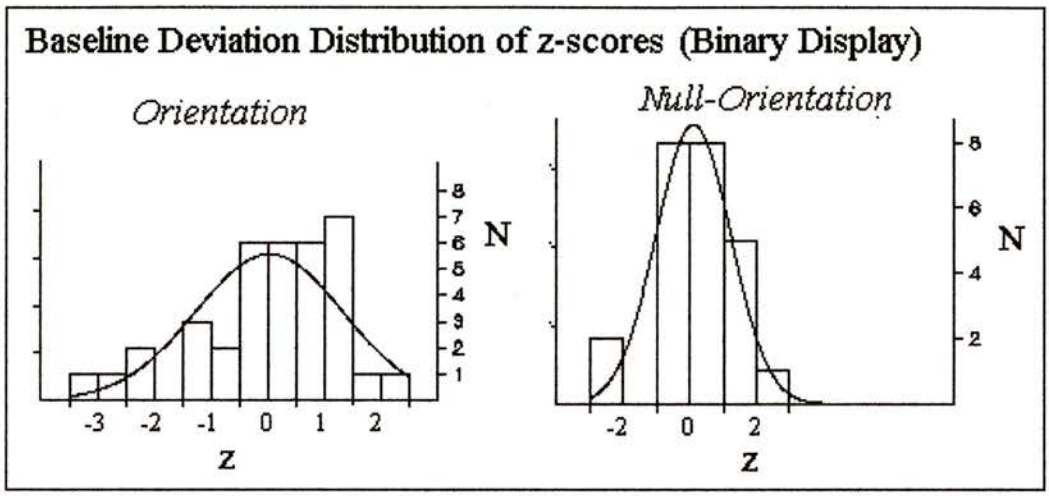

Figure VIIc

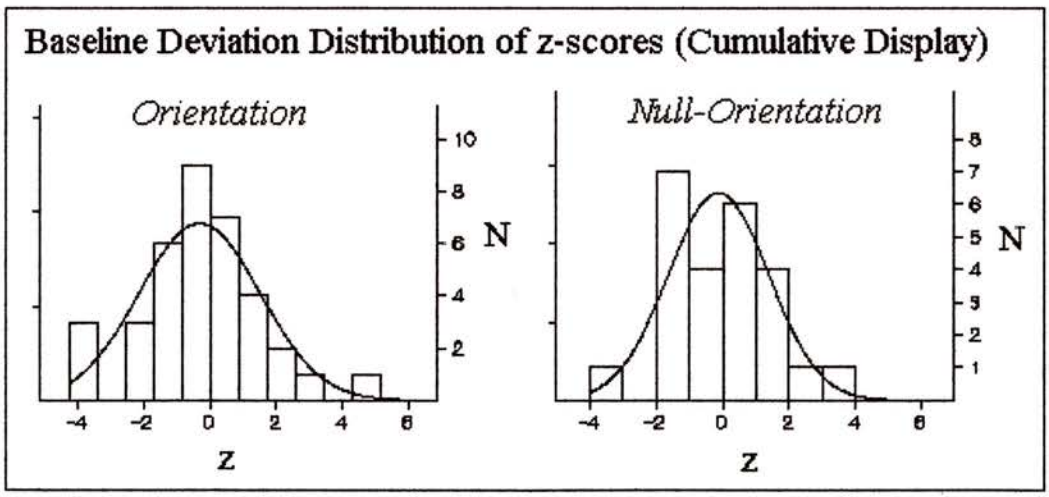

Figure VIId

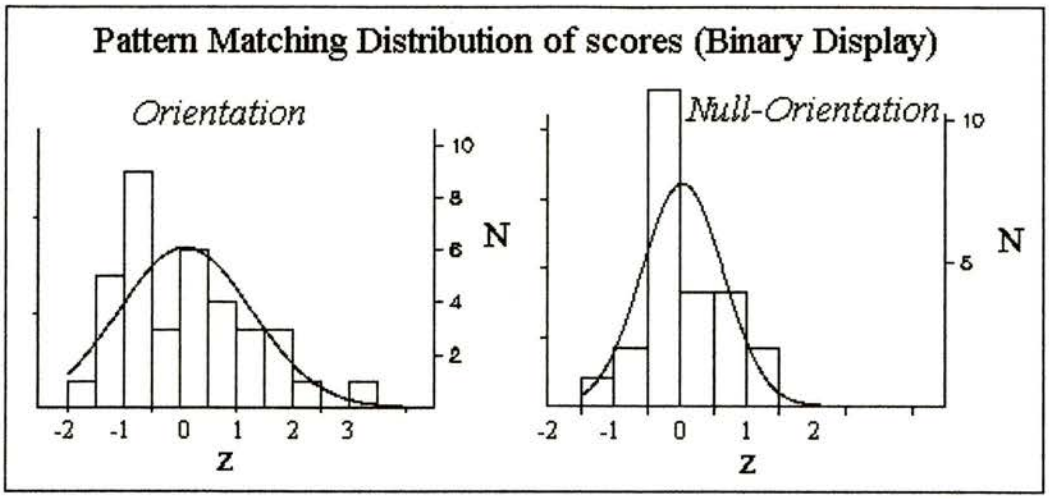

Figure VIIe

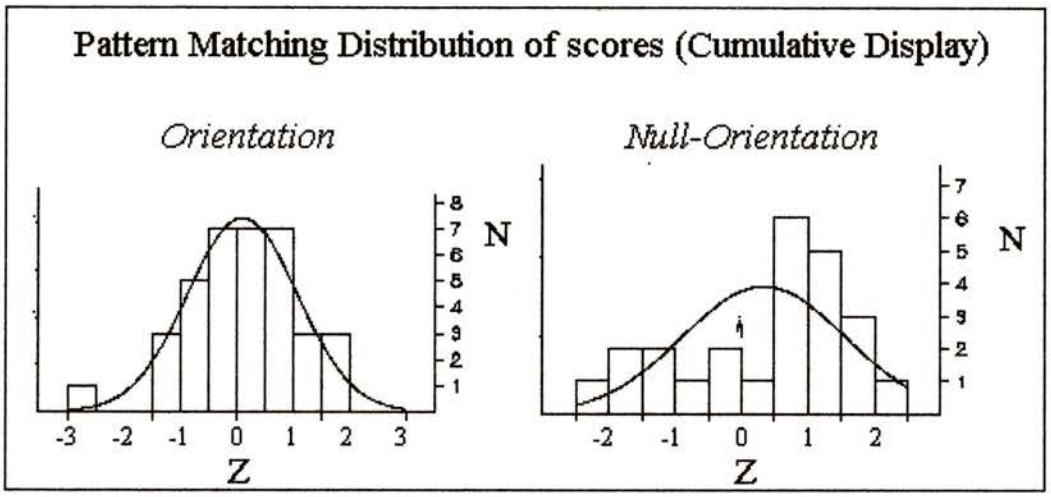

Figure VIIf

Test of hypotheses

For all tests, influence and post-control conditions were reported as these were the only conditions where a comparison could be made. Comparison of other conditions would involve contrasting pseudo-random with true-random data.

Table VIIc: T-test results testing H1a - *Baseline deviation will be greater for the orientation than for the null-orientation group.*

Absolute z-scores	t (df=58)	prob (1-tailed)
Binary influence	-0.505	0.308
Cumulative influence	1.844 *	0.035
Post-control	-0.516	0.304

*direction opposite to prediction

Based on the means of the z-scores for each session, the hypothesis was not supported, with the cumulative influence showing a significant effect in the opposite direction to that predicted.

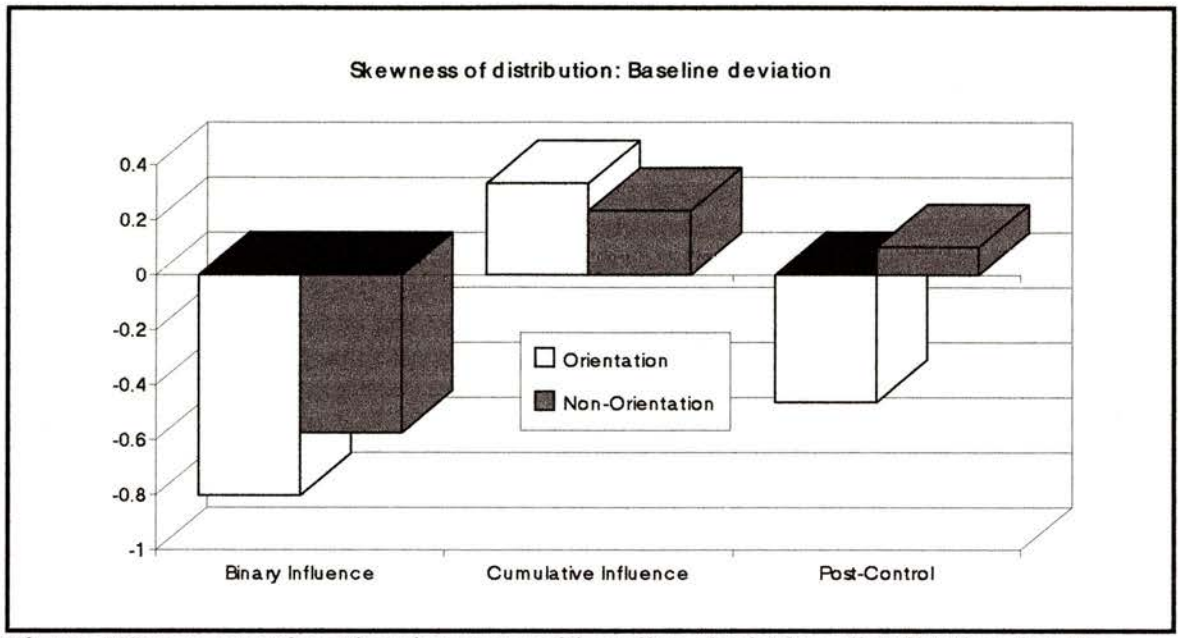

Figure VIIg: comparing the skewness of baseline-deviation distribution for the two conditions.

As a comparison of means for each group makes the assumption that all of the participants are contributing to the final mean score (i.e. all are utilising PK), this may not be the most sensitive way of determining if the experimental condition was effective or not. If we assume that there will be a lot of noise from participants who were unsuccessful at utilising PK, then we expect that the orientation/null-orientation condition would affect only the remaining participants. This might be reflected by a higher proportion of deviations large in magnitude in the orientation group, skewing the distribution. Figure VIIg shows the skewness (using the G1 skewness measure) of the z-scores for each condition for the influence periods. In all periods, the orientation group achieved larger deviations from baseline. This was also true of the post-control period. It should be noted that for the baseline-deviation, the direction of the skew is unimportant - the presence of any deviation was sufficient. However, the consistency of the direction of the skew for each of the two displays may be taken as evidence that the results show a valid effect and are not due only to chance variations.

Table VIId: T-test results testing H1b - *Pattern correspondence will be greater for the orientation than for the null-orientation group.*

z - scores	t (df=58)	prob (1-tailed)
binary influence	-0.102	0.469
cumulative influence	0.836*	0.204
Post-control	-1.924	**0.030**

Bold type indicates significance was reached.

* = direction opposite to prediction

For the binary feedback, the trend was in the predicted direction, but the data did not reach significance for the influence session. Cumulative feedback was in the opposite direction to that predicted. It is also interesting to note that there was a significant difference between conditions for the post-control period, in the predicted direction !

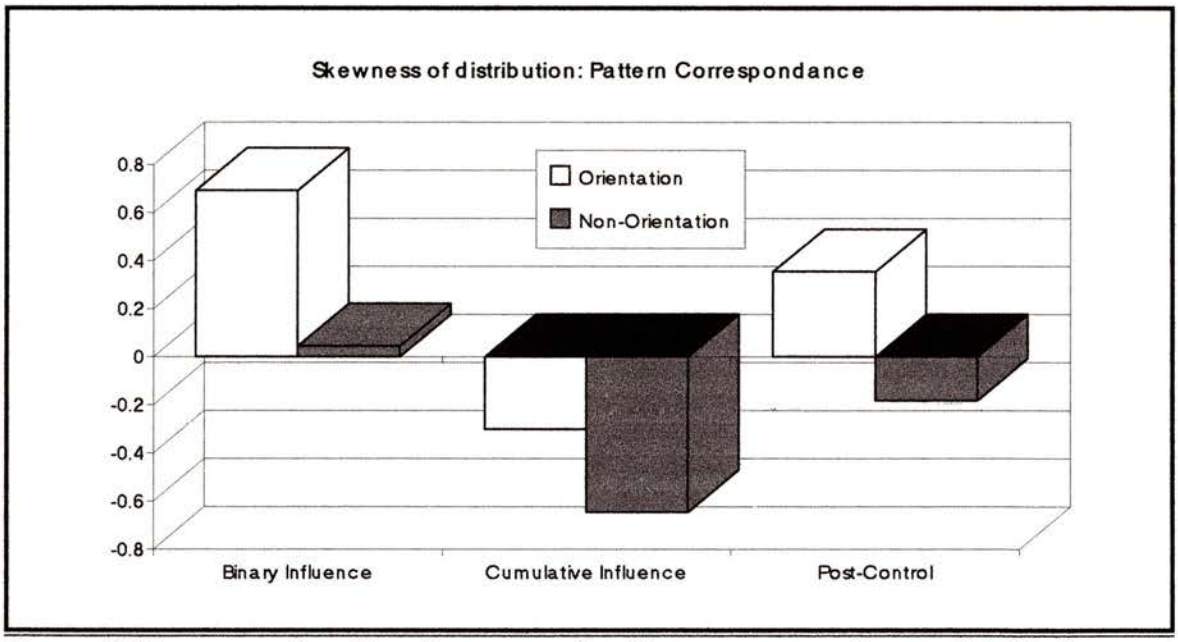

Figure VIIh: comparing the skewness of pattern-correspondence distribution for the two conditions.

As before, it seemed worthwhile to compare the skewness of the distributions of the z-scores. In this case, a positive skew would indicate that the

display was better matching the target pattern, whereas a negative skew would indicate an inverted target pattern.

Figure VIIh shows that, for the binary influence period, there was a strong positive skew, indicating that more people in the orientation group achieved some degree of pattern correspondence. That the pattern correspondence was skewed negatively in both conditions for the cumulative influence period may be another indication that the colours of the cumulative display served to confuse rather than aid participants. Again, the direction of the effect was consistent within conditions, possibly indicating that this was due to the nature of the display rather than a chance occurrence. Why in this instance the effect was actually stronger for the non-orientation condition is not known.

Table VIIe: T-test results testing H2a - *Baseline deviation will be greater for the cumulative than for the binary display.*

z-score	**t**	**df**	**prob (1-tailed)**
Overall	1.011	59	0.316
Null-orientation	0.607	23	0.275
Orientation	0.807	35	0.425

Although in the predicted direction in all cases, none of the t-test results were significant.

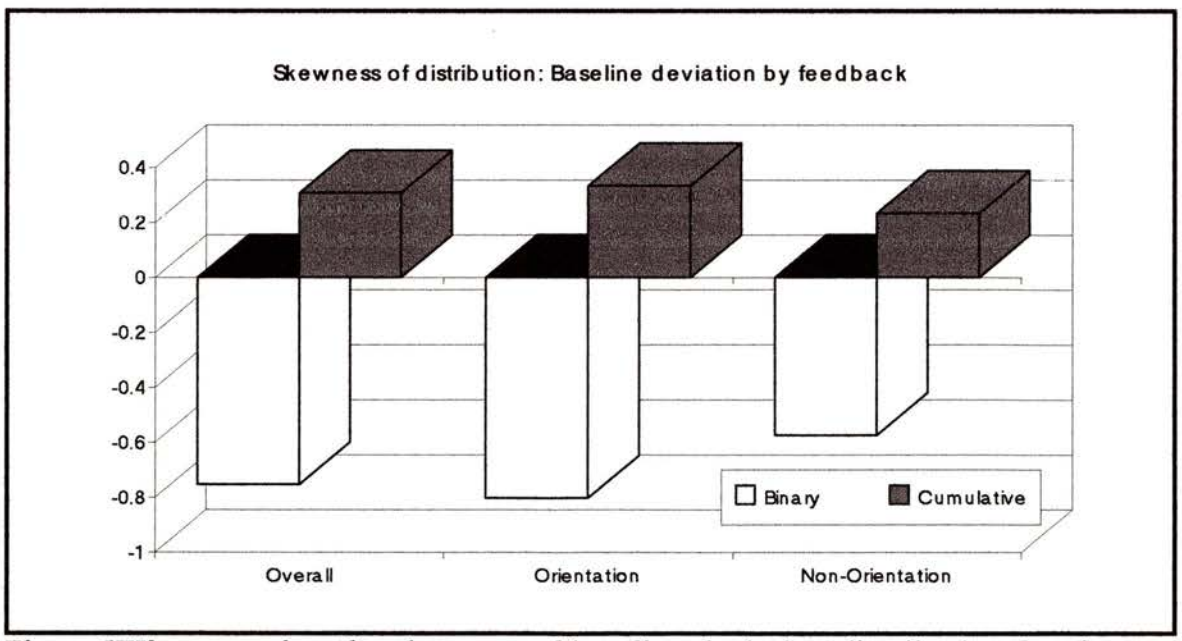

Figure VIIi: comparing the skewness of baseline-deviation distribution for the two feedback displays.

Once again, as a test of the means may swamp any small effect, a comparison was made between the shape of the distributions. A consistent effect was seen between the two orientation conditions, where the binary display showed a greater skew than the cumulative. As this is opposite to the expected effect, hypothesis H2a must be rejected.

Table VIIf: T-test results testing H2b - *Pattern correspondence will be greater for the cumulative than for the binary display.*

z-scores	**t**	**df**	**prob (1-tailed)**
Overall	-0.506	59	0.308
Null-orientation	-0.709	23	0.243
Orientation	-0.008	35	0.497

Although in the predicted direction, the difference between the two feedback displays was not significant for the pattern-correspondence scores.

Again looking at the skew of the distributions, there is a positive skew for the binary display and a negative skew (a higher proportion of inverted pattern matching) for the cumulative display. The binary display effect was of a greater magnitude in the orientation group, whereas the cumulative display showed greater inverted matching in the null-orientation group. Results are thus mixed, but do not clearly support the hypothesis.

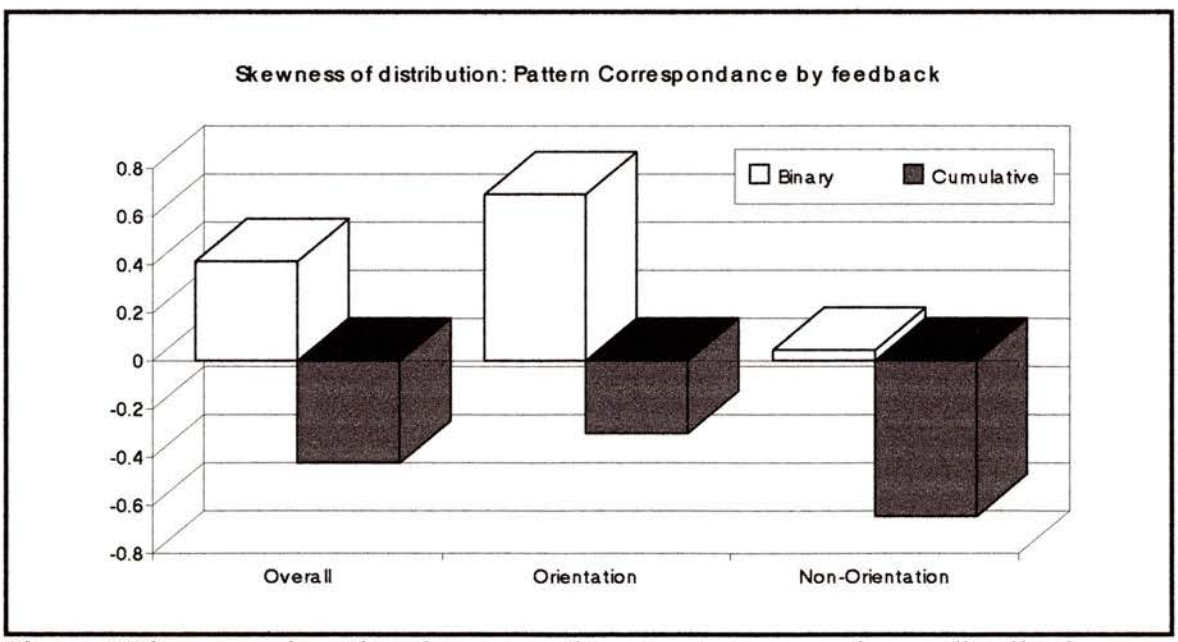

Figure VIIj: comparing the skewness of pattern-correspondence distribution for the two feedback displays.

Further exploratory analyses to test the model

If the model is correct, then it would be expected that there would be associations between certain psychological variables and the outcome of the PK task. 'Deviation' represents the mean of the absolute baseline-deviation z-scores within each condition; 'Pattern' is the mean of the pattern-correspondence z-scores with in each condition. For all the tables below, the Spearman's r was also transformed into a z-score (using the approximate method $z = r\sqrt{n-1}$) and the p-value quoted. Although it is thought that the patterns of correlations are more indicative of the validity of the model, the strengths of the correlations themselves are more informative if the p-value is given, due to the varying number of returns for some of the questions asked.

- **Is PK related to the ability of the agent to monitor their internal states?**

Table VIIg: Spearman Correlations of results, amount of mentation and self-reported factors

(a) Binary Display

	Orientation Condition		Null-orientation Condition	
	Deviation r (p)	Pattern r (p)	Deviation r (p)	Pattern r (p)
Mental Imagery (Binary Display)	***0.124** *(0.50)*	0.081 *(0.66)*	***0.109** *(0.61)*	-0.348 *(0.10)*
Mental Imagery (Cumulative Display)	0.091 *(0.62)*	**0.031** *(0.87)*	-0.190 *(0.37)*	**0.352** *(0.10)*
Self-report Relaxation	0.048 *(0.79)*	**0.177** *(0.34)*	-0.133 *(0.54)*	**0.036** *(0.87)*
Practise of mental discipline	0.068 *(0.71)*	-0.052 *(0.78)*	-0.013 *(0.95)*	0.317 *(0.14)*

Bold type indicates that correlation is directionally consistent across the orientation conditions.

* shows a correlation that is also consistent in order of magnitude

The mental imagery measure used was the overall score of three PIF questions asking about ease of production and vividness of mental imagery. It was expected that those participants who scored high would be better at internal self-monitoring and so would, under this model, be better at PK. This appeared to be true only for the baseline deviation with binary feedback, and for pattern correspondence with cumulative feedback. Self-reported relaxation was related to the pattern correspondence score, with a greater correlation being found in the orientation condition as expected. The mental discipline practise was a simple yes-no answer.

As expected, there was a positive association between imagery and the baseline deviations, though only for the binary display. This was consistent between conditions, and also ties in with the findings so far that the hypotheses have been supported mainly for the binary display only. The expected association between the degree of relaxation, practise of a mental discipline and the final score were not supported.

- **Is PK ability will related to the agent's ability to perceive the correlations between internal and external stimuli, and to other aspects of the agent's psychology ?**

Table VIIh: Spearman Correlations of results and psychological factors

	Orientation Group		Null-orientation Group	
	Deviation r (p)	Pattern r (p)	Deviation r (p)	Pattern r (p)
Ambiguity Tolerance	**0.301** *(0.14)*	0.403 *(0.05)*	**0.458** *(0.05)*	-0.153 *(0.52)*
Control	-0.324 *(0.04)*	**-0.266** *(0.14)*	0.215 *(0.36)*	**-0.074** *(0.76)*
ESP Belief / Experience	**0.246** *(0.19)*	**-0.133** *(0.47)*	**0.395** *(0.06)*	**-0.366** *(0.09)*
PK Belief / Experience	**0.084** *(0.65)*	**-0.238** *(0.20)*	**0.379** *(0.08)*	**-0.008** *(0.97)*
Machine Breakdowns	-0.105 *(0.57)*	0.031 *(0.87)*	0.099 *(0.65)*	-0.392 *(0.07)*

Bold type indicates that correlation is directionally consistent across conditions.

Ambiguity tolerance was measured using the AT-20 (MacDonald, 1970). Control was the control sub-scale of the Multidimensional Personality Questionnaire (Tellegen, 1982). The other measures were the overall score from questions on the Koestler Parapsychology Unit participant information form (PIF) asking about belief and experience of ESP and PK, and about the incidence of machine malfunctions. The control sub-scale and all the PIF questions used a seven point Likert-type scale.

It was expected that ambiguity tolerance would be positively correlated with PK, as ambiguity tolerant people may be better at both synthesising a pattern from the postulated weak environmental 'signal' and the feedback display, and also at coping with the general uncertainty of the situation. This association was found for both baseline deviation and pattern correspondence in the orientation group, but only for the baseline deviation in the null-orientation group. Possibly this is due to the confusion caused by the false feedback in the latter condition, resulting in a unexpected correlation.

For the control sub-scale, people with high control scores were considered to be better at long-term predictive modelling (the MPQ sub-scale is concerned more with the planning out of activities) but that this could be at the expense of detail, depending on the cognitive abilities of the individual. Conversely, people with low control scores would be worse at long-term predictive modelling, but may be better at short-term, giving a greater bias to detail. This would mean that, under the current model, low control score people would be better at real-time PK, being better at the short-term, detailed modelling needed to match internal states with external events. This was indeed the case for the orientation condition group (significantly so for the baseline deviation measure), but was not the case for the null-orientation condition group. Again, this appears to support the model as the latter group's modelling ability would be useless with the false feedback given in the orientation period.

As expected, experience of and belief in ESP and PK correlated positively with baseline deviation, but it was surprising to find that it correlated negatively with pattern correspondence. These findings were consistent across conditions.

There were no consistent findings between the scores and the degree of machine malfunction experienced in everyday life. The strongest correlation was

for the null-orientation pattern correspondence, where machine malfunction was inversely related to pattern correspondence score. This could indicate that machine malfunctions are sometimes related to uncontrolled PK effects but that the people who experience such malfunctions are able to avoid uncontrolled PK effects when there is adequate feedback.

Internal PIF Correlations

Table VIIh: Spearman Correlations of PIF factors

	Orientation group r *(p)*	Null-orientation Group r *(p)*
ESP : Mental Discipline	**0.579** *(0.002)*	**0.125** *(0.56)*
PK : Mental Discipline	**0.204** *(0.27)*	**0.145** *(0.50)*
ESP : Machine Breakdown	-0.090 *(0.63)*	0.029 *(0.89)*
PK: Machine Breakdown	**-0.169** *(0.36)*	**-0.065** *(0.76)*
ESP : PK	**0.412** *(0.03)*	**0.539** *(0.01)*

Bold type indicates correlation is consistent across conditions.

As expected, the number of ESP and PK experiences was related to the practise of a mental discipline. Under the model, such practitioners would be better able to self-monitor their internal states and so would be more able to gain information from their environment (ESP) and to use that information to create their own, or utilise existing, modifications (PK).

ESP belief/experience was not related to machine breakdowns whereas PK belief/experience was inversely related. Again, this is consistent with the proposed model. As such phenomena are (presumably!) not desired, PK-related machinery malfunctions would be the result of uncontrolled PK. The model predicts that ESP occurs before PK can occur in a controlled manner. Thus, people without ESP experiences would have less control and could experience more malfunctions.

However, people who experience PK phenomena, and recognise them as such, may be more likely to start to notice internal changes that apparently relate to external (especially unusual) phenomena, thus increasing their control and decreasing the number of malfunctions.

Finally, as the model suggests ESP as being a necessary precursor to PK, there should be a correlation between the number of ESP experiences and the number of PK experiences. This was indeed the case, showing a significant correlation in both conditions.

Cross-modal test

As there has as yet been no evidence for a specific psi detector in the human brain or body, it was thought that environmental detection may be perceived cross-modally. That is, the physiological changes may be noticed as a series of percepts unrelated to the perceptual task being undertaken (i.e. watching the feedback display). It was decided to look at the mentation supplied by each participant during the orientation period and to assign a code of -1 if there was no imagery reported, a 0 if there was imagery but it was unremarkable, and a 1 if the imagery was either very surprising to the participant, if the imagery was copious and detailed, or if cross-modal mentation was reported (e.g. 'I feel like I'm being pushed backwards in the chair - feels like I'm getting smaller', '

Table VIIi: Spearman Correlations of mentation predictors

Predictor for:	**Pattern Correspondence** r *(p)*	**Baseline deviation** r *(p)*
Null-orientation	-0.134 *(0.52)*	-0.165 *(0.43)*
Binary	-0.022 *(0.91)*	-0.275 *(0.19)*
Cumulative	-0.009 *(0.97)*	0.001 *(0.99)*
Orientation	0.049 *(0.77)*	-0.081 *(0.63)*
Binary	-0.027 *(0.87)*	-0.003 *(0.98)*
Cumulative	0.122 *(0.47)*	0.117 *(0.49)*

As was expected, the predictors were inversely related to the results of the null-orientation group, with the strongest correlation for the binary feedback. Any

mentation would in this condition have represented noise as the feedback was false.

However, the orientation condition is less consistent. The correlation was positive (as expected) for the cumulative feedback, and but much smaller and negative for the binary feedback.

DISCUSSION

Based on the overall means, any PK effect in the data was very small and the effects of the orientation condition inconsistent. Looking more closely at the data, although no effects were found that were statistically significant at the p=0.05 level, some consistent patterns seem to emerge, offering some limited support for the model. The first hypothesis - that the baseline deviation would be greater for the orientation condition - was supported only for the binary feedback, being reversed for the cumulative display. However, looking at the skewness of the distributions revealed an effect wherein the orientation condition data showed a consistently stronger skew. This was interpreted as a possible indication that the orientation condition had the desired effect but that only some of the participants were actively contributing a PK effect to the data, the others representing noise.

The second hypothesis - that the pattern correspondence would also be greater for the orientation condition - was again only supported for the binary feedback display, being inverted for the cumulative feedback. This was also found when looking at the skewness of the distribution, where the binary display showed a much larger skew for the orientation condition.

The above results appeared to indicate that there was a difference in the results for the two types of feedback display. It was hoped a closer look at the effect of the display would further clarify this. The third hypothesis was that the baseline deviation would be greater for the cumulative display. This was supported in both conditions, though significance was not reached in any case. However, looking at the skewness of the distributions, it was found that the binary feedback gave a greater skew in all conditions, consistently negative. The cumulative feedback showed a consistently positive skew. This could indicate that the cumulative display enabled some individuals to produce a greater PK effect, but that more people were able to utilise the binary feedback to produce a smaller effect. The hypothesis is thus not supported.

The fourth hypothesis - that the pattern correspondence would also be greater for the cumulative display was again in the predicted direction but non-

significant in all cases. Once again, the skewness of the distribution shows a greater, positive skew for the binary feedback in all cases, and a lesser, *negative* skew for the cumulative display, which seems to indicate that the binary display was actually more useful. It is certainly true that the majority of participants expressed a preference for the binary display. This hypothesis is also not supported.

Further testing of the model involved looking at some psychological variables. It was expected that, for both conditions, the vividness and ease of production of mental imagery would be positively related to the final PK results, both for baseline deviation and pattern correspondence. This was found to be the case in the orientation group for both types of feedback, but true only for the binary-feedback baseline deviation and the cumulative-feedback pattern correspondence in the null-orientation group. It is possible that the correlations were mixed up due to the null-orientation participants being actively confused by the false-feedback rather than just less able to produce a PK effect. It was also expected that the degree of relaxation experienced by the orientation group participants during the session would be positively related to their final results. This was found to be the case, but was also true for pattern correspondence for the null-orientation group. Unexpectedly, no consistent correlations were found between PK performance and the practise of a mental discipline. There was some indication that such a practise was helpful to the null-orientation group when attempting to achieve a pattern correspondence. This could possibly indicate that, even in the absence of the learning period received by the orientation group, participants having trained in a mental discipline were better able to increase their PK performance, having a greater awareness of their own internal states and possibly greater control over them.

A high degree of ambiguity tolerance was expected to be correlated with PK performance in the orientation group as this should better enable participants to learn to make the weak correlations between the feedback and their internal states. There was also expected to be a lesser correlation with the null-orientation group as a higher ambiguity tolerance is also correlated with belief in the possibility of psi. Although the expected correlation was found in the orientation group, a stronger correlation was found for the null-orientation baseline deviation scores.

If the model is valid, then extrasensory perception (ESP) experiences, and associated belief, would also be correlated with the participants PK scores in both conditions (the detection of environmentally-induced internal changes is considered

to be related to ESP). This was found to be true only for the baseline deviation scores, being negatively correlated with the pattern correspondence scores. This was not related to an abundance of inverted but high magnitude pattern correspondences, so the reason for this is unknown. Possibly the pattern correspondence required a higher degree of control that was not related to the simple internal-external correlation that first needed to be made.

It was expected that belief in and experience of PK would be related to the baseline deviation scores, but it was unclear how this would relate the pattern correspondence. The correlations showed a positive relationship for the baseline deviation in both conditions, but again a negative correlation for the pattern correspondence. At the moment, the reason for this is not forthcoming.

Finally, the idea that people who suffer a high number of machinery-related breakdowns may be utilising PK in a psi-missing manner was studied by correlating participants' estimates of average machinery malfunctions with the PK results. If the idea has merit, then it would be expected that a negative correlation would be found with pattern correspondence (where the direction of PK is important), and a positive relation for baseline deviation, where only the magnitude of any effect was taken into account. This was the case only for the null-orientation group, being reversed for the orientation group.

Although not directly related to the model being tested, it seemed pertinent to include the correlations between the items on the PIF. Fairly strong correlations were found between both the belief-experience ESP and PK measures and the practise of a mental discipline, and between the ESP / PK measure themselves. This latter finding strengthens the idea that ESP and PK tend to go together and may be two parts of a single process as the model suggests. No correlation was found between the belief-experience ESP measure and machinery malfunctions, but the expected negative correlation was found for the belief-experience PK measure, albeit weak.

The last part of the study attempted to find a predictor of PK performance, based on the presence of cross-modal associations or surprising mental imagery. The predictor was correlated negatively with the PK performance of the null-orientation group as expected, but the expected positive correlation for the orientation group was found only in the case of cumulative feedback.

So what overall picture may be gained from these results? First is that allowing the participants to orient themselves to the target system seems in some cases to have increased their chances of achieving a PK effect. Although there was

some confusion relating to the type of feedback given, it seems safe to say that the data are suggestive of the orientation process making a difference to the outcome. The model may need to be improved, but it looks like a promising starting point.

Second is that the type of information contained in the feedback is important. The binary display, which gave real-time feedback, appeared to allow more people to achieve high baseline deviations whereas the cumulative display gave greater magnitude deviations, but for fewer people. Unless using pre-selected participants, future studies may find it advisable to stick with real-time feedback.

There is also the intriguing possibility that there are two different modes of PK operation - one used to achieve 'simple' deviation and one for more complex outcomes such as a desired pattern. This is shown by the skewness graphs (figures 6-9) where the pattern correspondences consistently show opposite skews to the baseline deviations, and also for the ESP and PK belief-experience measures which were reversed for pattern correspondence versus baseline deviation. Moreover, the degree of relaxation was related only to pattern correspondence[7]

Regardless of the results, there are still problems associated with the suggested model. A PK effect seen in pseudo-random numbers, such as those produced by a computer algorithm, can not easily be explained. Any 'environmental modification' during the PRNG operation would essentially be indistinguishable from that of normal computer operation, hence its use in the null-orientation condition. There is also the inherent difficulty in altering the essentially preset sequence of numbers generated by an algorithm. Pre-recorded and true-random seeded algorithms also have a similar problem. In the latter case any influence would have to be on the part of the experimenter at the time of seed generation. For such situations, DAT would seem to be the most economical model.

As a further interesting speculation, it might be wondered whether the balancing effect proposed by Pallikari-Viras (1993) and even the decline effect

A further interesting speculation concerns the balancing effect proposed by Pallikari-Viras (1993) and the decline effect. The balancing effect is described as an ordering principle wherein, if the action of a PK agent has been to positively bias the target system, there will later be an opposing effect showing a negative bias. The system will thus be brought back to its random statistical distribution. The decline effect is defined as the tendency of extra-chance scoring in psi tests to

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[7] It should be noted that the degree of pattern correspondence was not strongly correlated with the degree of baseline deviation (Spearman's r = -0.128)

regress towards chance expectation during a session or series of trials (Edge et al, 1986).

Under the current model, it seems feasible to suggest that these two phenomena may turn out to be biological rather than physical effects, akin to over-stimulation adaptation effects seen in colour vision. As the desired state is stimulated and maintained, adaptation occurs. A greater degree of stimulation is required - an increase which doesn't normally occur in PK experiments. After the task is over, stimulus to the adapted cells is reduced, causing a complementary effect: an afterimage in vision, a balancing effect in PK ? It is worth mentioning that the post-control period (when participants had left the room and were undergoing debriefing) showed a significant difference between conditions for the pattern correspondence (see table 4). As the pre-control periods did not show such behaviour, the possibility exists that some sort of carry-over effect was operating.

Summary

This chapter has looked at the mental experience of psi for human agents. The basic form one psi interaction was suggested to not necessarily involve a direct conscious experience, being a purely physiological response. The higher level form two psi interaction would involve a conscious experience having the goal oriented appearance suggested by other researchers as supporting the observational theories. This was due to a learned correlatory response, akin to normal motor control coordination, between the psi agent's internal state and an external event. This event would hopefully relate to the source of the psi signal which was responsible for perturbing the agent's internal state, but could still form a meaningful psi experience if misinterpreted.

VIII. Sources of interference

In any system which is receiving or emitting a signal of some sort, or even one which processes information irrespective of how that information entered the system, there is the possibility of noise. Noise is defined as any undesired disturbance in a system which degrades the useful information in a signal. Note the 'undesired' part - one man's noise is another man's information. It is essentially the meaning assigned to a particular but fairly arbitrary configuration of a system which determines what is noise and what is information.

In this chapter, we will consider what might constitute noise in a psi system, and how the knowledge of such might help us to improve our understanding of psi functioning. Even in the absence of knowledge about the signal itself, finding out what affects that signal, directly or indirectly, can tell us much about it.

Geomagnetism

Geomagnetism refers to the magnetic field that surrounds (and penetrates) the Earth. This is basically a dipole field - that is, its field is like that of a simple bar magnet with a north and south pole - but one which is then modified by the flow of particles and gases emitted outwards from the Sun (the *solar wind*). The effect of the solar wind on both the geomagnetic field and the Earth's outer atmosphere is to produce a region of charged gas known as the *magnetosphere*. The densest region of the magnetosphere is better known as the *Van Allen radiation belts*. The field is thought to be generated by motion in the conducting fluid interior of the Earth, this movement being caused by convection and rotation. There are also localised anomalies due to the presence of magnetic materials in the Earth's crust and transient *magnetic storms* (variations in electric currents in the magnetosphere).

Although the existence of the GMF might seem to be of little interest to anyone not concerned with space- or geophysics, it actually plays an important part in our everyday lives. It's main role is to protect all life on the Earth's surface from the damaging effects of solar and cosmic radiation. Without it, we would be continually bombarded by X-rays, gamma rays and high-energy particles, most of which are instead absorbed by matter trapped in the magnetosphere. In recent times, our increased use of electronic devices and telecommunications has also

revealed other effects - that changes in the geomagnetic field can interfere with power lines, telephone connections and sensitive electronic equipment.

While our knowledge of the structure of the magnetosphere comes mostly from theory and satellite measurements, the geomagnetic field itself may be measured by ground based measuring stations. A *magnetometer* is used to measure the magnetic field[8] at a specific location in units of *Tesla* (or, in cgs units, in *Gauss, where 1 T is equivalent to 10000 G).* Generally, several values will be quoted - the total field (F) and the field in the vertical, North-South, and East-West directions.

Rapid changes in the geomagnetic field are induced by electric currents in the upper, charged layer of the atmosphere (the *ionosphere),* these changes being caused by the movement of this electrically-conductive layer across the geomagnetic field lines. This movement is primarily due to heating by the Sun, although tidal effects on the atmosphere due to the moon and, to a lesser extent, the Sun, also play a part. As the main effect is due to solar heating, a regular, day-night variation is seen in the geomagnetic field, with the local field being less active during the night. Solar radiation also directly changes the conductive properties of the ionosphere, altering the range of electromagnetic frequencies which will be reflected back [9]. However, other regularities can also be found corresponding to the lunar month, solar year, and so on.

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[8] **Technical Note:** The measurement made is of the *magnetic flux density (symbol B)* of the field, a unit which can be visualised as the number of magnetic field lines passing through a specified area. 1 Tesla is defined as the magnetic flux per square meter which, when passing through a single wire-loop circuit, produces an electromotive force of 1 Volt when it uniformly decreases to zero in 1 second (remember, a current will be induced in a circuit only when there is a changing magnetic field).

[9] **Technical note:** This effect is due to photoionisation of the ionosphere by solar radiation, the number of electrons present being greater during the day than during the night, and showing a sharp increase/decrease at sunrise/sunset. As high energy particles arrive in the solar wind, they collide with atoms and molecules in the upper atmosphere, knocking electrons out of their atomic orbits and thus creating a separation of charge e.g. $O_2 + h\upsilon \rightarrow O^+ + e^-$, the excess energy being taken up as kinetic energy by the electron and ion. A property of the ionosphere is that it will only transmit electromagnetic waves having a frequency higher than the

The most typical measures of the geomagnetic field used in research are split into two main groups: those relating to the *magnitude* of the field, and those relating to the *changes* in the field. As mentioned earlier, the total flux density of the field, F, gives a measure of the absolute magnitude in the vicinity of the measuring station, the vicinity covering a radial distance of approximately 200 km from the station. There may be local variations based on geological or artificial anomalies, but the measure is taken to be a good estimate of activity within that region. This measure may also be broken up into the North-South (X), East-West (Y) and Vertical (Z) components, the vector sum of them being equal to F.

Change is represented by a set of measures termed *geomagnetic indices*. These are relative measures, showing the absolute changes from baseline but giving no information as to the absolute magnitude of that baseline field. The most common measures are the planetary equivalent amplitude (ap), daily planetary equivalent amplitude (Ap), daily linear planetary index (aa), the 3-hourly range index (K) and the planetary 3-hourly range index (Kp). The K index is a scaled measure representing ranges of fluctuation intensity (the magnitude of a typical fluctuation is 10^{-9} Tesla), with the largest recorded fluctuation in any component X, Y or Z of the field being used. The Kp measure is the same as K, but with the largest fluctuation in any axis from any of thirteen global observatories being used. The ap index is based on the Kp measures, but scale to take latitudes into account. Ap is the daily average of the ap measures. The aa measure is the same as the ap measure, but based on only two observatories (one in the UK and one in Australia, hence 'a' for 'antipodes').

WHY ARE PSI RESEARCHERS INTERESTED IN GEOMAGNETISM ?

Past psi research has often shown a correlation between the state of the geomagnetic field and success in psi tasks, or in the frequency of spontaneous psi experiences. This possible relationship has been more consistent, possibly due to more research, for ESP protocol experiments, finding a negative correlation between the magnitude of geomagnetic fluctuations and psi success / experience. A good review of the relevant studies has been given for lab studies by Persinger (1989), and for spontaneous cases by Wilkinson and Gauld (1993). Only a summary of the results will be presented here. Analyses have been conducted with all of the above

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its resonant frequency, this frequency being proportional to the square root of the electron density.

measures, although there has been a preponderance for using the daily measures rather than the 3-hourly ones which, if we assume a direct relationship, would be more likely to show any effect. The reason for this may have been that the Ap and aa indices are often easier to obtain, and the latter do have continuous records back to the 1890s, allowing retrospective analyses of very old data.

Examples of statistically significant findings include Persinger and Krippner (1989), who found higher scoring for dream based ESP on days of relatively low geomagnetic activity, Tart (1988) and Persinger and Makarec (1987) who found the same correlation for laboratory based ESP and forced choice card guessing scores respectively, and Spottiswoode (1990), who found a negative correlation between free-response ESP and the three-hourly geomagnetic activity measure. More recently, the author, in collaboration with a colleague, carried out a study looking at data from the Edinburgh ganzfeld ESP research (Dalton and Stevens, 1996). The expected negative correlation between ap index and ESP success[10] was found (Spearman's rho=0.212, df=96, $p<0.05$), again replicating earlier results. Further analyses based on the field intensity rather than the changes were all non-significant, confirming the idea that it is the relative changes in the field that are important and not the absolute intensity.

PK protocol studies have shown less consistency, but are also far fewer. Chauvin and Varjean (1990) found that an applied unchanging electromagnetic field (broadly equivalent to quiet geomagnetic activity) could be used to significantly increase a directional PK effect on a random mechanical cascade, but not to reduce it. Gissurarson (1992) found a significant negative correlation between the directional REG output and the K index. Nelson and Dunne (1986) report a non-significant positive correlation between the aa index and both REG output and random mechanical cascade distribution.

HOW MIGHT THIS EFFECT WORK ?

Currently, whether these correlations show an actual direct effect of the geomagnetic field on psi functioning or have some other more complex or spurious relationship is not know as there is no demonstrated mechanism known. However,

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[10] The value for rho is positive due to the way in which ranking is performed, greater success being represented by a lower rank. The actual effect is still a negative correlation between success and geomagnetic activity.

based on what we know about electromagnetism, there have been speculations as to the possible ways in which a direct effect might work.

- **Geomagnetic field acts as a carrier wave**

First proposed by Persinger (e.g. see Persinger, 1989) and also by Kiszkowski and Szydlowski (1981) in relation to dowsing, this proposed that psi information was modulated onto naturally occurring waves in the geomagnetic field, presumably due to the electromagnetic activity of the brain. When this wave reached another person, the information would be 'decoded' into their brains by a direct action of the field. An alternative interpretation is that there is not information encoded onto the field, but that natural fluctuations in the field (or related electromagnetic events which would show up as geomagnetic fluctuations e.g. piezoelectric seismic events) caused psi like experiences. If two people experienced the fluctuations at the same time, they might have similar experiences which they later deduce to have been psychic. If either of these scenarios were true, then any other sources of perturbation to the geomagnetic field would corrupt the information, or change the induced effect. We would thus expect to find that there was a relationship between geomagnetic activity and psi experience, as the state of the field would determine the amount of noise in the encoded information, or would be in itself responsible for inducing the psi experience. However, we might then expect to find that there would be more psi for an active field, rather than the other way round. Persinger does not offer any suggestions to explain the reported direction of the correlations.

- **Physiological driving**

Another suggestion is that the geomagnetic field acts to affect the physiology of a sensitive person, making them more likely to have a psi experience. Roney-Dougal and Vogl (1993) suggest the pineal gland as being the area of action, as it is known than electromagnetic field changes alter pineal functioning, causing changes in the levels of the neurochemicals serotonin and melatonin, both known to be related to states of consciousness and levels of arousal. Persinger (e.g. see Persinger, 1989) points to the temporal lobe as being electromagnetically sensitive. Relating as it does to memory consolidation and retrieval, the individual's sense of self in time and space, the attribution of meaning and emotional significance to perceptual events, the senses of hearing and smell, and the processing of complex visual patterns, he suggests that changes to this area of the brain have the potential to cause a wide range of experiences, either relating to psi or being interpreted as psi. Persinger also mentions

the pineal gland as having a regulatory effect on the temporal lobe through the production of melatonin. Suppressed concentrations of melatonin, which would occur for high magnetic fields, increase the threshold at which 'strange' effects will occur in brain. Increased electrical activity in lobes may give greater access to memory fragments so post-mortem and other apparitions may be induced. A decrease in the electromagnetic field gives a higher melatonin concentration, the anticonvulsant properties of which would allow brain to function at a more sensitive level without epileptic events occurring, possibly resulting in effects such as telepathy or clairvoyance.

Wilkinson (in a Society for Psychical Research Study Day Lecture "Geomagnetism and Psi", November 1989) suggests that cells may have properties akin to a physical device known as a Josephson junction (which makes use of some superconducting effects). If so, exposure to an electromagnetic field would act to alter cell membrane permeability and thus also alter the cell 's functioning and metabolism.

- **Direct signal interference**

There is always the possibility that the geomagnetic field could act to interfere with the psi signal itself, whether this is of the type proposed in this thesis or otherwise. Just as conventional electromagnetic signalling is disrupted at times of high geomagnetic activity (especially during magnetic storms), so perhaps is psi. The main problem with this approach is that nothing is known for sure about the psi signal properties, so it is difficult to do more than speculate as to direct interference effects.

The physiological driving idea of Wilkinson's is closest in concept to how a geomagnetic field effect might work under the proposed model. Essentially, the field would act as a source of noise in receptive psi, and possibly as an amplifier in emissive psi. The electromagnetic sensitivity study found that the effect of any field was to increase the level of arousal. This would probably act to swamp any subtle modifications due to a psi signal, making it harder for the recipient to detect and make use of that information. For emissive psi, the increased arousal might act to make the emissive signal clearer. Warnke (1994) found that a 3 Hz electromagnetic field of only 1 nT intensity acted to slow brain rhythm but to give an increased amplitude in electrical activity, resulting in a slower frequency but an overall level of more cohesive activity.

On a direct interference level, we may also find that the geomagnetic field can alter the state of the background zero-point energy field. As this field is essentially electromagnetic radiation (albeit very weak with respect to conventional electromagnetic signals), other sources of such radiation such as the geomagnetic field might be expected to interfere in some way. How is not known exactly, although we might assume that a more active field would give more interference (neglecting any frequency effects). This results in the situation that, although a less active field is predicted to be better from the viewpoint of receptive psi, there are both positive and negative aspects for emissive psi, an active field then enhancing the signal at source but possibly interfering with its propagation. Again, we might get around this by considering individual psi study protocols on their own, based on the form of psi expected to play a major role.

Thus, a DMILS protocol, relying on the presence vs. the absence of any physiology generated psi signal would be relatively insensitive to geomagnetic field conditions, an increased level of geomagnetic activity possibly increasing the signal generation strength and the lability of the receiving system, but possibly also causing a ceiling effect in the receiver's physiology. This would relate to the individual acting as receiver, so there may be some individuals who are better in active conditions and some who are insensitive (which I think would show up as a positive geomagnetic activity - psi relationship using the common statistical procedures).

An ESP protocol, requiring the generation of a more complex physiology based signal, could go either way, depending on the complexity of the transmitted information. Simpler emotional targets, thought to induce a more 'hard-wired' response in the receiver and being related to a more global level of activity in the source system, might be more resistant to interference and actually enhanced by an ambient electromagnetic field, and so would work fairly well under both quiet and active geomagnetic conditions. More abstract information transfer (requiring more complex generating physiological activity) would probably not benefit from the enhancement due to electromagnetic driving, and so would be better under quiet conditions.

A PK protocol, if based on a simple deviation of the target system from a baseline, would be better under active geomagnetic field conditions (the field both enhancing the signal generation and possibly increasing the lability of the target system itself), whereas a more controlled PK effect would require a more complex signal and would again be better under quiet geomagnetic field conditions.

Whether such predictions are correct remains to be seen, as past studies have not made the distinctions within protocols that are suggested to be important.

However, as studies looking for geomagnetic correlations with PK protocol data have been very inconsistent, finding significant correlations in both directions, then this at least suggests that this area is worth investigating.

'Look I'm psychic wasn't I...' : using the same system for emission and reception

The proposed model utilises a cellular level mechanism in a fully reversible process of reception and emission of a psi signal. That is, the receiving system is one and the same with the emitting system. Indeed, the act of receiving a signal will in itself create activity that will generate a signal! This in itself is not a problem - radio systems after all show a similar effect. Such an effect is responsible for creating a phase lock between systems such that they will move towards a state of mutual synchronisation in their cycles of activity. The problem lies in the extended processes associated with the conscious detection or emission of the signal, as these processes also use the same systems which are responsible for detection and emission. An analogy is with the well known phenomena in students of meditative practises wherein the victorious thought 'I am meditating now' itself disrupts the meditative process and causes its own invalidation - a case of self-destroying prophecy! With psi, the signal is detected through a passive recognition on the part of the receiving agent that their thoughts (or other epiphenomena based on cellular processes) have been altered in a particular patterned way, that pattern containing the desired information. If a real-time analysis of the this alteration is attempted by the agent, the underlying physiological activity of that analysis will destroy, or at least obscure, the very pattern that is being analysed. If a passive approach, one where thought processes are, as much as is possible, simply observed as though the agent were external to the observed system, is used and then the noted alterations analysed at a later time, it is thought that the psi-borne information would come through with less corruption. Such a process may relate to the psychological construct known as dissociation and would be true for both ESP and PK protocol tasks, the latter still requiring reception of a psi signal for feedback purposes.

The other option would be to take the conscious aspect out of the system entirely, relying instead on subconscious, physiological measures of an agent who is unaware that they are trying to receive a psi signal. This was the approach taken in the techno-dowsing study, which appeared to show identifiable physiological response patterns of the participants when they viewed real-time concepts relating

to an undetermined future event. Here participants were unaware that they were taking part in a psi study at the time, having being instructed merely to passively watch some images on a computer screen while physiological measurements were taken. They were therefore not attempting to analyse their physiological responses and so should not have corrupted those responses too much. It is thought that efficient use of real-time psi would require a great deal of dissociation, effectively isolating a physiological subsystem from conscious intervention so that it could be used as a psi detector. Possibly this is what occurs, assuming such cases in part constitute genuine manifestations of psi, with automatic writing (where analysis comes later based on an objective measurement - the written text) or in mediumship (where the analysis is carried out by external observers listening to the mediums utterances).

Multiple psi sources

Akin to the divergence problem of the Observational Theories (See chapter II) the proposed model has the problem that any study will be subject to the influence of multiple psi signal sources. These could be biological, naturally occurring non-biological and artificial sources. As the psi signal is thought to be the result of normal physiological and equivalent processes, any target system will be awash with signals coming from all directions, all with different characteristics. In systems which are sensitive merely to the presence of a signal, this could be a problem, with the excess signals acting as a source of interference (as they will not be synchronised with the REG activity due to lack of feedback to the originators of the signals). Hopefully, this will not normally constitute a huge problem as the excess signals will show random phase relationships to each other and be virtually indistinguishable from the background field. The only problematical situations would be where there were psi sources unrelated to the experiment who were emitting more coherent signals, or where the experimenter had been working with the same target system in repeated sessions. In the former case, as might be found when large groups of people are engaged in simultaneous unifying activity (group PK effects were mentioned in chapter VI, in the 'Controlling emissive psi' section), the largest effect might be due to the group rather than the experimental participant. The latter case would count as an experimenter effect, and might come about where the experimenter had worked sufficiently with the target system to have undergone an orientation period, learning which internal states corresponded to the psi signal he or she receives from the target system. Even in the absence of

feedback, once the orientation had occurred, they might be able to have an effect on the target system. If the experimenter is not blind to the experimental conditions, then any effects may well be due to them and not the participants.

Summary

This chapter has looked at possible interference effects in psi systems, especially with respect to experimental studies. Some predictions were made as to the effect of geomagnetic field activity on different protocol psi studies, based on possible effects that would be found in the framework of the proposed model, that might shed light on some of the inconsistent results found in past research into a possible relationship between psi and the geomagnetic field. The problems associated with the same system being used for both reception and emission of the participant psi signal were discussed, and some methodological suggestions made as to reduce these. Finally, the problem of extraneous psi signals from sources unrelated to the experiment, relating this to earlier mentioned group phenomena, and emphasising the need for double blind experimentation in psi research.

IX. Discussion

This thesis has presented a conceptual framework within which psi, within the specified range of phenomena, may be interpreted. The fundamental assumption made was of a physical signal, emitted from the target within a psi system and interacting with the receiving subsystem, acting to perturb ongoing processes within that subsystem. Effects were discussed on a variety of levels, based on the possible physical parameters of a psi signal, the physiological modifications resulting from an interaction with such a signal, and the psychological experience of this.

Chapter I defined the phenomena with which this thesis was concerned, and emphasised the need for an underlying theoretical framework for any experimentation to take place within. It was noted that there were a number of different levels at which the psi phenomena may occur - physical, physiological, psychological and even spiritual - but which differences were often neglected by researchers who concentrated primarily on one particular level.

Chapter II discussed the primary current theoretical approaches which attempt to account for a variety of psi phenomena, offering a synopsis of their main points, and a criticism of their weaknesses. It was noted that few of the theories had significantly advanced methodology used in psi research, and that none of them had received widespread adoption by researchers.

Chapter III introduced a systems approach to psi phenomena. The characteristics of the psi experiencer, subjective experience and of the apparently objective phenomena were each considered, and a simple model constructed to cover these three levels. An emphasis was placed on the seeming arbitrariness of the labels applied to any psi experience, the precise term applied being based more on the viewpoint of an external observer than on any objective characteristics. It was assumed that a system consisting of the environment (the domain of a psi signal), the experiencer's physiology (the site of interaction with a psi signal) and the experiencer's psychology (the realm of the experience engendered by the signal's interaction) would be sufficient to conceptualise a psi event involving a sentient organism. Non-sentient or non-living systems would also be covered by this model, with the neglect of the psychological element, and the substitution of the equivalent activity in place of physiological activity. This model was also used to organise the subsequent chapters, each dealing with a different level of a psi event. The basic level was that of the physical psi signal itself, the next of the generation or

reception of a signal by both biological and non-biological systems. The next level considered some psychophysical characteristics which would better enable an organism to control generation of, or be more sensitive to, a psi signal, and finally the mental experience of interaction with a signal.

Chapter IV considered the rationale for considering psi to be due to a physical signal, concluding that the data did not support the radical step of assuming a non-physical signal, nor that such an assumption had any conceptual benefits that would advance our understanding of psi or of the methodology used to research it. As psi is intimately associated with living systems, processes within such systems which could generate an emissive signal were considered, and it was proposed that the properties of electromagnetic waves could allow for many of the observed properties of psi phenomena. A simple computer simulation of a random event generator was presented, based on the notion of such a generator being responsive to the underlying fluctuations of a zero-point field. The simulation data found good agreement with empirical REG data. A psi signal perturbation, thought akin to a psychokinetic effect, was then added to the simulation. When the generated data was compared to empirical data, some agreement was again found, offering limited support for zero-point field fluctuations as the site of interaction for psi. Finally , the physical properties of the most commonly used target system in psychokinesis experiments - the semiconductor REG - were considered.

Chapter V initially reconsidered the information content of a signal, discarding the traditional mental radio model of a psi signal and replacing it with a signal that conveyed information about the activity of the emissive system, be it the activity of the actual target in a psi experiment, or the physiological activity of the perceiver of that target. Next, the physiological, or non-biological equivalent, processes which might be capable of generating a psi signal were detailed. The physics of basic biological cells were briefly considered, noting that these properties were shared by all known biological systems due to the evolution of a common cell morphology. Possible emissive characteristics noted, and a comparison with non-biological emissive systems was made. Based on these suppositions, the potential information content of such signals was then discussed, with the aim of assessing how useful a psi signal could be to a sensitive organism. Having considered the emission of a psi signal, the required properties of receptive systems were examined, again both for biological and non-biological systems. The effect reception would have upon an organism's physiology was then discussed, noting that that zero-point field fluctuations acted to partly determine the stochastic qualities of cell

gating. As a psi signal was proposed to modify zero-point field fluctuations, this suggested that it might act to bias this gating in a specific manner. Parallels were drawn with some concepts used in cognitive psychology, one theory of particular interest being a theory by Reinsel et al (1992) which also attempted to explain the bizarreness of dream imagery in terms of the stochastic properties of cell gating. Finally, some parameters of systems expected to be sensitive to a psi signal were inferred, and predictions made as to the relative success of different experimental protocols. A study comparing psi sensitivity to electromagnetic sensitivity in humans was detailed, the underlying signal detection processes being presented as analogous to those utilised in psi signal detection and so offering an empirical way of predicting basic psi sensitivity. A further study was then given, using a similar methodology to the previous study, but using a non-biological system as the receptive entity. Some similar effects were found in both studies, a decrease in variability (variance of autonomic system activity versus variance of events) in the presence of an applied field. As some similarities between biological cells and semiconducting materials were noted earlier and suggested as being the site most sensitive to a psi signal, a comparable finding in both biological and non-biological systems for a electromagnetic signal thought analogous to a psi signal was seen to be supportive of the proposed electromagnetic nature of the psi signal.

Chapter VI considered the psychophysiological properties of humans which might be advantageous in the utilisation of psi. Ways of determining levels of somatic awareness and differences in perceptual styles were detailed, the former thought to be useful in self-monitoring of physiological activity (the proposed site of interaction with a psi signal) and the latter dealing with how information about physiological change might be processed and made use of. Next, possible mental strategies of use in controlling the generation and reception of a psi signal were discussed, noting the traditional association of disciplining techniques such as meditation with psi experiences and their associated conferral of increased physiological awareness and control. A study looking at physiological reactions in unaware participants to future events was related, using the novel aspect of a neural network trained to predict the nature of the future target based on present time physiological measurements. Although complete prediction was not achieved, the network appeared able to reduce the possible target pool, reducing the chances of successful prediction from 1:8 to 1:2 for eleven out of twenty participants, implying the existence of a specific physiological pattern of activity relating to foreknowledge of an undetermined event.

Chapter VII looked at the mental experience of psi, from the most basic correlatory relationship between the simple detection of a psi signal and some form of explicit feedback related to the target system's activity (termed 'orientation'), up to more perception-like experiences where the reception of a psi signal alone might have a deeper meaning. The role which feedback played in the psi experience was considered, being defined as a stimulus providing confirmation of a psi-related hypothesis about the environment. It was concluded that this stimulus would normally be in the form of conventional sensory information, but that it could, in limited circumstances, be purely psi-based, implying a need to reinterpret the conclusions of some psi studies which supposedly did not provide feedback to participants. Based on the earlier described findings of the electromagnetic sensitivity study, the proposal was made that any type of ambiguous stimuli, especially if non-sensory, would act to increase the physiological activity of the sensitive system, resulting in a non-specific feeling of 'significance'. In the absence of internal identifiers as to the source of this feeling, the percipient will look to their environment for possible cues. It was suggested this could be responsible for some cases of 'paranormal' phenomena such as hauntings or a sense of presence, the interpretation of the event being related to site-specific characteristics. A comparison between music perception and psi perception was made, both being thought to involve the processing of a signal with spatial and temporal characteristics but also involving subjective responses. Finally, a experiment was described which used a psychokinesis protocol to test the need for an orientation period, finding some slight evidence for an increased PK effect for participants having been given valid feedback during the orientation period when compared to participants having been given false feedback during this time.

To conclude, chapter VIII looked at possible sources of interference of psi functioning, either effects on the signal itself or by an alteration in the state of the emissive or receptive systems. The Earth's magnetic field was considered, based on reported correlations between geomagnetic activity and psi experiences, with several possible mechanisms for interference being discussed. Next , the problems that could arise if the same system was used both for emission of a signal and for the reception of a signal was discussed, with some options to decrease any interference in the human system offered based on dissociative techniques and subconscious measures.

Also mentioned were the possibility of multiple psi signal sources affecting the target system, and of a simple experimenter effect, emphasising the need for double blind experiments.

The role of consciousness

One of the most unfashionable ideas presented in this thesis, but also one of the most fundamental, is that consciousness is not necessary for psi, which in organisms is thought to be produced purely as a result of normal physiological activity. It is doubtless required for the higher level use of psi, but only because consciousness '...provides highly integrated information from many parts of the body... [emphasising] the degree of interconnectedness between psychological processes and physiological arousal... it is highly likely that [consciousness represents] an integrated response that incorporates all major bodily systems, including psychological systems.' (Thayer, 1989). Psi can exist without consciousness, but, whatever else it is, consciousness is the end product of Nature's best method for integrating a whole range of information into a unitary structure. This has proved to be an important evolutionary step, enabling man and other animals to better adapt to, and ultimately alter, the environment. It seems likely that it will also be involved in future evolutionary steps - perhaps further development of psi is one of those. The important point to note is that, with the proposed ideas, psi is a source of information based on a physical signal, exactly as is the case with conventional forms of perception. Consciousness may also give us an advantage in the way we use the physical signal that is light to view our environment, but this does not mean that consciousness is necessary to interact with the light. All objects can interact with light, some reacting to it when it is absorbed, and some emitting it - there are simply different levels at which the information contained within the light may be used. I suggest the same is true of psi. This does not reduce the psi experience to a purely physical phenomenon any more than a knowledge of the way light refracts reduces the experience of seeing a rainbow, but does differentiate between the physical mediator of information and the experience itself. We are talking about two interrelated but discrete levels of the phenomenon.

Plant and machine psi

This being the case, we must now also consider the possibility of plant and machine psi. Again, I cannot emphasise enough that I am *not* suggesting any form

of animistic world view here. I have suggested that psi is due to an electromagnetic signal and, as such, a wide variety of systems might be expected to interact with it. In the case of organisms, we might further expect them to make use of the signal to some extent - if information is available, nature usually finds some way to make use of it.

If the cellular level is the site of interaction in organisms, rather than it being connected to mind or consciousness as some theorists suggest, then we would expect to find a psi effect in systems that we would not expect to be susceptible under some of the other theories of psi.. An example of this is an experiment on the haemolysis of blood cells (Braud and Dennis, 1989), where participants could apparently reduce the rate at which haemolysis occurred. As haemolysis, essentially the disintegration of the cell, is related to the permeability of the cell membrane, this appears to support the idea that the site of influence was the cell membrane. Although not currently popular, there were also early studies looking at the effects of psi on plants.

Morris (1977) reports on a series of experiments performed by Cleve Backster, where unattended plants showed increased electrical resistance (akin to the electrodermal response in humans) in their leaves during trials when other organisms were killed in a random automated procedure (although, as Morris notes, three independent replications of this experimental protocol which had improved methodology gave results at chance expectation levels): Nash (1984) offers results apparently showing a psychokinetic effect on the mutation rate of *E. coli* bacteria; Barry (1968) conducted experiments on the effects of intention on fungal growth, finding significant results in 85% of cases; and Brier (1969) found significant results for the effects of a participant's attention on one of two plants wherein bio-electrical activity was increased only for the focus plant. Although it could be argued that such effects were due to actual psychokinetic control of the relevant growth or other internal processes, a more economical answer would be that the plants themselves were responding to a detected signal that mimicked a naturally occurring signal that triggers the specific response processes. As some of the 'plants' were cellular cultures, this again supports the idea of a signal operating at this level. Moreover, with the exception of Backster's study, the other studies were of human interaction with plants. If a psi signal is in effect a by-product of normal electrodynamic activity, then we would also expect to find interaction effects in the absence of humans, between two plant systems, or even between two non-biological systems. This offers the idea of automated 'psi' experiments where the

sender-receiver pair are both plant-life! In such a case, the target stimulus would have to have relevance to the needs of the plant (e.g. water, nutrients, disease) for it to broadcast physiological activity relating to defence or survival mechanisms. The main problem would be in ensuring that the entire experiment was at least double-blind, to avoid the risk of experimenter effects, and also in controlling other relevant environmental factors to which both systems would be responsive (e.g. weather, humidity, light levels). Furthermore, although less likely to show a detectable effect, being restricted in their ability to change in response to a detected signal, there remains the possibility of a psi interaction between separated electrical systems. For example, two similar REGs might show some degree of synchronisation in their activity, once possible environmental factors had been allowed for, as each responds to the emissive activity of the other. The main problem would be one of using a sensitive enough analysis, possibly directly measuring the analogue activity of the REG rather than simply using the digital output.

Strengthening lab effects

Braud (in Wolman, 1977) lists a passive mode of thought, a reduced level of physical, physiological and mental arousal, and an increased awareness of internal states as being psi conducive in experiments. Based on the premises of this thesis, such states would also be predicted to increase receptive psi (which includes the period of orientation thought to be necessary for later controlled emissive psi). Emissive psi should also benefit from such states, with the exception of physiological arousal, as it is presumed that there will be an increase in a specific pattern of physiological activity when a controlled psi signal is emitted. Improving psi could thus be achieved by having such states of relaxation, but by also training participants to become more aware of their own physiological activity, and emphasising techniques which enable better control of that activity (such as the meditative and biofeedback techniques discussed in chapter VII).

Going back to the examples of cohesive behaviour mentioned in chapter VI, group attempts at a PK task might also give larger magnitude effects. The important requirement would be the existence of some sort of external synchronising signal given to the people involved, to ensure that they were not interfering with each other's attempts. Ideally, the explicit feedback given to the group should contain information not only about the target system but also about the action of the other member of the group. This would allow each individual to act in a coherent manner

as part of the group, rather than in a hit and miss fashion. A gross example would be a shared reaction to an unexpected and startling stimulus, in which all members of the group undergo a burst of physiological activity simultaneously. For a sensitive target system (such as a REG or a distant human receiver), we might then expect to find a stronger effect in the target system relating to the time of the stimulus for a synchronised group of senders than if there were only one sender. The main problem with using groups to increase effects is that the precise physical properties of any psi signals that would be generated are not known, so it is difficult to predict what effect the physical layout of the group (that is, their position and proximity relative to one another) might have. For simple effects (such as micro PK), it seems likely that a synchronised group would be superior to a single person as they would cause a greater perturbing psi signal. For a more complex psi signal where more information is transferred, the group members' individual signals might merge to create a larger amplitude but hopelessly confused signal due to interference effects.

The limits of psi ?

Another oft asked question concerns the limits of psi. With no clear mechanism, the popular teleological approach, and the possibility of transtemporal communication, it often seems as though psi might be capable of any effect, by passing experimental constraints and being essentially uncontrollable and possibly unknowable too. Braude (1986) argues that we have few good reasons to ignore even the more outrageous macroscopic PK claims, based purely on theoretical reasoning, pointing out that we cannot claim macro PK to be any more unlikely than micro PK without having some notion of the mechanism underlying each type of phenomenon. However, it does seem reasonable to restrict initial attempts at theorising to those phenomena which have been investigated under controlled conditions, while still remaining open to the possibility of larger scale phenomena. With this qualification, and acknowledging that it is far from being a complete explanation for psi, the proposed model may offer some tentative parameters within which psi may operate.

The most likely effects observed would be very small, operating within the normal parameters of the receptive system, but biased in the intended manner. Thus for a human receiver, common effects would be based around their normal physiological activity, showing a slight increase or slight decrease from baseline levels. If more abstract information is transferred, it seems unlikely that it could be

something that is completely new to the receiver, relying instead on evoking existing responses based on the receiver's past experiences. Effects of this sort would also be more likely if that receiver had an expectation for the type of incoming signal (as in post-mortem apparitions where the death is not unexpected). In cases where the psi signal contained completely incompatible information (i.e. was generated by an unfamiliar physiological pattern of activity, or came from a very dissimilar system), we might find the receiver constructs a self-consistent but highly subjective perception, as was discussed under the heading of mythoperception earlier in chapter VII.

For a non-biological receiver, such as the REGs used in psychokinesis protocol studies, we would again expect effects to commonly be within the normal parameters of activity. A human generated psi signal would act as a source of additional noise for such systems. The application of this noise would be under the control of the PK agent to some extent, but it is unlikely that they will be able to effect precise control unless they are extremely capable of controlling their own physiologies and there is some way of screening the REG from other sources of psi signals, which seems unlikely on the basis of the physical aspects of the proposed model.

Healing effects may well be possible if we consider them to be the result of an externally applied signal which acts to regulate the dysfunctional activity of the diseased or injured system. The healer may be viewed as a source of a 'healthy' signal - a non-specific pacemaker if you will - which acts on the healee's physiology to bias it back to within normal parameters. If the healer has some degree of voluntary control over their emissive signal, then they will be better healers. In this context, it is noted that many healers speak of the passive role they play, allowing energy to flow through them rather than attempting to influence anything (as an anecdotal example, see Bentine, 1987). From the perspective of the model, they are placing themselves in a relaxed state, and attempting simply to be, letting the relaxed, healthy state of activity of their bodies serve to regulate the other's physiology. We would thus expect to find that healer's might improve the rate of recovery, enhance immune system activity, and decrease pain levels, but not effect any miraculous alterations. In short, the healer would not be able to do anything that was beyond the capabilities of the healee, had the healee themselves been healthy. There will also obviously be other psychological factors, but I am here concentrating on the psi aspects of healing which would not be in common with conventional medical practise.

With the current state of knowledge, little more can be said about the spatial and temporal limits of psi without a greater comprehension of the physical mechanism underlying a psi signal. If the speculative ideas presented in chapter IV have any validity, then there may well be spatial limitation to psi, limits beyond which the signal does get lost amid the noise. If transtemporal phenomena do occur, then it seems likely that similar parameters will apply to temporal distance as to spatial distance. Whether this distance will be large or small remains to be seen.

Problems with the model

The primary premises of the model are that there exists a physical psi signal, that this signal is generated by electrodynamic activity, and that it operates on a cellular or equivalent microphysical level for receptive systems. On the physical level, a suggestion was made as to the properties of a psi signal and the site at which interaction occurs,. This was based on the properties which would be required to account for the types of psi effects observed. The intent was to offer a starting point for a physical mechanism about which some broad predictions could be made and tested. The subsequent experimental results, while not directly supporting the suggested mechanism, do at least not rule out an electromagnetic based explanation of psi. The most speculative idea was that an electromagnetic field could modify the zero-point field fluctuations. This idea could not be tested directly, but led to the experiment testing the effects of electromagnetic fields on a REG. That such effects, which would not be expected under any conventional electromagnetic interaction, were observed suggests further investigation along these lines may be useful.

The extent to which the premises were tested was necessarily superficial, the aim being to present indications of support for the overall model rather than to rigorously test any one specific aspect. As such, there remains the possibility of alternative explanations for the results found. However, given what the author views as an overall consistency to the findings presented in this thesis, it is felt that the data is sufficient to encourage further investigations along these lines. Particularly open to relatively easy investigation is the idea of a link between physiological activity at the time of influence/sending and the activity of the perturbed/receiving system, as well as the continuation of a study of links between electromagnetic sensitivity and psi ability.

Also fairly superficial was the treatment of the way in which mental experience would be linked to reception of a psi signal. In the absence of detailed knowledge of the possible structures of a signal, only conjecture is possible about the precise effect of successful detection. The empirical data suggested a base effect consisting of a non-specific change in physiological arousal, so the discussion was based primarily on this effect and how it might manifest on a conscious level. The low resolution of the physiological data taken, due to a balance being struck between making the experiments enjoyable and not too time-consuming for the participants and the need to attach as many sensors and electrodes as possible, meant that a lot of potential information may well have been lost. The same is true of the typical types of data analysis employed. Future use of some of the relatively recent non-linear analytic techniques, such as the more sophisticated neural nets and the phase-space visualisation techniques of nonlinear dynamics (popularly called 'chaos theory'), may reveal layers of complexity which current data analysis does not. This may well be the case if the earlier suggestion of possible phase locking between separated systems is true, in which case the construction of pseudo-time series from the activity of both may show attractor patterns common to nonlinear systems, indicating synchronisation effects.

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Appendix A: Computer program listing of the simple PK - REG interaction simulation

The following program conforms to the Borland C++ v3 implementation of the C programming language. It runs under DOS, or in a DOS window, on any IBM compatible PC.

```
// Program for simple model of random event generator based
// on structure of underlying random energy field.
// Copyright Paul Stevens February 1997.

// The 'randomness' is actually achieved by superposing and
// averaging 50 sine waves. REG threshold for an event to be
// registered is zero,  with the 'energy' range being ±0.5
// (to allow for destructive interference)
// The program can generates a simple graphical display to
// illustrate  the principles, but works faster if this is disabled.
// The command line parameters are:
// name of file for saved data - up to eight characters plus three
// character extension
// Psi - 0 means no psi signal, 1 means add a psi signal
// Visual display - 0 means no display, 1 means display.

#include <conio.h>
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <dos.h>
#include <string.h>
#include <graphics.h>

#define xmax   60
#define ymax   30
#define waves  50

FILE *fp;
struct palettetype pal;
int huge Always() {return 0;}

//=====================================================================
void GfxOn(void)  {
      int GraphDrv=DETECT, GraphMod , errorcode,i;
      installuserdriver("SVGA256",Always);
      initgraph(&GraphDrv,&GraphMod,"");
      errorcode = graphresult();
      if (errorcode != grOk)  {
printf("Graphics error: %s", grapherrormsg(errorcode));
            exit(1);    }}
//=====================================================================
void main(int argc, char *argv[])   {
float space[xmax][ymax];      //remember arrays start at [0][0]
float xr[waves],yr[waves],tr[waves],sr[waves];
float x,y,xc,yc,d;
int i,psi,l, count=0, display,sig;
double t;
```

```
if (argc<4) {
printf("Format is: pkmodel <filename> <psi> <display>");exit(1);}
else
printf("\nDatafile: %s Psi mode: %d Display
%d",argv[1],atoi(argv[2]),atoi(argv[3]));
delay(1000);
if ((fp = fopen(argv[1], "wt"))== NULL)    {
      fprintf(stderr, "Cannot open output file.\n");
      exit(1);    }
psi=atoi(argv[2]);
display=atoi(argv[3]);
randomize();
if (display==0) goto graphics_skip;
GfxOn();
getpalette(&pal);
// set blue scale
for (i=1; i<=100; i++)  {
      setrgbpalette(i,  10,10, (20+i)/2); }
setrgbpalette(110, 255,0, 0);
setrgbpalette(120, 0,255, 0);
setrgbpalette(255, 255,255,255);
graphics_skip:;
sig=40;
//set up initial sine wave values
for (l=0;l<waves;l++)     {
     xr[l]=(random(300)-150)/10;
     yr[l]=(random(300)-150)/10;
     tr[l]=random(10)-5;if (tr[l]==0) tr[l]=.1;
     sr[l]=random(10)-5;if (sr[l]==0) sr[l]=.1; }
loop:;
t+=10000; //time increment
for (y=0;y<ymax;y++)    {
  for (x=0;x<xmax;x++)  {
     space[x][y]=( sin( (xr[l]*x)+(yr[l]*y)+(tr[l]*t) ) );
     for (l=1;l<waves;l=l+2)  {
         space[x][y]+=(sin( (xr[l]*x)+(yr[l]*y)+(tr[l]*t) ) );
         space[x][y]-=(sin((xr[l+1]*x)+(yr[l+1]*y)+(tr[l+1]*t))); }
     space[x][y]=space[x][y]/l;     }}
if (display==0) goto visual_skip;
for (y=0;y<(ymax);y++)  {     // generate visual display
      for (x=0;x<(xmax);x++)  {
            putpixel(x,y,(space[x][y]+1)*50); }}  //gives value 1 to
100

//add RNG
rectangle ((xmax+10)-xmax-1,(ymax/2)-1,(xmax+10)-xmax+1,(ymax/2)+1);
visual_skip:;
if (psi==0) goto psi_skip;
//add psi perturbation - approx 1 wavelength sine
for (y=0;y<=ymax;y++)   {
      space[sig-6][y]+=0.35;
      space[sig-5][y]+=0.5;
      space[sig-4][y]+=0.35;
      space[sig-3][y]-=0.35;
      space[sig-2][y]-=0.5;
      space[sig-1][y]-=0.35;
      space[sig  ][y]+=0.35;
      space[sig+1][y]+=0.5;
      space[sig+2][y]+=0.35;
      space[sig+3][y]-=0.35;
      space[sig+4][y]-=0.5;
      space[sig+5][y]-=0.35;  }
```

```
if (display==1) putpixel (sig,ymax+1,120);
if (display==1) putpixel (sig+1,ymax+1,0);
psi_skip:;
gotoxy(1,14);printf("RNG      Energy:      %f",      space[(xmax+10)-
xmax][ymax/2]);
gotoxy(1,18);printf("Count: %d", count);

if (space[(xmax+10)-xmax][ymax/2]>0)      {
      if (display==1) putpixel ((xmax+10)-xmax,ymax/2,255);
      fprintf(fp, "\n1");     }
else  {
if (display==1) putpixel ((xmax+10)-xmax,ymax/2,0);
      fprintf(fp, "\n0");}
count++;
if (count>200) goto end;
sig=sig-1;
if (sig<0){
if (display==1) putpixel (sig,ymax+1,0);
      sig=40; }
while (!kbhit()) goto loop;
end:;
fclose(fp);
if (display==1) closegraph();
}
```