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Memory and Precognition

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Abstract—David Bohm's interpretation of quantum mechanics suggests that if a neuronal pattern is repeatedly activated in the brain at the time of an initial experience, it may resonate with, and influence, any similar pattern that is spontaneously activated in the present. This may lead to a sustained activation of the present pattern, and it could assist in the retrieval not only of memories that were formed in the past, but also of memories that will be formed in the future. A comparison is made between the processes of memory and precognition, and it is shown how precognition can occur without any risk of the percipient confronting the intervention paradox. Empirical support is given by the results of target-guessing experiments in precognition, and a mechanism is suggested for the way in which subjects identify the future targets. The model suggests that all forms of extrasensory perception may be due to resonances between structures created in living brains and that the "clairvoyant" interpretation can be eliminated. Suggestions are made for experiments to confirm the proposals.

Keywords: memory system—precognition—intuition—intervention paradox

Introduction

The retrieval of a memory depends on the activation of a neuronal spatiotemporal pattern in the brain that is similar to the pattern activated at the time of the initial experience. The problem is that, until now, it has been little understood how the neural impulses are able to "know" which pathways to take through the memory networks at the moment of retrieval.

In order to resolve the problem, I suggest that on retrieval, the brain may activate a number of alternative pathways until one of them happens to match fairly closely the pathway activated at the time of the initial experience. This might enable a resonance to occur, and it might result in the pathway sustaining its activation until the memory is recalled. Furthermore, since the initial experience is one that could occur either in the past or in the future, retrieval from the past and from the future would be accomplished in much the same way. The model could therefore serve to explain both memory and precognition.

Now, although meta-analyses performed on the results of precognition experiments give outstanding evidence for the occurrence of contacts with the future, mainstream science has been reluctant to accept either precognition or the other forms of ESP. The main reason for this skepticism may be due to the lack of a satisfactory theory. Several attempts have been made to offer "causal" explanations (e.g., Feinberg, 1975; Rao, 1977; Rush, 1986; Stokes, 1987). Most of them invoke fields of one sort or another, and whilst they go some way towards offering a plausible explanation for telepathic communication in the present, they fail to explain the "backwards causation" implied in precognition.

This has led some theorists to look for "noncausal" explanations, in which information has to be communicated between two points in space-time without the intervention of a physical signal between them. Theories based on noncausal influences have been proposed by Carl Jung (1985), Ninian Marshall (1960), and Rupert Sheldrake (1988), but the theories do not consider in detail either the quantum-mechanical processes involved, or the effects produced on specific structures within the brain. The present model will attempt to incorporate these details.

If precognition does occur, then it presupposes that the future events must already exist in some sense. So in order to develop the proposal, we start by assuming the concept of the block universe, in which past and future events already exist in space-time, in accordance with Einstein's special theory of relativity. We are therefore dealing with absolute, rather than potential, futures. (A conceptual model of the block universe is given in Taylor, 2000, pp. 197–200.)

It follows that in order to explain the noncausal influences, we need an interpretation of quantum mechanics that is compatible with the special theory of relativity. We review Bohm's interpretation, which suggests that if similar structures are created at different locations in space and time, the structures will "resonate" with a tendency to become more closely similar to one another. This would enable information to be transferred from one location to another, both in space and in time.

We then review current knowledge of the long-term memory system, and we see how a neuronal spatiotemporal pattern that is repeatedly activated on the occasion of an initial experience may influence any similar pattern that happens to be activated in the present. This may lead to a sustaining of the activation of the present pattern and to a retrieval of the memory.

Empirical support to the proposals is given by the results of target-guessing experiments carried out to test precognition. However, investigators have for many years faced a conceptual problem regarding the interpretation of these results, and the majority of them have assumed the contact to be a direct "clairvoyant" one with the target that is generated in the future. I suggest, however, that such a contact would be logically impossible, and experiments are proposed to support this suggestion.

Furthermore, confusion has also arisen from the results of experiments in distant mental interaction between isolated individuals. These experiments have often been considered to demonstrate "telepathy", but the effects could be due to real-time psychokinetic (PK) influences produced by the sender. I suggest that

PK influences may be based on principles that are quite different from ESP, and that by taking this into consideration, our understanding of ESP will be simplified considerably.

Information Transfer in Space-Time

Among the modern interpretations of quantum mechanics, the one proposed by David Bohm (1995) suggests the kind of effects that we need to explain both memory and precognition.

Bohm proposes that behind the quantum-mechanical processes obeying their statistical laws, there is a deeper level of activity involving sub-quantum-mechanical entities that are subject to their own laws. He calls these entities hidden variables and suggests that they influence the collapse of the wave function and determine which of the potential outcomes (represented by the Schrödinger equation) becomes the real outcome.

The theory is based on the concept of the zero-point field that extends throughout space and time. Bohm refers to this field as the implicate order, and suggests that it is from within the implicate order that the hidden variables exert their influence on the wave function to create the manifested universe. He suggests that the implicate order constantly unfolds to create the successive instances of the manifested universe—the explicate order—and that these instances are then immediately re-enfolded back into the implicate order. The notion of continuity of existence is approximated by that of the rapid recurrence of similar forms.

Bohm suggests that all similar structures "resonate" in the implicate order, with the result that they tend to replicate one another when they are unfolded (Bohm & Weber, 1982). He gives the example of a relatively stable structure, such as a "mountain", in which the resonance helps to maintain continuity of form, as each instance of the mountain is successively unfolded.

However, the structures do not necessarily have to be unfolded in continuous succession. If similar patterns of neuronal activation are created in the brain on different occasions, they will also resonate with a tendency to replicate (become more closely similar to) one another. Since the resonance takes place in a field that extends throughout all space and all time, the tendency will still exist, even if the patterns are completely separated, spatially and temporally.

The synapses that form the patterns are affected by a phenomenon known as brain plasticity (discussed in The Long-Term Memory System), and their structures depend on the flow of impulses through them. On the occasion when an event is experienced, the corresponding pattern is activated many times, and the synapses allow the neural impulses to flow freely. However, when the pattern is spontaneously activated during a retrieval, some of the synapses allow the impulses to flow less freely. The replication tendency could momentarily affect these synapses in such a way that they show a greater tendency to allow the flow of impulses. Thus, if an extra set of impulses are able to follow the same pathways through the networks, the pattern may be said to have been "replayed" as a result of the replication tendency. If the brain can detect the replay, this will indicate that the pattern corresponds to an event experienced at some other moment in time—and that could be either in the past or in the future.

Now, whilst it is the entire spatiotemporal pattern that resonates, the replication tendency has only to produce microscopic changes at the synapses. Sir John Eccles suggests that quantum indeterminacy may play a significant role in synaptic action (Beck & Eccles, 1992), and this does support the possibility that the changes could be produced.

The microscopic changes of this kind would allow the laws of quantum mechanics to be conserved to a very high degree of accuracy. In the words of physicist and mathematician Roger Penrose (1995, p. 309), this leads to the kind of viewpoint that allows the wave function "to provide an accurate mathematical description of a *real* quantum world—a world that evolves to an extraordinary degree of precision, though perhaps not with total accuracy, according to the mathematical rules that the equations provide". Thus, when the wave function collapses, the probability of a given outcome will be very slightly biased, and this will influence what otherwise would be the *random ingredients* in the outcome produced. It is within these "random ingredients" that the structural replication tendency is manifested.

At the time when Bohm put forward his proposals, many physicists rejected his concept of the hidden variables, but more recently a renewed interest has been shown towards them. For example, Mark Hadley (1997) points out that since, according to relativity theory, the past and future already exist, then it would be natural for both to affect the present.

Notice that when the implicate order unfolds, it still projects into a series of elements that build up to create a fully determined universe, as required by the special theory of relativity. David Albert (1994, p. 39) suggests that the notion of the implicate order could lead to the future unification of the quantum and relativity theories, both of which might be derived from it as abstractions that are valid within their limited domains.

The Long-Term Memory System

Memories about events, about ourselves, and about our experiences with the events are stored in neuronal networks. When stimuli are applied to the inputs, chains of impulses trace pathways through the networks, and they trace out a highly complex pattern that has extension in space and duration in time—a *spatiotemporal pattern* of neuronal activation. When the level of activation reaches a certain threshold, it may give rise to a conscious experience of the information contained in some of the networks.

The basic elements of memory refer to simple features of the environment, such as shapes, colours and sounds. These memories are inherited, and they are arranged in modular cell assemblies in the primary sensory areas of the posterior cortex. As the brain develops, associations are created between the assemblies. Networks begin to be formed, and they extend into the association areas of the neocortex. When an event is experienced through the senses, the brain activates an *existing* network that represents the experience. The sensory stimuli are matched to the network because similar stimuli have already contributed to its formation on previous occasions. However, with elements of *new* experience, new associations are created, and they are added to the existing networks.

It is now believed that short-term memories are stored in the same system as the long-term memories. Cognitive scientist Joaquin Fuster (2003, pp. 117–121) gives outstanding evidence to show that the information goes straight into the long-term memory system as soon as it arrives from the sensory areas.

It is also believed that the *working memory system* located in the prefrontal cortex does not store memories either; it controls the activation of the long-term memory networks. The working memory cells are activated through re-entry circuits from limbic structures, such as the hippocampus and amygdala.

The Encoding of Memory

Prior to birth, vast numbers of neurons are produced in the neocortex. The neurons are connected to form an unimaginably complex structure that serves as a matrix. At the time of an initial experience, chains of impulses trace pathways through the matrix and this initiates the microgrowth of the synapses. As the pathways continue to be activated, the synapses are strengthened and networks are formed.

In order to produce the continuing activations, impulses are applied from various sources. First, the impulses from the sensory areas are applied to the networks for as long as the experience continues. Second, re-entry circuits connect the outputs from the networks, via the hippocampus, back to the inputs. The resulting feedback loops lead to further reactivations. And third, since the networks corresponding to the experience are associated with networks corresponding to the effect it produces upon oneself, an *appraisal* may be carried out according to whether the experience is beneficial or harmful. It is now known that the appraisal is carried out by a separate mechanism, which involves the amygdala. Re-entry circuits from the amygdala also go back to the networks, either directly or via the arousal systems. Thus, even more reactivations are produced, and they may continue after the sensory experience has ended (LeDoux, 1998, pp. 284–291).

Now, depending on how often the networks are subsequently activated, the synapses will show a tendency to either strengthen or regress. This leads to the occurrence of brain plasticity, which is due to the microgrowth of the synapses. Some recent research suggests that the glial cells, previously thought only to supply nutrients to the synapses, may help to control brain plasticity (Fields, 2004).

The networks themselves contain *items* of information, and they are connected in such a way that any given network has a large number of inputs from other networks, as well as a large number of outputs to other networks. An impulse arriving at *any one* of the inputs will lead to the activation of the core of the network. Thus, the core is activated far more often than any of the pathways leading to it, and this will be reflected in the degree of strengthening of the synapses. As Fuster puts it: "A more appropriate view is that of a network with relatively firm connections at the core, made of repeatedly enhanced synaptic contacts, as well as weakly enhanced and *noncommitted* contacts 'around the edges'" (2003, p. 82).

The Retrieval of Memory

Retrieval occurs when networks are activated that are the same or similar to those activated on the occasion of the initial experience. The neural impulses have to follow similar pathways and create similar patterns of activation.

According to the classical models, retrieval is accomplished by searching alternative pathways from a *retrieval cue* to the various items associated with it. But here a problem arises. How does the brain "know" which of the pathways to take? Whilst the "searching" of pathways is carried out, many combinations of items will be activated, and most of them will not correspond to coherent situations at all.

This is where a resonance between the patterns may serve as an important aid to retrieval. The neural impulses follow various pathways through the system, until a particular pathway (or combination of pathways) happens to coincide with one that is activated at the time of an initial experience. The patterns resonate, and this produces a tendency for the newly activated pattern to be replayed; that is, for a second set of impulses to travel through the system a fraction of a second later.

But there is still a problem, because the chains of impulses may travel along diverging pathways corresponding to different experiences, and any intelligible information will be lost in a background of "noise". Fuster recognizes this problem and suggests that we need "not only the selective activation of certain cortical networks, but also the concomitant *inhibition* of other networks" (2003, p. 164). He speculates that a "lateral inhibition" may serve the exclusionary role and that it would be achieved when the frontal cortex reciprocates inputs from the posterior cortex with inhibitory outputs to that cortex. He notes that such inhibition has been observed, both in humans and in monkeys, in the areas adjacent to those that are active.

The implication here is that the activation of one set of networks is sustained, and this, in turn, leads to the inhibition of the others. However, it is possible that there is an underlying tendency for inhibition to be applied to *all* the networks after the passage of the first few impulses. Thus, a pathway through one set of networks would have to distinguish itself in such a way as to resist the tendency to be inhibited.

This might occur if the pathway is replayed because of its resonance with the pathway activated at the time of the initial experience. The replay would result in stronger stimuli being produced at the outputs from the networks, and since these are connected, via the hippocampus, back to the working memory system, it might result in the activation of the corresponding working memory cells. These cells sustain their firing, causing the same networks to remain active long enough for the information they contain to be processed. At the same time, inhibition would continue to be applied to the other networks.

The networks that continue to be active thus enable the retrieval of memories. The key to retrieval would seem to lie in Fuster's "noncommitted" synapses that join the networks and assemblies forming the pattern. These are the synapses that are close to the point of transmitting impulses—the ones that could be influenced into doing so within the random ingredients of quantum indeterminacy. If this occurs, it might result in a replay of the pattern.

Memories of the Past and Future

Since the resonances can occur between patterns that are activated at any location in space and time, retrieval from the future should be achieved in very much the same way as retrieval from the past. The pattern activated at the time of the initial experience influences a similar pattern when it is spontaneously activated in the present. This leads to the sustained activation of the pattern, and a conscious awareness of the information may be produced.

The reason why memory of the past is so much more efficient than precognition is because the pattern corresponding to the past experience has already been consolidated at the time of that experience. There is a greater tendency for the impulses to travel along the same pathways when stimuli are applied in the present. The pathways corresponding to what will be *new* experience in the future have not yet had the opportunity to be strengthened, and the impulses will be less likely to follow the same pathways.

Furthermore, in order for the patterns to match and for the resonance to occur, not only do the pathways have to be similar, but the structures of the synapses forming the pathways also have to be similar. The problem is that whilst the synapses are being strengthened, they undergo constant changes due to brain plasticity. If a pathway has already been strengthened in the past, the synapses may not have changed very much when the pathway is activated again in the present. But if the impulses do happen to follow a pathway corresponding to what will be new experience in the future, the synapses forming this pathway have not yet been strengthened. A poorer matching is obtained.

This suggests that retrieval should be more likely to occur when the temporal distance to the initial experience is shorter. The matching is closer, and this increases the likelihood of a replay. We know from common experience that events in the recent past are recalled more easily, and later we shall look at experimental evidence which shows that precognition is more likely to occur when the precognitive interval leading up to the experience of the future event is shorter.

The likelihood of retrieval would also be expected to increase when the initial experience is of greater emotional significance. Re-entrant stimuli from the appraisal mechanism cause many more reactivations of the pattern. As well as consolidating memories, these reactivations build up the strength of the resonance and increase the likelihood of a replay in the present. Again, we know from common experience that "emotional" events in the past are recalled more easily, and in the case of the precognition experiments, we shall see later how the results do depend on the subject's emotional response to guessing the targets correctly.

Both these factors enable the brain to achieve some degree of selectivity, by eliminating experiences that occur at greater temporal distances and experiences that are of little personal significance.

The likelihood of retrieval might also increase with increasing complexity in the pattern activated. This could increase the strength of the resonance and produce a greater tendency for the present pattern to be replayed. For example, details of the environment, or context, will increase the complexity of the pattern, and these details may not change very much over the time interval between the initial experience and the moment of retrieval.

It is well known that the recall of past memories is aided by similarities in context. For example, if we learn something in a given environment, and then we go back to the same environment, we find it easier to remember what we learned (Bower, 1992). The context is believed to serve as a good retrieval cue, but perhaps a better explanation is that it facilitates retrieval because a stronger resonance is produced. We should expect the retrieval of a future memory to be facilitated in the same way, and this would be quite easy to verify experimentally.

The representations of oneself, and of one's previous experiences of the event, are also contained within the pattern, and again these representations may not change very much over the time interval concerned. They could help to produce a stronger resonance and serve as a further aid to selectivity, by helping a person to connect with his own experiences, and not someone else's. A precognitive contact should therefore be far easier to produce than a telepathic one with a different person.

We conclude that there may be two separate requirements for retrieval. First, a neuronal spatiotemporal pattern has to be activated in the present that is similar to the pattern activated at the time of the initial experience. And second, the pattern has to be replayed as a result of the resonance. The model suggests that retrieval doesn't necessarily require the reactivation of the initial pattern; if a similar pattern is activated elsewhere in the brain, the resonance will still occur. This may explain how people sometimes recover memory after permanent damage to certain areas of the brain (e.g., Teuber, 1975).

Notice that the pattern spontaneously activated in the present contains only a description of the event; it says nothing about whether or not the event occurs. But if the resonance leads to a sustained activation of the pattern, this indicates that the event has occurred at some other time, and that there is a *possibility* of it occurring again.

Information about the *likelihood* of occurrence of the event could then be assessed according to the level of subsequent activation of the pattern. For example, the processing of information about the prevailing circumstances may lead to the continued application of stimuli to the inputs. The pattern continues to be reactivated, and this in turn triggers a number of activations of the appraisal mechanism. It produces an emotion containing a certain level of belief towards the occurrence of the event. The greater the number of activations and appraisals, the stronger will be the "belief" produced (Taylor, 2007).

However, apart from the activations caused by the stimuli initially applied to the inputs, some additional activations will be caused by the re-entry of stimuli from the outputs (spatial feedback) and also by the effects of resonance with past or future patterns (temporal feedback). These additional activations will mediate the assessment of likelihood of the event occurring. The implications are that temporal feedback due to the resonances could play an important role in cognition.

Precognition and the Intervention Paradox

If precognition occurs, it must do so in such a way that there is no possibility of the percipient coming up against the intervention paradox. This would happen if a percipient were to precognize a future event and then *change* the event, because it would raise the question as to where was the future event that led to the precognition in the first place?

However, the structures resonating in the implicate order correspond to *processes* that have duration in time, in the manifested universe of space-time events. Such processes occur in the brain when neurons and neuronal networks activate one another (by association) to form spatiotemporal patterns. The association between a pair of networks refers to a "cause" producing an "effect", and when a resonance occurs, the information transferred also refers to the cause producing the effect. A precognition therefore refers both to the cause *and* to the effect, *even if only one of the networks is activated sufficiently to produce a conscious awareness of the corresponding event.*

First, let us consider events that are subject to a person's influence. The brain may initially activate a number of patterns in which networks corresponding to "something that the person does" are associated with networks corresponding to "the event that is caused". The associations are appraised to determine their significance for well-being. This may lead to an *intention* being created, as the level of activation approaches the threshold at which the motor networks are triggered. The intention will be for the person to cause a relatively beneficial event to occur, because that is the kind of event more likely to ensure his survival as a member of the species.

We will suppose that the person intends to cause an event to occur, in the present, and his experience is that of causing the event to occur, in the future.

The present and future patterns of activation are similar to one another, and they resonate with one another. This may lead to a replay of the pattern activated in the present, and if the person detects the replay, it will enable him to precognize the fact that he will successfully fulfil the intention.

Suppose now that the person intends to *change* the event. This is where the intervention paradox could arise, because if he were to precognize the event, he might then decide to change it. However, if he intends to change the event, it really means that he intends to cause an event to occur which is *different* from the one that will actually occur. The present intention refers to "him doing something to cause a relatively beneficial event to occur", whereas the future experience refers to "him doing something different and causing (or allowing) a relatively harmful event to occur". The present and future patterns are quite different from one another. Resonance is not produced, and the person cannot precognize the event that actually occurs.

However, when the event is no longer subject to the person's influence, such an event is said to be caused by circumstances. It is the association between the networks corresponding to the "event" and the "effect upon himself' that is appraised. If circumstances *do* cause the event to occur, and if similar patterns are activated in the present and in the future, a precognition can be produced.

This limitation on the occurrence of precognition can be summarized as the *Principle of Intentionality,* which states that *a precognition can only occur when, as a result of the precognition, the percipient is either unable to change, or does not intend to change, the future event precognized* (Taylor, 1995, 2007).

Future events therefore can exist in space and time. It is access to information about the occurrence of the events that is denied if the percipient intends to change them.

Intuition

According to the *Principle of Intentionality,* we cannot precognize an event (such as an accident) that we would prevent if we were to know about it in advance. In order for the precognition to occur, the future event that leads to the precognition must also be allowed to occur.

However, instead of trying to precognize the accident itself, we can try to precognize whatever we intend to be doing at the time when the accident occurs. Since there will be no experience of fulfilling the intention, there will be no reactivation of the pattern in the future, and nothing to cause a replay of the pattern activated in the present. If the brain can detect the *absence* of the replay, it can then deduce that the nonfulfilment of the intention might be due to an accident.

This detection of the absence of an intended future could form the basis of *intuition,* which Dean Radin describes as: "being aware of something without knowing how you are aware of it" (1997, p. 28).

There is definite evidence that people can use intuition to avoid accidents. W.E. Cox (1956) carried out a survey of passenger statistics over a number of years on the U.S. railway system. The survey shows that significantly fewer people travelled on trains at the time of accidents, compared with the number who travelled on comparable "control" days (e.g., 7 and 28 days) before the accidents.

In fact, an experiment has been carried out which also suggests that people can use intuition to seek out futures that are beneficial to them. In the experiment, subjects played a card game in which they had to select cards, one at a time, from four alternative decks. Unknown to them, two of the decks contained a higher proportion of winning cards and the other two contained a higher proportion of losing cards. The subjects found themselves choosing the cards advantageously, before they knew the strategy that would be advantageous to them (Bechara et al., 1997).

Rex Stanford (1990) suggests that living organisms constantly "scan" the environment, looking for information related to the fulfilment of their needs. He calls it *psi-mediated instrumental response* (PMIR), and he suggests that the scanning is done using ESP as well as the normal senses and that it leads to an "instrumental response" to satisfy the need. The hypothesis suggests that the response can be produced in ways in which the percipient would seldom notice it, and that it may sometimes produce effects in quite trivial situations. It would explain, he says, the many odd coincidences that turn out to have unexpected significance, such as "just happening" to find oneself in the right place at the right time. Carl Jung (1985) examines these meaningful coincidences and proposes the term *synchronicity* to refer to them.

Sometimes, cases are reported that are suggestive of intervention. For example, a passenger finds herself deciding not to take a train, and later she reads the news of an accident. She assumes that she must have precognized the accident and that she later intervened to avoid it. But she never did precognize the accident; all she obtained from the future was the knowledge that she would be unable to do something that she intended to do later that day. It enabled her to deduce the possibility of the accident occurring. This explains all the cases of apparent intervention discussed in the parapsychology literature (e.g., Rhine, 1955).

Evidence from Precognition Experiments

We shall consider the target-guessing experiments of the forced-choice type, in which the subject has to guess which of a known set of symbols corresponds to a target that will be randomly selected in the future. For example, in the case of ESP cards, five different symbols are used, so that with each trial the subject has exactly a 20% probability of correctly guessing the future target by chance alone. If a subject can systematically guess the targets at a rate higher than chance, then the additional correct guesses may be attributed to his extrasensory ability. Thus, the experimenter records the number of trials and the number of correct guesses, and then calculates the odds against such a result being produced by chance alone.

Meta-analyses performed on the results show that subjects can guess the future targets with a probability far greater than chance. For example, Charles Honorton and Diane Ferrari (1989) carried out a meta-analysis using a database of 309 series of experiments with over 50,000 subjects and a total of nearly 2 million trials. A small, but reliable, overall effect was found. Thirty percent of the studies were statistically significant, whilst 5% would be expected by chance. The probability of such a result being produced by chance would be less than 1 in 10^{24}.

Now, since the targets used in these experiments are not selected until *after* the subject makes his (or her) guess, the results provide outstanding evidence for an extrasensory contact with *something* in the future. But it is not immediately clear with what the contact is made. The majority of parapsychologists believe that the contact is a direct one, with the target itself. I suggest, however, that such a contact would be logically impossible.

First, if information about the future target were to be communicated directly to the subject in the present, the subject could later change the target and he would come up against the intervention paradox. The target that was supposed to have led to the precognition would no longer exist. Second, an inanimate target cannot collect and encode information about itself in a way that would be intelligible to the subject's brain, either in the present or in the future.

I therefore suggest that the contact is made with the subject's brain in the future, after the subject has been given feedback, via the normal senses, of the target information. In fact, the Honorton and Ferrari meta-analysis (1989) includes a study of a subset of experiments in which information is provided about the degree of feedback given to subjects. The study shows that when no feedback is given, *the significance of the results falls to chance expectation.*

The question now arises as to how the subject is able to score a "hit" by correctly guessing the target symbol in the present? As discussed earlier, the precognized information refers to the process in which a network corresponding to a "cause" is associated with a network corresponding to an "effect". The "target symbol" on its own is not a process, but if the idea of "the subject selecting the target symbol" is associated with the idea of "scoring a hit", then in neural terms, this does represent a process.

Thus, the subject may have to select the option which, in the future, he associates with the effect of "scoring a hit"—an association that he will appraise to produce the emotional feeling of "satisfaction". Since the appraisal mechanism is activated, re-entrant excitation causes many more activations of the pathway through the networks. This provides a convenient way of building up a relatively strong resonance, which may cause a replay of the same pathway when it is activated in the present.

Let's suppose that the subject selects the correct option—symbol X. The present intention is for "his selection of symbol X to be associated with scoring a hit", and the future experience is that in which "his selection of symbol X *is* associated with scoring a hit" when the target information is revealed. The intention is fulfilled, and the resonance between the patterns enables him to precognize the successful outcome. A positive response is produced.

However, when he selects an incorrect option—symbol Y—he intends for "his selection of symbol Y to be associated with scoring a hit". Since there is no future experience of this occurring, the intention is not fulfilled and a negative response is produced.

The determination of the correct option is made by means of a series of intuitive decisions to systematically eliminate the incorrect options. It is important to notice that the subject has to start with the assumption that each option is the correct one. He must have an initial intention to go ahead and register the option, so that it is the absence of the replay that prevents him from doing so, if the option is incorrect. This is necessary to prevent a "causation loop" from being set up, in which the replay of the pattern would cause him to select the correct option, and the selection of the correct option would (through the resonance) cause the replay to occur.

In neural terms, it means that input stimuli initially have to be applied to each of the pathways through the networks. If a pathway will not be reactivated in the future (and a replay is not produced), inhibition from working memory then causes the activation of the pathway to cease. This prevents the subject from registering the option. But if the pathway being activated corresponds to one that will be reactivated in the future, the pathway is replayed. The re-entry of excitation to the working memory system prevents inhibition and allows the activation of the pathway to be sustained until the motor networks are triggered and the subject registers the option. The inhibition is therefore applied automatically, unless an immediate replay of the pattern prevents it. This supports my earlier suggestion that there must primarily be a tendency for inhibition to be produced in all the networks.

Interestingly, Rhea White (1964) carried out a survey of the subjective conditions necessary for responding to targets. She found that a subject performs best when his attention is kept away from the target options by concentrating on some trivial event that doesn't evoke an emotional response. The subject then waits for as long as necessary, whilst allowing tension to build up gradually to the point at which the answer comes spontaneously.

These findings not only support the techniques that were successfully used in the early days of target-guessing, but they also accord with the mechanism now proposed. For example, if the subject is deliberately trying to score, it means that he is applying excessive stimulation to each of the options. This will override the possibility of the inhibitory influence preventing the incorrect options from being selected. But if attention is kept away from the options, and tension allowed to build up gradually, the level of activation of each of the pathways will also build up gradually to the point at which the subject is about to register the corresponding option. However, at this critical level, the inhibitory influence is still sufficient to prevent this from occurring in the case of the incorrect options.

The mechanism I have described explains the apparent anomalies observed in the ESP experiments performed in the past; for example, the "decline effect" in which the results of experiments fall to chance expectation after repeated testing (Edge et al., 1986, pp. 35, 117, 209). This is because the subject becomes bored with the experiment. The association between "the subject selecting the target symbol" and "scoring a hit" is no longer appraised in the future to produce the emotion of "satisfaction". Fewer reactivations of the pattern are carried out, and the strength of the resonance is reduced to a level at which it is less likely to cause a replay of the pattern activated in the present. We noted earlier that both memory and precognition tend to refer to the more "emotional" events.

Another apparent anomaly is that in which the significance of the results tends to fall as the temporal distance to the future experience increases. The Honorton and Ferrari meta-analysis (1989) includes a study of a subset of data which shows that the results are highly significant for precognitive intervals of a few hundred milliseconds and they fall to being nonsignificant for intervals of more than one month. However, as the interval increases, so do the effects of brain plasticity and the patterns match one another less closely. This reduces the strength of the resonance, and the pattern is less likely to be replayed in the present. It explains how a subject obtains selectivity when performing a forced-choice experiment, because he is more likely to connect with his future experience in which he scores a "hit" in the trial being performed and not with his future experience of scoring a "hit" when the same symbol appears in a later trial.

The mechanism also explains the results of the "sheep and goat" experiments (Lawrence, 1993; Schmeidler, 1945) in which believers in ESP (the "sheep") scored significantly *above* chance, whereas the nonbelievers (the "goats") scored significantly *below* chance. A nonbeliever in scoring a "hit" is really a believer in scoring a "miss". He tries to select the options which, in the future, he will associate with the idea of scoring misses. These are the associations that he will appraise to produce the feeling of "satisfaction". He therefore scores a higher proportion of misses, and the proportion of hits falls to below chance expectation. The results always go in the direction of the subject's belief.

A New Approach to Psi Research

According to the mechanism described, precognition and telepathy should operate in much the same way. In precognition, a percipient makes contact with his own brain in the future, whereas in telepathy, he makes contact with the brain of another person. And this could occur at any time—past, present or future.

However, a telepathic contact may be very difficult to produce, for the simple reason that *different* brains are involved. Each brain activates a pattern that includes a representation of the person and of his previous experiences with the event. It will therefore be difficult to obtain a good matching between the patterns. Furthermore, it will be difficult to obtain selectivity between an event experienced by the sender in question and similar events that might be experienced by other senders at other times. In precognition, this problem is overcome because the synapses belong to the same brain, and the closer matching between them over shorter temporal distances will ensure that percipients tend to select events that occur within their own experience and in the near future.

For many years, experimental work in telepathy has faced a major conceptual problem, because of the apparent difficulty in making a distinction between a telepathic contact with the sender and a direct clairvoyant contact with the target. Most of the experiments did not attempt to make the distinction, and were designed to measure "general ESP". It was then found that similar results were being obtained, whether or not a sender was involved, and this led to the assumption that the contacts were indeed clairvoyant ones (Radin, 1997, pp. 67, 68, 93).

However, for the reasons already given, it would seem highly unlikely that a clairvoyant contact can occur at all. What might have happened in the experiments is that the subject made contact with his future knowledge as to whether or not he had guessed the target correctly. This would enable him to make an intuitive decision with respect to that future knowledge. The possibility of subjects using precognition seems to have been ignored, and little or no attempt has been made to prevent them from obtaining feedback of the results. For example, in the case of the Maimonides dream laboratory experiments in telepathy (Ullman et al., 1989) and the automated ganzfeld experiments (Honorton et al., 1990), the reports specifically mention that feedback was given to subjects after the sessions were over.

Similar comments apply to the remote viewing experiments that were carried out at the Stanford Research Institute. Russell Targ and Harold Puthoff (1978) found that subjects performed better when they later received feedback, for example, by visiting the target locations. This was believed to be conducive to "psi training" (see also Puthoff, 1996). However, I suggest that the feedback would actually have been necessary for the subjects to make intuitive decisions with respect to their future knowledge of having guessed correctly the various elements of the location they had to describe. In fact, one of the subjects, Ingo Swann, referred to the difficulty he experienced in making decisions about "what is there and what is not" (Targ and Puthoff, 1978, p. 2).

This interpretation may explain why poor repeatability was sometimes found when different laboratories tried to replicate the experiments. In those cases in which subjects were unable to receive feedback after the session, the results would be expected to fall much closer to chance expectation. This might have happened in the case of some of the ganzfeld experiments. For example, Honorton (1985) reports a meta-analysis of twenty-eight ganzfeld studies carried out in ten laboratories. Although the combined score across the ten laboratories was highly significant, four of the laboratories were unable to produce positive results.

It would therefore be important for new experiments to be carried out in which the amount of feedback to the subject is systematically varied. In the case of a forced-choice target-guessing experiment, for example, if only the result of a series of trials is given, the significance would be expected to fall because the subject would have to try to create an association between the idea of "him selecting a given combination of symbols" and the idea of "producing a significant result". If no feedback is given, and steps are taken to eliminate the possibility of any form of telepathic communication, the results would be expected to fall to chance expectation. This would confirm the findings of the Honorton and Ferrari meta-analysis (1989).

Now, if it can be shown that ESP consists only of connections between living brains, this will give support to the model I am proposing for memory and precognition. Furthermore, by eliminating the clairvoyant interpretation, ESP research will be simplified considerably. New experiments can be designed to attempt to detect pure telepathy. The experiments could make use of a context that is unique to the sender and to the subject at the moment of each trial (cf. the *token objects* used by psychometric mediums). This would improve selectivity, by creating a unique resonating field for that trial. The effect of giving feedback of the subject's guess to the sender could also be tested, and attempts to amplify the effect could be made by using additional senders (Taylor, 2007).

Notice, however, that a number of experiments have been carried out in the past to investigate distant mental interaction, and these may have further confused the issue regarding telepathy. In these experiments, the sender directs emotional thoughts towards the subject, and the effect on the subject's autonomic nervous system is observed by measuring the changes to his or her electrodermal activity. The results have proved to be highly significant and they do not require feedback to be given to the sender (e.g., Braud and Schlitz, 1991).

However, the experiments show two important differences when compared with the traditional ESP experiments:

1. The influence is a nonspecific one, affecting only the general emotional state of the subject.
2. The influence is produced in time-sync with the initial stimulus to the sender.

The effect is probably due to PK influences, and it suggests that two different principles might be involved in psi. ESP seems to depend on influences produced by spatiotemporal patterns that are activated at different places and different times. They enable the communication of information on *processes* ("cause-and-effect" relationships) that have duration in time. Psychokinesis seems to depend on a nonspecific influence produced in real-time, probably by large numbers of neurons extending over a large area of the brain.

One approach to the problem of PK influences would be to consider the effects of *quantum coherence* in the cytoskeletal activity of neurons. Frohlich (1975) suggests that large-scale quantum coherence may occur in biological systems, especially where there is a large energy of metabolic drive. Hameroff (1994) gives evidence that these effects occur in the microtubules that run along the length of the axon and dendrites of the neuron and control the transportation of neurotransmitter molecules to the synapse. Penrose (1995, pp. 351–377) suggests that the quantum coherence may extend from one microtubule to another, across large areas of the brain, possibly using *Einstein-Podolsky-Rosen* (EPR) nonlocality.

However, if large-scale quantum entanglement can occur in a single brain, it might well be possible to extend this to a second brain, especially in the case of an identical twin. Once trapped in the microtubules, the entangled state could be carried to an unlimited distance by either of the twins. Experiments have been performed to show that identical twins are prone to showing correlations in brain activity over long distances (e.g., Duane & Behrendt, 1965).

It is not yet understood how the quantum organization is "tapped off' to produce the changes in the synaptic connections, but presumably a similar mechanism would explain how PK influences can produce the statistical changes in the circuits of random number generators (e.g., Radin and Nelson, 1989). It is quite possible that microtubule research in the future may help us to understand psychokinesis.

Meanwhile, the more important task will be to eliminate the clairvoyant interpretation of ESP along with some of the extravagant claims that have been made for this interpretation. For example, if we can eliminate claims of the mental ability to "read" a symbol printed on the surface of a hidden ESP card, or to identify a remote location given only its geographical coordinates, this should help to bring psi research into a much closer alignment with mainstream science.

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