PRECOGNITION—A MEMORY OF THINGS FUTURE

G. FEINBERG

I. INTRODUCTION

It appears to be the view of most, if not all, parapsychologists that precognition, if it can definitively be shown to occur, would be the most difficult of psychic phenomena to explain in the context of ordinary physical theories.[1] Indeed, some parapsychologists have gone further and stated that the occurrence of precognition is inconsistent with known laws of physics and that if precognition is established, these laws would have to be abandoned or changed.

While I do not know whether there is convincing evidence for precognition, I think that if it does occur, it is prudent to be skeptical about the view cited above on several general grounds. One is that physical theories often possess unexpected powers to explain new phenomena, not anticipated until the phenomena are discovered. An example of this is the use of Maxwell's theory of electromagnetism to explain the properties of x rays, discovered twenty-five years later. Another ground is that physicists usually do not try to work out all of the hypothetical consequences of a given theory. Instead, they tend to concentrate on those which seem most directly related to known phenomena. As a result, other consequences may not be recognized for a long time afterwards, often not until they are observed without the aid of the theory. In view of these historically demonstrable aspects of physical explanations, one can reasonably be cautious about accepting the dictate of the parapsychologists cited above, unless and until a careful analysis of the relevant physical laws actually could demonstrate that precognition, or any other phenomenon of interest, is inconsistent with these laws.

Actually, the solution with regard to precognition and accepted physical theories is quite different than the above picture would suggest. Instead of forbidding precognition from happening, these theories typically have sufficient symmetry (between the past and

future) to suggest that phenomena akin to precognition should occur in a manner qualitatively, although not necessarily quantitatively, similar to the occurrence of retrocognition. Indeed, phenomena involving a reversed time order of cause and effect are generally excluded from consideration on the ground that they have not been observed, rather than because the theory forbids them. This exclusion itself introduces an element of asymmetry into the physical theories, which some physicists have felt was improper or required further explanation.[2] Thus, if such phenomena indeed occur, no change in the fundamental equations of physics would be needed to describe them. Only a change in the solutions used would be necessary.

The details of these aspects of physics relevant to this possibility will be given below. However, it is worth noting first that the occurrence of physical effects that propagate backwards in time may be related to precognition very indirectly. To see this, we note that the information about the past that is available to any person at a given time does not mainly consist of his sense data at that instant. Indeed, we usually do not think of sense data as giving information about the past, although strictly speaking it is the past we are observing, because of the finite time required for any known type of signals to propagate across space. Instead, our information about the past comes either from inferences we make from these observations or through the poorly understood process we call memory, through which we can bring into our present awareness observations that we, or others, have made in the past and which have somehow been stored in our brains.

A plausible analogy between information about the past and future would suggest that if information about the future is available to a person at all, the main source of it might well be observations that he or others will make in the future and which will then be stored in his brain. It might be expected that whatever the mechanism of precognition, it could work more easily upon the future state of the percipient's own brain than on the world outside. In other words, I am suggesting that precognition, if it exists, is basically a remembrance of things future, an analogy to memory, rather than a perception of future events, an analogy to sense perceptions of the very recent past. This suggestion has at least the merit of being fairly easy to test through simple experiments or perhaps even through a careful literature search. I shall spell out below some of the simple consequences of this model for precognition and how to test it. If it is correct, it would not directly indicate

the physical mechanism for precognition, any more than the existence of memory indicates its physical mechanism. However, if it does turn out that memory can operate into the future as well as into the past, it would suggest that the symmetry of physical laws mentioned above is involved and that physicists have been premature in discarding those solutions to their equations that describe reversed time order of cause and effect.

II. TIME SYMMETRY OF THE EQUATIONS OF PHYSICS

The equations that describe the evolution in time of physical phenomena have a rather simple form according to relativity theory. A typical example, which illustrates the main points, is the wave equation in one space dimension, whose form is

$$\frac{\partial^2 \phi}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 \phi}{\partial t^2} = \rho(x,t), \tag{1}$$

where c is the velocity at which the waves move through space. In this equation, ϕ represents the amplitude of some wave phenomenon (and depends on space and time) and ρ represents a material source density for the wave. For instance, ϕ might represent an electric field strength and ρ the distribution of charge or current that produces the field. In a physical applicaton of this equation, we would take ρ to be a prescribed function of space and time and use the equation to calculate ϕ for all values of x and t. The values obtained for ϕ will depend on the value of ρ, but in a rather complex way. However, generally speaking, a change in ρ at one point in space and time will lead to a change in ϕ at many points in space and time, in a way prescribed by the equation. A human being, or an instrument, sensitive to the value of ϕ in some region of space-time will therefore receive different impulses depending on the value of ρ in other regions of space-time and hence will know something about what is happening in those other regions. Clearly, the relation between ρ and ϕ is a critical factor in determining what regions of space-time are accessible to a particular observer through measurement or sensing of the value of ϕ at his location.

Because Eq. (1) is a second-order partial differential equation in the time, it has in general two sets of solutions. The particular form of Eq. (1) is such that one set can be obtained from the other set by the change of t into $-t$, in both ϕ and in ρ. We can study the character of these solutions by considering the simple case in which ρ is a transient disturbance, such as a light bulb that is turned on and

off in a short period of time, and is limited to a small region of space. We shall call the point at which ρ is localized x_0, t_0. The solutions for this case can then be described as follows. One solution, called retarded, has $\phi = 0$ for all times earlier than t_0, everywhere in space. For times after t_0, ϕ is nonzero at the points $x = x_0 \pm ct$. This corresponds to the generation of two pulses of radiation, each traveling outward from the source point at velocity c. An observer at a distance d from the point x_0 would detect this radiation at a time t, later than t_0 by d/c, the time taken for the radiation to travel the distance d. This retarded solution is the one generally chosen to represent the physical phenomena described by the wave equation.

The other solution, obtained from the retarded solution by letting $t \rightarrow -t$, is known as the advanced solution. It has the property that $\phi = 0$ for t later than t_0, everywhere in space. For t earlier than t_0, ϕ is nonzero at the points $x = x_0 \pm ct$. This solution may be interpreted either as two pulses of radiation traveling outwards from the source, but backwards in time, or as two pulses coming from spatial infinity, but forwards in time, to meet at the source at t_0. With either interpretation of the advanced solution, there is associated with the disturbance at t_0, effects at times earlier than t_0, rather than later than t_0, as for the retarded solution. An observer at a distance d from the point x_0 would detect the radiation corresponding to the advanced solution at a time t, earlier than t_0 by d/c. In the case of an electromagnetic wave, traveling at the speed of light, this time is usually very short. When d corresponds to a distance of a few meters, d/c is about 1/100 of a microsecond, so that the advanced notice of a disturbance available in this way would not be very useful. If one considers waves propagating more slowly, such as sound waves, the advanced notice would be somewhat longer but still too short to be directly useful for precognition. However, indirect effects of advanced waves are more promising and will be discussed below.

Whatever use we could make of advanced waves, we must first ask whether they actually occur in the world, as against occurring as mathematical solutions to equations. The general solution to Eq. (1) is a linear combination of the retarded and advanced solutions with unknown coefficients. As mentioned above, physicists have usually, although not always,[2] supposed that the coefficient of the advanced solution is zero and only the retarded one is present. The reason for this is that advanced effects do not appear to occur, at least within some range of accuracy. The evidence for this is simple. If there were advanced effects comparable in size to retarded ones, many

bizarre astronomical phenomena would be observed. For example, two images would be seen of a planet, or other astronomical objects, displaced by the distance that the object moves in twice the time it takes light to go from the object to earth. For the planet Mars, these images would be displaced by more than the planet's apparent diameter and would have been easily detected. Another example is that phenomena that occur at a well-defined time at the place of origin, such as eruption of a solar prominence, would appear to occur twice in the same spot, once corresponding to the arrival of the advanced wave and then later corresponding to the arrival of the retarded wave. Since these phenomena have not been reported by astronomers, we may conclude that advanced waves are not as strongly produced as retarded waves.

However, this does not imply that they are not produced at all. Conceivably, the ratio of strength of advanced and retarded waves is quite small, but not zero. This would not necessarily make the advanced waves useless for precognition but would rather imply that precognition would not be as effective as ordinary perception or as memory of the past, a conclusion for which there is ample evidence. Experiments to detect a relatively small amount of advanced light wave are not hard to imagine and some may soon be carried out by Professor Riley Newman of the University of California. In the simplest such experiment, a light source is turned on at a time that is very sharply defined, say to within 10^{-9} seconds. A detector is placed at a distance of 10 meters from the source. The detector will ordinarily indicate the presence of the retarded wave after about 3×10^{-8} seconds have passed, corresponding to the transit time of the light over the 10 meters. If an advanced wave is also present, the detector would react to it at a time 3×10^{-8} seconds before the light is turned on and this time is large enough that the advanced and retarded signals are easily distinguished. The consequence of not turning on the light after the advanced signal is detected is left to the reader to consider. Professor Newman believes that an advanced wave of intensity as little as one part in 10^{19} of the retarded wave could be detected in this way, so we should soon know if advanced electromagnetic waves occur. Advanced solutions for other kinds of wave motion, such as sound, can be treated by similar mathematics. However, since these motions generally involve a real medium through which the wave moves, such as the atmosphere, it is unclear whether the interpretation would be the same. No experimental evidence about such advanced solutions is known to me.

III. A MODEL FOR PRECOGNITION

In the following, I shall outline a very speculative model for precognition that relies on advanced waves. The model is qualitative rather than quantitative because it involves workings of the brain where detailed physical information is unavailable. Yet I believe that model is sufficiently precise that it can easily be tested, providing that precognition can be demonstrated at all.

We assume that when some sensory input reaches the brain, an oscillatory variation of some internal patterns in the brain occurs, which is specific to the input. This oscillation persists for some period of time in at least part of the brain. When the person involved remembers the stimulus, what has happened is that the stored oscillatory pattern has influenced another part of the brain, bringing the memory into consciousness, or at least into something accessible to consciousness. Those familiar with the literature on memory will recognize that I have given a very sketchy description of one model for short term memory. There is some indication that long term memory involves rather different mechanisms.

Suppose now that the oscillatory pattern set up by an external stimulus has not only a retarded part, which propagates forward in time, but also an advanced part, propagating backwards in time. Although we do not know what equations this pattern would satisfy, it is not implausible that these equations are sufficiently similar to Eq. (1) that both types of solution exist. As in the case of light waves, the relative amounts of the two that are involved in an actual situation are not determined by the equation and must be decided by experiment. I shall assume that the advanced part is nonzero but presumably smaller than the retarded part, since precognition in practice is not a very effective way of getting information. Since the retarded part of the oscillation, which in this model allows memory of the past to occur, is known to persist for at least some time without great attenuation, it is possible but not certain that the advanced oscillation would be able to propagate for a corresponding time into the past before the stimulus occurs. So at least over this period of time, by a process similar to memory of the past, it could be possible for the advanced pattern to be brought into consciousness, so that the person involved would "remember" the future stimulus connected with the advanced pattern.

This in brief outline is the model for precognition that I wish to consider. There are several qualitative features of this model that can be simply recognized.

(1) One can only "remember" things that one will eventually sense or learn about through someone else's report. At least this is the case if one disregards the possibility of extrasensory information to be obtained at a later time and remembered by this mechanism at an earlier time. While this neglect may not be entirely justified, it would seem a useful working hypothesis, since, in any event, the amount of information obtained by extrasensory means is small compared to the other sources I am considering.

(2) If the retarded oscillatory pattern is correlated with short term memory, and if the latter has a relatively short term of operation, then we will expect that the advanced pattern would also have a similarly short range into the past. This would imply that precognition would be effective only for events in the not very distant future, perhaps on the scale of hours. Within this time period, precognition would be expected to show a "decay" curve similar to that shown by ordinary memory. Thus precognition would become easier as the percipient approached events more closely in time.

However, if precognition became a well-controlled ability, it would become possible to "pass" information back indefinitely into the past. For example, suppose someone were going to observe an earthquake at noon and became aware of it precognitively at 11:45. He could write out the sentence "There will be an earthquake at noon," and show it to other people. The recording of this sentence would then itself become a new stimulus, which could be recognized precognitively sometime before it was real, or ideally, more than the 15 minutes warning gained by the imagined precognition. This process could be repeated indefinitely, and so the warning time increased indefinitely. Of course, several paradoxical results can be reached in this way and these will be alluded to below.

(3) There should be little or no correlation between the spatial location of the primary event and the ability to precognize it. This is because precognition is operating on the future state of the percipient's own brain rather than directly on the distant event. For example, if there were a supernova explosion in a distant galaxy, whose light will reach earth 15 minutes from now, precognition would be able to give a warning of that explosion sometime before the light reaches earth about as well as it could about an event that occurs in the percipient's immediate vicinity.

(4) We would expect that the same types of external and internal factors that are known to affect ordinary memory, such as drugs, fatigue, age, and training, might be expected to have similar effects

on precognition. The demonstration of such differential effects would of course be very exciting for parapsychological studies.

(5) If we omit from consideration the precognitive "chains" discussed under (2) above, it should not be possible for anyone to precognize about any event that will occur after that person's death, since no sensory input about that event could ever reach his brain. This conclusion is independent of the length of time that the advanced pattern can propagate into the past. It is consistent with one old legend to the effect that prophets cannot foretell their own death but inconsistent with other legends. Of course, even if it is true that precognition cannot be used to foresee one's own death, other explanations are available to account for this and it is therefore not a prediction very specific to the present model.

These properties that precognition should satisfy according to this model suggest a number of experimental tests of the validity of the model. Several of these tests will be discussed in the next section.

IV. TESTS OF THE FUTURE MEMORY MODEL OF PRECOGNITION

In order for a model or explanation of any phenomena to have any value, it must be possible to confront it with experimental tests or to make new observations of the phenomena about which the model makes specific predictions. This is not hard to do for the "future memory" model of precognition, provided always that we have fairly definite evidence that precognition is occurring in a specific instance.

The simplest aspect of the model to test is probably the prediction that a percipient can precognize only those things he will eventually know through ordinary perception. In order to test this prediction, one might first make a search of the literature on precognition to see whether accurate predictions have been made under conditions that preclude the obtaining of the information by the percipient at anytime after the prediction was made. If this turns out to be the case, it would be evidence against the model.

A more convincing test would involve an experiment designed for the purpose. The simplest version of this might be a precognition test in which the results are not ever revealed to the subject. A slightly more sophisticated version would involve a randomized decision pattern for revealing the data a fixed time after the trial. A comparison of the rate of success when the data are revealed as against those in which they are not could indicate the validity or invalidity of the model even if the level of precognition was low.

A possible objection to such experiments is that it is difficult to ensure that the object will never have access to the data at any future time. However, if point (2) above is correct, information obtained long after the trial has taken place would be useless because of the decay of the advanced pattern at times long before it is established. A test of this point can also be carried out along the lines described above, if it is found that the basic effect exists. To do this, it would be necessary to give information about the data to the percipient at various time intervals after the trial and investigate how the success rate of precognition would vary with this time delay. If the model is correct, there should be a dependence on time delay that is similar to the dependence of short term memory on the time lapse after the initiating stimulus. I am assuming here that there is no precognitive equivalent for long term memory, as the latter appears to involve a kind of static chemical storage rather than an oscillating pattern in the brain. If this assumption were wrong, the particular test just described would give negative results and precognition would be possible of any event up to the death of the percipient. This possibility, while it should be kept in mind, seems less likely to me.

Another testable aspect of the model is that the success rate of precognition should not depend on the spatial location or any other physical attributes of the event being precognized. This could be tested by varying such attributes of the target but keeping the information about it eventually furnished to the percipient and the time advance constant. Under these conditions the success rate would not be expected to vary, even if the target is at astronomical distances or is extremely well shielded. These properties are in qualitative agreement with some anecdoted reports of precognition.

Finally, if the model is correct, we would expect precognitive ability to vary greatly from person to person, just as short term memory does. In fact, it is possible that the same people that have good short term memories would also be good at precognition, although that connection is not definite. Nevertheless, it would be worth testing people with good memories for precognitive abilities. Furthermore, it should be possible to improve precognitive ability by using the techniques that are used to improve short term memory. Probably, these techniques would improve the accessibility of the advanced pattern to the conscious mind, rather than affecting the absolute amount of advanced pattern generated by the event. The latter amount is probably determined by the basic laws by which the brain operates and is not subject to alteration by training.

I believe that if a series of experiments of the type described is carried out with a subject who has real precognitive ability, it would definitely decide whether the memory model of precognition is valid. Perhaps what is even more important, such experiments would furnish much new information about precognition, which would be useful in any case, even if the model should prove wrong.

V. CONCLUSIONS AND DISCUSSION

Since I believe in a materialist description of natural phenomena, including those involving human beings, I believe that if advanced effects occur in the human brain, they must occur elsewhere in the world, since brains are made of the same kind of matter as other objects are. It therefore appears plausible to me that if the future memory model of precognition is valid, it should also be possible to detect advanced effects outside of the human brain, perhaps in the type of experiment that Dr. Newman plans to carry out. Conversely, if his experiments gave a positive result, showing that advanced effects do occur, it would lend more credence to the idea that they are what is involved in precognition. Even if the advanced effects are very small compared with the retarded ones, this would not rule out their playing a role in brain processes, provided that they are larger than the "noise" background. It would be interesting to estimate how small the ratio of advanced to retarded effects could be in the brain and still have useful advanced effects, but I have not tried to do this.

Physicists have sometimes raised the objection that any occurrence of advanced effects in nature would lead to unavoidable paradoxes and causal anomalies. Careful analysis of this question has not substantiated this claim,[2] but the question is not completely closed. However, it should be recognized that if such problems exist, they would also occur just from the existence of precognition, whatever the physical interpretation of the phenomenon. The analyses that have been carried out of possible causal anomalies due to advanced effects could usefully be applied to the precognition directly, rather than to its physical interpretation. I believe that the limited accuracy of precognition, and especially the impossibility of knowing whether a given precognition will turn out to be accurate until after the event has occurred, eliminate the possibility of such causal anomalies, but it would be worthwhile to carry through the analysis.

Finally, it would be interesting to follow up on a suggestion that is sometimes made to investigate the extent to which all valid reports of extrasensory perception can be explained in terms of ordinary

perception combined with precognition. My impression is that many such reports can be so explained but I do not know if they all can be. If it were possible to do so, this would mark a substantial advance in our understanding of these phenomena and in linking them to other aspects of the physical world that we know better.

REFERENCES

[1]See, for example, J. B. Rhine, *The Reach of the Mind* (William Sloane Associates, New York, 1947).
[2]For example, R. P. Feynman and J. A. Wheeler, Rev. Mod. Phys. **17**, 157 (1945).

DISCUSSION

WALKER: First, Karlis Osis has done some work on precognition in which he gets positive results for time delays of up to 33 days; he also studied spatial effects of about a thousand kilometers and more. There has been an experiment which achieved positive results where a random number generator was used as the target, without the target being revealed.

Secondly, the problem about parapsychology is that you would have difficulties even if there were no precognition. The difficulties of attributing telepathy and in particular clairvoyance have been discussed in the IEEE publications.

Finally, I'd like to make a prediction that in the experiment that you are referring to, no advanced potential will be observed. In the solution that you give, of course, the advanced and retarded solutions *are* proper, and the advanced solution appears where it's supposed to, which is, in problems having no light switch. When you introduce a light switch, you introduce the coefficients of one and zero.

FEINBERG: I don't understand what your third comment means.

WALKER: What I'm saying is that the solution is present in the ideal version. Here a wave propagates into the origin and then passes back on out, and both advanced and retarded solutions have coefficients of one. But if you change your boundary conditions, e.g., you introduce a light bulb *and* a light switch, the light switch mathematically requires the corresponding coefficients, your zero and one. Before, you had a zero and so forth. However, this equation has been around for several centuries, and nobody has

been anguished over the fact that there is no coefficient for the advanced potential.

FEINBERG: The solution with advanced potential is not for a free wave, but for a wave in the presence of a source. Only for that case is there any difference between retarded and advanced waves. See any text in electrodynamics. The experiments on precognition you mention are certainly worth looking into. I don't, as I said, know the literature very well, and I can't comment on the experiments for that reason, but I think it's certainly possible that experiments have already been done which say something about the validity of this model.

BEAUREGARD: When you are speaking of a contracting wave that is absorbed, you must not speak of a source, but of a sink. Although this is not usually observed on the macroscopic level, it is not intrinsically self-contradictory that, say, a pipette is dipped into a glassful of mixed water and ink, and just happens to suck a concentrated ink drop that has finished concentrating at the right time. This certainly would look like a miracle. •In essence, it is advanced actions, or anti-causality, or finality, and my claim is that such phenomena, though rare, should exist.

WALKER: This is a pure solution in which there's not even a filament. In the pure solution, you have the wave propagating to the origin; it goes through the origin and comes back out. The wave can be absorbed if you put in an object at the origin. Of course, the process has to be represented in your boundary conditions, when you solve the problem originally. If there is no absorber at zero, the wave propagates in, goes to zero, and propagates back out.

FIRSOFF: Any equation or model is a tool that can be modified to fit various situations, because it's only a description. But the fact that it has a solution doesn't necessarily mean that this solution has any physical significance.

On the other hand, if we assume that we may have a signal which propagates faster than light, then we'll have a time reversal, and in this case, we can foresee a future event. But the further difficulty is that any future event is virtual. It has only a certain probability of occurring, and it may not occur.

I know of course the division between long term and short term memory, but we have some peculiar effects, like flashback and hypnotic hypermnesia, when a hypnotized subject remembers in

tremendous detail—which would be physically very difficult to explain—happenings of many years ago. He normally does not possess this memory but acquires it in a trance when directed by the hypnotist to regress.

BASTIN: Could I just ask a question regarding the physical background of this model? Suppose you have two separate observers—two different people—working according to your model and using the advanced and retarded potentials to incorporate precognitive effects. Now, the question that arises in my mind is, "would they describe the world consistently?" Would there be a world independent of each, which they were both describing without conflict of order?

FEINBERG: I would think so. I'm not quite sure what you're getting at. That question can be asked on various levels. You can ask the same question about observers using retarded potential, that is ordinary observers—to what extent are their worlds consistent? If one accepts for the moment that they are, in ordinary discourse, I should think they would be equally consistent, using the other solution.

BASTIN: I am puzzled because I worry away at this problem of consistency. If we allow these extraordinary precognitive effects, how can we still suppose that there will be the Nautical Almanac with those fantastically precise predictions? This puzzle led C. D. Broad to suggest that there was a logical impossibility in precognition.

FEINBERG: There is of course the point, which is perhaps what you're saying, that independently of the physical model or any other explanation of precognition, there are still problems related to precognition as a phenomenon, involving free will and such. On that I don't have anything useful to say. I think the model for precognition is not very relevant to such problems. If you can somehow come to grips with the paradoxes and problems of precognition as such, I think any model you have for explaining it would have to be consistent with your resolution of those paradoxes. And if that's what you're alluding to, I have nothing really further to contribute.

SCHMIDT: I'm very much in favor of your general approach, emphasizing that perhaps we don't have to change physics very drastically. Certainly the acceptance of advanced potentials would for many people be a rather drastic change.

Suppose that you could find some advanced potentials in the brain. Would you have hope that one could derive from that some long term advance mechanism, required to explain precognition over long time spans?

FEINBERG: Well, I would certainly hope that you could do what you said, but it's only a hope. I certainly don't have any kind of concrete proposal for doing that, any more than I have a way of showing, using ordinary electromagnetic phenomena, how to make a model of memory within the brain. People have made some vague attempts to do that, but they're not tremendously successful.

SCHMIDT: Yes, but there at least you can imagine some computer type models, which are certainly not realistic. The question is, could you conceive of any resonating systems which could serve as a rough model?

FEINBERG: The answer is, I have not tried to do that. It would certainly be the next thing to attempt, if such things are observed, but I have not tried to do it myself.

SCHMIDT: Generally speaking, advanced potentials could be studied to advantage in several other regions of physics. However, if there are any such studies being made, as I understand, one can get into considerable logical difficulties. The introduction of advanced potentials raises logical problems similar to the introduction of tachyons.

FEINBERG: Yes, there have been studies of some of the logical difficulties. In my paper, there is a reference to Feynman and Wheeler,[2] who did in fact consider the introduction of advanced electromagnetic potentials. They analyzed one of these logical difficulties having to do with an effect produced by an advanced potential which then eliminates the cause of the advanced potential in the future. They came to the conclusion that this is not really a problem, since a careful analysis could eliminate the paradox involved.

SCHMIDT: It is interesting, I think, that the theoretical problems arising in systems with advanced potential are quite similar to some problems encountered in the parapsychology laboratory, like the problem of the role of the observer, problems related to the possibility of intervention in precognition tests, etc.

FEINBERG: Yes, I agree with that. I think it's worth studying, if only as a logical exercise, even if none of this turns out to be true. At least it's a good way of exercising the mind, to try to see what can be made of it. In some of the work that I did on faster than light particles, I made an effort to resolve some of the logical paradoxes that people have brought up, but evidently not successfully enough to convince everybody of it. I've come to the conclusion that, like many issues in philosophy, each person must resolve such paradoxes for himself rather than finding a universal resolution, as you do for a physics problem.

WHITEMAN: I would like to raise some problems in regard to the testing of the theory. I take it that the fundamental subject we are here to discuss is parapsychology, and that we are trying to link physics to it in some way to help explanation. And I take it also that all types of precognition should be considered as evidence, provided they are acceptable. We are not limiting ourselves to a particular kind of electronic effect.

There are two points I want to take up. First, we are told that this model involves the workings of the percipient's own brain. Second, there is the statement that it should not be possible for anyone to precognize any event that would occur after that person's death.

Now, I have been going over in my mind various cases of precognition, some of which I would like to mention, to see how the model stands up to them.

Regarding the first point, that the model refers only to the percipient's own brain, there is the problem of other people possibly being involved in the events. In the Aberfan disaster, for instance, hundreds of people were involved. How does that connect with some percipient's brain?

FEINBERG: Could you just say what precognition is involved there? I did not quite understand the reference.

WHITEMAN: It was an event in which over a hundred schoolchildren were killed when a coal-tip slid down a mountain side onto their school. A collection of 35 cases of precognition of this event by other people was published in the *Journal of the Society for Psychical Research* in 1967, three cases being outstanding as regards the vivid detail seen.

FEINBERG: May I just respond to that? The way in which someone's own brain would be involved in that is the following. Let's imagine Mr. X, the day after this disaster occurs, reads in his

newspaper, "Disaster in Wales. . . ." Some information is now stored in his brain that there was a disaster in Wales on that particular day. A year later, that person might very easily recall that there was a disaster in Wales on that day. If he read the account in enough detail, he could even know how many people were killed, what happened, and so on.

The model I am describing also says that, some time before the disaster happened, the fact that he read about it in the newspaper after it happened would have produced a trace in his brain which went back before it happened, so that he could remember it before it took place. Unfortunately, precognition is connected in the model with short term memory, hence the time involved would be only in the order of minutes or hours. Therefore if people precognize the event a month or so before it takes place, such precognition would be inconsistent with this part of the model. However, it is not inconsistent with what I said about precognition involving the person's own brain, assuming that the people involved who had the precognition eventually had the opportunity to read about it.

On the other hand, if someone like Nostradamus precognized something that would happen 500 years after he had died, that kind of precognition would be inconsistent with this model. And so to the extent that one believes such reports, this model does not account for them.

WHITEMAN: I would like to turn to Nostradamus later. In the meantime, if I may continue with other examples, I think we should consider cases in which, instead of the precognition being bits of information, an actual scene is visualized complete. Myers has published a remarkable case (*Human Personality,* I. p. 591) in which the sensitive, Kate Wingfield, with the help of a crystal, found herself in a scene, looking through the open door of a hotel bedroom and watching a lady with distinctive appearance and dress washing her hands. The whole scene was correct for an event which happened, it appears, a day or more later, but not in her own experience.

In such a case it does not seem that we have merely information read about and dramatized.

FEINBERG: Can I comment on that? That does not seem a difficulty to me, because some people have very vivid memories also. There are people who, an hour, or a month after something has happened to them, are able to recall it extremely vividly and give a very detailed description of what happened, the color of everybody's

clothing, the conversation, and so on. And, therefore, it doesn't seem unlikely to me that someone could do the same thing ahead of time, if the mechanism of the kind that I describe occurs.

PUTHOFF: Actually, I want to comment on Professor Firsoff's comment that precognizing something must in some sense involve a virtual event.

The idea of a virtual event makes clear one thing that I think is true for both your theory and precognition theories in general: The propagation backward in time that puzzles most people and seems to lead to a paradox is not really a paradox. When people worry about precognition they consider it possible that someone, who precognizes a certain event in the future, may decide that he does not want the event to occur and would then take action to prevent it from occurring. If so, then how could the person have precognized the event?

I do not think this is really a problem in a model in which a person views the future event as the result of information propagating backward from that event.

The paradox is lifted out by simply ascertaining that something will occur in the future. Whatever is the source of the information that propagates backward is that which is precognized. It is also the actual event that occurs.

However, if one postulates that some event may occur virtually, propagate backward, and then be changed, it is placed outside this model. The reason is that if it is changed and then the event does not occur, there has been no event there to generate or propagate backward in the first place. Hence, the paradoxical event cannot occur.

FIRSOFF: I have no special comment about that. But there's an interesting case, reported by John Björkhem. I don't know how reliable it is.

It is a case of psychometry. There was a girl student in Lund, if I remember correctly. She was given a Chinese figurine, and she reconstructed the scene in which she saw the friend of hers who bought this particular figurine—they were in Chinatown in San Francisco. And that happened some years back. She tried to communicate with him and couldn't. So here we seem to have an action that relatively to her was a descent into the past, but for that other person with whom she tried to communicate, it was an intervention from the future. But they were not able to communicate with each other.

FEINBERG: It sounds like some of the problems of relativity theory and space-time intervals.

HILL: I'd just like to say that regarding the reliability of information versus time-distance curve, I think that quantitative data to resolve this problem exist. This was recently published in the *Journal of the Society for Psychical Research* (June 1974) in a paper called "Precognition and Time." The author presented a quite nice graph, with logarithmic coordinates for the time difference versus precognition.

FEINBERG: And with what results?

HILL: I think that, contrary to your statement that short term memory is more likely to be involved, cases involving longer term memory were more often classified. I think an interval greater than the order of minutes is involved.

FEINBERG: You mean, precognition doesn't have the *K* curve comparable to short term memory?

HILL: It has the *K* curve, but it's not on the order of minutes.

FIRSOFF: Well, we could have sort of a chain reaction. That is to say, somebody precognizes an event which will happen 100 years hence, but it is a precognition of another precognition and so on, relayed by persons who pass it on.

FEINBERG: That could happen. In that way you can get around the short time difficulty. However, that explanation requires a rather elaborate conspiracy among many people, and presumably wouldn't happen in most circumstances. But it is true, in principle, if you can get any distance into the past, you can get arbitrarily far by passing the chain on—in the same way that ordinary memory can be passed on arbitrarily into the future by having one person tell another one, and so on.

ANGOFF: Professor Whiteman would like to go back to Nostradamus for a moment.

WHITEMAN: I think it may help if I try to summarize very briefly one of several remarkable quatrains in Nostradamus referring to details of the French Revolution. It is about the flight of Louis XVI and Marie Antoinette to Varennes. Anyone who has read John Buchan's account of this will realize that it was an event of crucial historical importance, and history might have turned out quite

differently if the people concerned had not continually made foolish errors. One is reminded of those cases of precognition where the events seem forced through in spite of repeated attempts to escape them.

The quatrain mentions the King by the title of "elected Capet" (as it happens, at that time he held the title of King only by mandate of a Constituent Assembly). It is stated explicitly that "a couple, in flight awry [deux pars voltorte]" will come at night to Varennes, and the result will be "blood and cutting off."

Now, here is a prophecy which was printed about 230 years before the events took place, giving details concerning an unprecedented historical incident and its aftermath. I would like to hear what Professor Feinberg has to say about this.

FEINBERG: Well, I can only say that if one accepts the validity of what you say, it clearly isn't contained in the kind of model I described. I'm not in any position to say how valid Nostradamus's predictions are. I can't read old French, for one thing, and I don't know how good the translations are. Being a physicist, I tend to be more comfortable with experiments that are specifically designed to either demonstrate or not demonstrate a phenomenon, rather than taking things from the real world, so to speak, and trying to analyze them. And it would seem to me that the ways of testing this model that I describe are so simple that it would be worth carrying them out, independently of whether this kind of report can be demonstrated.

PUTHOFF: If we take as real the experiments we've observed, and accept that telepathy can occur, then it may be possible that all the brains which may view an event are available to a given individual. So it seems to me that the restriction both in your work and Dr. Walker's work can be overcome a bit, if it's assumed that rather than only an individual being able to operate on states of his own brain, he has access to states of other brains. I actually agree with the idea that the events as we record them and understand them eventually occur in connection with the brain. If we posit the evidence as indicating that telepathy exists, and a given individual may have access to all brains, i.e., is not restricted just to his own, then there wouldn't be any problem with the shortness of the short term memory, or the precognition of events that eventually will be retrocognized by someone else.

FEINBERG: I don't quite see how that will eliminate the problem of the shortness. Let us suppose that as an event takes place, it is

observed by a thousand people, and let's imagine that any one of them, or anyone in the world, can by telepathy gain access to the brains of all of these people. It still seems to me that in each of the thousand people that's observed it, there will be that kind of decay of the memory trace in the past in accordance with the model—assuming they've all observed it at once. If they observe it at many different times, it will vary. Imagine an earthquake that all observe at once. Then it still seems to me that only fifteen minutes before the earthquake occurs, anyone in the world could know about it by telepathy or some related process. Before that, it seems to me, there'll be no trace in anybody's brain of the earthquake, and therefore, assuming that telepathy works instantaneously, not into the future—otherwise you're just multiplying hypotheses—I don't think you get around the time problem.

A way of getting around the time difficulty would be to say that long term memory also works by some kind of oscillatory process. That seems much less likely to me, on the following grounds. There have been experiments where rats were taught to go through mazes; afterwards their temperatures were lowered to 0°C. The rats were frozen, kept at this temperature for an hour or so, and then thawed out. Some of the rats survived and went about their business. And in particular they found that the rats could still run these mazes as they've been taught to do.

Now, that to me seems to suggest that it's very unlikely that there's any kind of electrical oscillatory explanation for long time memory, because you would think that this kind of oscillation would be grossly disturbed by lowering the rat's temperature to 0°C for a while, whereas if long term memory is a chemical storage, then there's no great problem. If you take a painting and freeze it, then thaw it out, it's still there. And that evidence is cited by psychologists as indicating why long term memory is probably not an electrical storage. Maybe it's wrong.