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Avoiding the Intervention Paradox

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ABSTRACT: The author aims to show that there are possible models of time for which the Intervention Paradox is not a barrier to the possible existence of a type of precognition in which the event precognised is avoided or changed. Two different configurations of the 'block model' of space-time are used to show how this could be done: one with multiple futures and one with another time dimension.

The aim of this article is simply to show that there are models of time for which the 'intervention paradox' is not an obstacle to the possible existence of a type of precognition which results in action removing or changing the event precognised. That is the sole aim. I make no attempt to argue for the existence of any type of precognition or to propose a mechanism for the operation of precognition, although I do mention the possibility of 'backward causation'. It is not the aim of this article to propose or advocate any particular theory of precognition—the sole aim is to show that it is possible to construct models of the universe which would allow the existence of the type of precognition for which the Intervention Paradox is considered to be a problem.

In discussing this I will also go a little broader to consider the whole idea of 'changing the future', not just a particular precognised event.

The Intervention Paradox is defined by Michael Thalbourne in his *Glossary of terms used in parapsychology* as follows:

> If a person has a precognitive impression of an event E, and as a result of this information takes action such that E subsequently fails to occur, then the Intervention Paradox is the question of what it was that caused the precognitive impression in the first place, since the putative cause, viz. the future event E, never came into being. (Thalbourne, 2003, p. 57).

I would prefer to use the term "occurs" rather than "came into being" in the above definition, to remove any metaphysical assumptions.

Problems with talking about time arise with the very nature of the language we use because our language embodies assumptions about the nature of time and is itself conditioned by our experience of being 'in' time. We want now in this article to try to 'objectify' time and consider it as an entity in itself—in other words we will try to be 'outside' time rather than 'in' it. In order to do this we must separate the notion of existence (or 'being') from time itself. Normally we consider that for something to exist it must have a duration for a certain length of time, no matter how short, but in this article we will assume that existence is a separate matter to time. We need to do this because we are going to consider the existence of time itself.

In fact the term 'exists' has more than one use. It can be used in a purely time or place dependant sense to indicate something that is present at a particular time(s) or place(s) (see Thalbourne's use in the definition above). Or it can be used in a more general sense to indicate reality regardless of its presence in time or not. I will be using it in the latter sense in this article.

I will be arguing that the Intervention Paradox itself embodies a number of assumptions about the nature of time which imply a particular model of time. I will show that there are other possible models of time which circumvent the Intervention Paradox.

PRECOGNITION

First a word about precognition itself. I am assuming a meaning of precognition which implies some sort of psi, not a forecasting of the future that could take place by means of normally acquired knowledge of present or past conditions. Thalbourne defines precognition as "a form of extrasensory perception in which the target is some future event that cannot be deduced from normally known data in the present" (Thalbourne, 2004, p. 90).

One theory of precognition would have it that the precognised event is *deduced* or *extrapolated* from data about the world acquired in the present by ESP or super-ESP (clairvoyance and/or telepathy) (Irwin, 2004, pp. 99-100). Under that theory of precognition the Intervention Paradox need not be a problem. In this article I will obviously be considering the type of precognition for which the Intervention Paradox is considered a problem—precognition which involves the direct sensing by some unknown mechanism of future events or possible futures which in some sense exist. When I say precognition from now on I mean this type of precognition.

BLOCK SPACE-TIME

The nature of time is a great mystery. Philosophers have found that some of our everyday assumptions about time do not stand up under scrutiny, and physicists have found the same thing. One of these everyday assumptions is that time itself 'flows' or that we ourselves 'move through time'.

There are different ways of thinking about time, but embodied within the idea of precognition is the idea that future events exist or that 'possible futures' have some kind of existence. In contrast with this notion of time at least one modern physical theory of which I am aware (Chown, 2000, pp. 24-28)) operates within the paradigm of 'presentism'—the philosophical position that the present moment is all there is and there is no such thing as the future or the past (Dainton, 2001, pp. 79-82). Still other notions of time embody a 'growing universe' where there is a present and a past, but not a future (Dainton, 2001, pp. 68-69). It is difficult to see how precognition could operate at all in these latter models.

Since Einstein the dominant way of viewing time amongst both philosophers and physicists is in terms of geometry. Representing time as an extension in space has been around since cave-people carved notches along the length of a bone to measure the passage of the days. But Einstein came up with a much more sophisticated bone—a 4-dimensional one. Einstein's General Theory of Relativity explained gravitation in terms of the curvature of space-time (Barbour, 1999, pp. 147-181; Dainton, 2001, pp. 287-289; Hawking, 1988, pp. 32-36; 2001, pp. 30-41). Previously space and time had not been considered as physical entities in themselves, but were merely the background arena in which physical entities did their thing. Now space and time were brought into the fold and considered to be physical entities just as much as anything else in physics. They were also joined together into space-time. Time was conceptualised as an extra dimension like the three space dimensions—the so-called fourth dimension. Physicists do tell us that the time dimension is in fact different from the other (space) dimensions for reasons to do with the finite limit on the speed of light (Delsemme, 1998, pp. 281-283). However for our purposes we can conceptualise the time dimension as a fourth dimension of space at right angles to the others.

Gravitation was explained in terms of the curvature of this 4-D space-time and these days even sub-atomic particles of matter may be viewed as 'knots' in space-time. Note that physicists do not consider that space-time is curved *into* any higher dimension of space—the 4-D universe is not 'embedded' in any other space. This is hard (impossible) to visualise because as human beings we operate using a mental 3-D model of the world

around us in which anything that is curved is curved in space. But apparently, so physicists assure us, it is not a requirement of curvature that this be so, at least not for space-time itself (Martin, 1988, pp. 89-90).

The discoveries of quantum physics indicate that space may not be smooth and continuous but have a fine (and dynamic) structure (Smolin, 2004, pp. 56-65). Time may also not be continuous and there has been speculation about "chronons"—the quantum unit of time (Davies, 1995, p. 187; Smolin, 2004, p. 62). Also quantum physics is indicating that space and time may not themselves be fundamental properties of the universe but secondary derived phenomena from more fundamental realities (for example quantum properties) (Chown, 2000, pp. 24-28; Smolin, 2004, pp. 56-65).

We won't need to worry unduly about this—for our purposes it will be sufficient to model time as the 4th dimension of a 4-D universe. What we end up with is what is called in philosophy "block space-time" (also called the 'B-series') (Barbour, 1999, p. 143; Dainton, 2001, pp. 6-11; Davies, 1995, pp. 71-72). I shall call it the "block universe" because it includes not only space and time, but everything else as well, all incorporated into a 4-D sculpture of incredible complexity. I think it is fair to say that this is the dominant mainstream model of time in both philosophy and physics today (although quantum physicists may not be happy with it). I am going to use this model to talk about time even though it is destined to be qualified in the future by the findings of quantum physics and/or a totally new theory. Even if space and time turn out to be derived properties from more fundamental phenomena hopefully this model will still have validity as a depiction of the large-scale structure of the universe.

It is illustrated in fig. 1—the rectangular shape is arbitrary. The illustration does not show any of its complex structure: all it shows is the relationship between the 3 dimensions of space, represented in the diagram by a square 2-dimensional surface, and the 4th dimension of time at right angles to it. Each 2-dimensional section through the 'block' can be thought of as an instant of time in our 3-D universe. The key feature is that time is being modelled as an extension along the 4th dimension, like a space dimension.

One can see that in this model every position along the time dimension has equal status of existence. There is no 'preferred' position which is picked out as *the* 'present moment' as compared with any other 'moment' (or position along the time dimension). Any position along the time dimension could be taken as the 'present moment' under consideration. And at any of these positions along the time dimension the future exists just as surely as the past and the position that we are

designating as the present moment. So the block model supports the notion that the future exists.

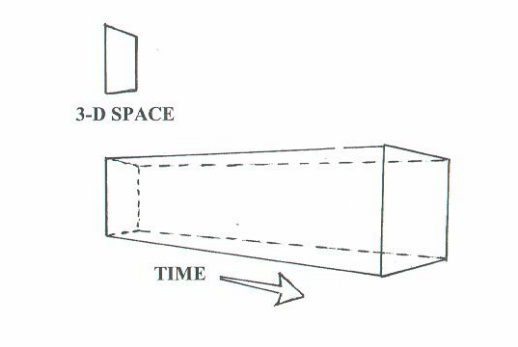

Figure 1. The Block Universe.

We are not going to worry about the complications of Special Relativity, which tell us that there are in fact no global 'universal' instants of time across the entire universe. Special Relativity tells us that different observers in relative motion measure time and distances differently (Dainton, 2001, pp. 254-268; Thorne, 1994, p. 71-84). However, we are conceptualising the impossible—to get outside the entire universe and view the structure as a whole from outside. The reason we are doing this is that we want to free ourselves from being trapped within time and model its structure. From our god-like perspective we are no longer subject to the limitations of observers within the universe. This includes their differing perspectives on times and distances. Observers within the universe experience motion and change. From our perspective we can see that there is in fact no change and no motion. The 'block universe' is a gigantic and incredibly complex 'static' piece of sculpture.

I need to expand just a little further on Special Relativity. The 'Special Relativists' tell us that there is no such thing as a universal time scale applicable to all observers. This is not just a limitation of the perspective of observers they tell us—there *really isn't* any universal time. This is so as long as you are in the universe. But from the 'impossible perspective' we are adopting where we are outside the whole structure of space-time we can see that there is an objective reality to what we call time.

The other thing to bear in mind is that the block universe does not float in any other space or dimension. There is in reality no 'outside' to it. Even though, due to the limitations of our minds, we must visualise it as

existing in a space, in reality it is not 'embedded' in any higher space—it encompasses all there is.

Also modern cosmologists speculate about 'other universes' and 'parallel universes' and other dimensions. We can regard all these as forming part of the total structure of the block universe. 'Universe' here is taken to be the sum-total of all there is including any 'other universes' and 'parallel universes'.

The objection may be raised that if there is no possibility of any observer getting outside the universe to attain such a view (since by definition any observer forms part of the universe) the model has no validity. My answer is we need to construct the model to 'objectify' time in order to understand how the future could be 'changed'—it is a *tool* to help understanding and remove us from a perspective where we are imprisoned 'within' time.

TIME AND MOTION AND THE 'NOW' MOMENT

I am now going to expand further on the nature of the block model to convince the reader that it can provide a satisfactory account of the universe we live in. I want to 'sell' the reader on the block model so that I can then use it to show how the Intervention Paradox can be circumvented.

One problem long recognised by philosophers and physicists is that the block model of space-time does not have anything in it which picks out any special moment (or 'position' along the 4^{th} dimension) as 'now', and has nothing which parallels our experience of 'moving through time' or a 'travelling present'. There is no privileged position along the time axis that can be designated as 'now'—past, present and future have equal status.

Another noticeable feature of the model is that it is 'static'. The problem is that motion is something that is subject to time, so if we were to incorporate anything moving into our model (such as a 'travelling consciousness' or a 'moving present') then we would have to posit yet another time dimension within which that motion could take place (a 5^{th} dimension to act as that time dimension). However, then we run up against the same problem because that total system of 5 dimensions is static—the motion of 'something' along the 4^{th} dimension is depicted as a static extension in the 5^{th} dimension. To reintroduce motion we have to introduce yet another time in the 6^{th} dimension and so on to infinity. We end up with an infinity of 'times'—what is called an 'infinite regression'. Physicists don't like infinities—they try to eliminate them from their equations. Also it never really solves the problem—it just pushes the problem further and

further away from you without ever really solving it. So infinite regressions are to be avoided if possible.

By the way J. W. Dunne, known to parapsychologists for his book *An experiment with Time* (in which he tried to explain precognition) constructed a theory of time based on extra time dimensions incorporating a 'moving consciousness'. He ended up with an infinite regression of time dimensions (and lived with it). He was trying to put 'motion' in his model of time. That always results in an infinite regression (Dunne, 1927/1958, pp. 105-159). Dunne also explained how the Intervention Paradox could be avoided within his scheme (Dunne, 1927/1958, pp. 184-188).

However, as far as motion within the universe is concerned, that can be depicted quite adequately within our static block model. The motion of any entity in 3-D space is incorporated within the structure as its 'world-line' through space-time like strands of spaghetti (see fig. 2) (Barbour, 1999, pp. 139-140; Dainton, 2001, pp. 182-183; Davies, 1995, pp. 75-76). 'World-line' is a term associated with Relativity theory—it describes the motion of an entity or observer through space *and* time. But the line itself does not move. Again there is no preferred position picked out as the present moment along this line. All positions along the world-line of an observer have equal status of existence, so the future of any observer exists as surely as their present and their past.

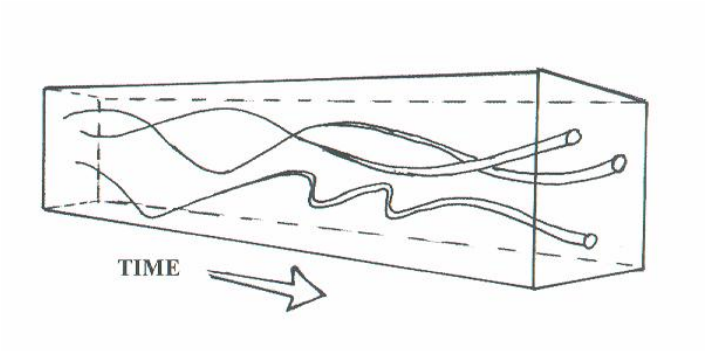

Figure 2. "World Lines" of three particles in the Block Universe.

But how do we depict our experience of a changing 'present moment' in this model? One way of doing it is illustrated in fig 3. In this illustration the 3 dimensions of space are represented by the vertical axis (a single line) and the time dimension by the horizontal axis—making a 2-D representation of 4-D space-time. An individual mind is represented at A,

B, C, and D—at successive times along the time axis. At each of these positions there is a 'static' structure which is the experience within this brain or mind of feeling that they are in the 'now' moment. Also at each position is a record of the past states (memories) so that B remembers A but has no structure representing knowledge of C or D which are in B's future. C remembers A and B, but has no knowledge of D etc. In this way the experience of a mind at each point in the block universe is that it is in the present moment and that it can remember the past, but does not know about the future.

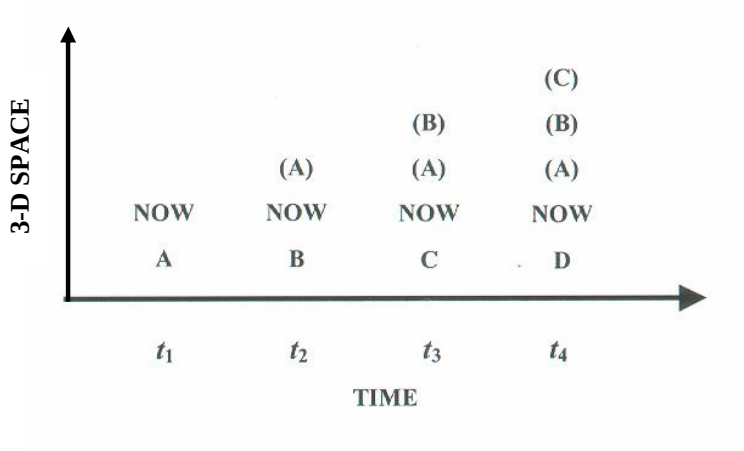

Figure 3. The history of a mind in the Block Universe (NOW = experience of being in the 'Now Moment').

The memories can also include the memory of an experience of the 'now' from the previous time so that the individual, at each point, has the experience of a changing 'now' and motion through time (for a graphic illustration and accompanying discussion which may help illuminate this scenario see Dainton, 2001, pp. 38-40).

Some physicists and philosophers are not willing to accept this scenario and feel that there must be some special process within the physical universe, or within the brain, or associated with consciousness which creates somehow a dynamic present moment. On the other hand all the dynamism, motion and experience of the present moment that you could wish for can be incorporated within the structure of our block model of the

universe. Remember that all observers are within the block universe and are part of it. No one can ever actually get outside of it to observe the 'static' structure—it is just a model. As far as all observers are concerned the universe is inherently dynamic and is full of change and motion over time. This change, motion and the experience of time are *real* in any sense of the word—it is the block model which if anything is 'unrealistic'. Once an appreciation of this is gained it can help in accepting the block model as a useful tool.

In fact the standard solution by physicists to the problem of our experience of the 'now' has been to pass the problem off to psychology and neurophysiology. This is the solution which has been illustrated in fig 3. This does not mean that we have to describe this experience as an 'illusion' in my view. The solution may *seem* very contrived, but it describes the features of the world that we observe. Our conscious perception of the passage of time is generated through our perceptions, memories etc.—mental activity. This is exactly what is depicted in fig. 3. At each point in time the mind of the conscious observer feels that "I am in *this* unique moment and no other." This happens at A and B and C and D—at each point the observer thinks (correctly) that they are in that one particular moment. From the viewpoint of our block model we can see all these moments displayed in series together—but this is from a viewpoint 'outside' the universe and 'outside' of space and time itself. It would be inappropriate to describe the experience of observers within the universe (of the passage of time and motion and change) as illusion—it is a concrete reality built into the complex actual structure of this 'block universe'.

For the same reason in my view the block universe model should not be interpreted as meaning that the universe is necessarily completely deterministic and that free will cannot exist. Any indeterminism (such as quantum indeterminism) or free will (if it exists) is 'built into' the block universe as part of its structure. But this does not mean we have to call these features an illusion. From the point of view of observers within the universe (and that is *all* observers) these features (if they exist) are a reality.

As I've said, this is I believe the most generally accepted way of thinking about time amongst physicists and philosophers today. I will now use the block model to portray the Intervention Paradox and ways around it.

THE INTERVENTION PARADOX

Embodied within the Intervention Paradox is the notion that future events exist. This assumption is consistent with our block model.

Figure 4 depicts the incompatible conditions involved in the Intervention Paradox. In this figure, 3-D space is again represented by a vertical line and the time dimension by the horizontal axis. In Condition 1, an observer O has a precognitive perception P of event E in the future. O carries the memory of this perception with them into the future towards E. In Condition 2, O has recognised the lead-up to event E and taken action to avoid it, so E does not appear at t_4.

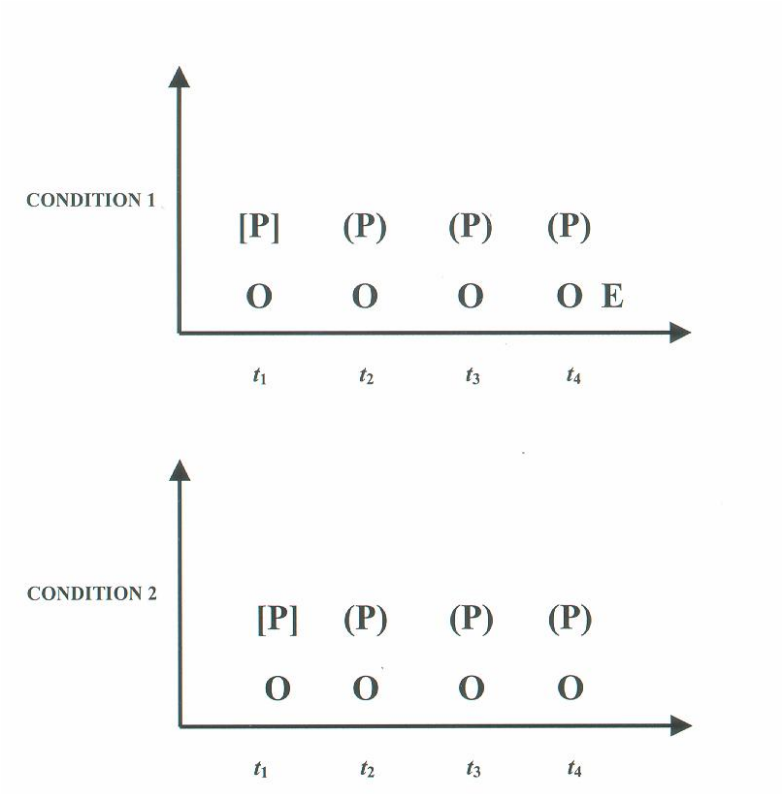

Figure 4. Incompatible conditions involved in the Intervention Paradox.

Note: we assume that the precognition is the type of story in which say a person dreams of being involved in an accident at a bend in the road around which they normally never slow down. In the dream a truck comes around this corner on the wrong side of the road and there is a head-on collision. When the person finally finds themselves at that corner in the

future they remember the dream and as a result of that dream slow down to a crawl. The truck of the dream comes around that corner on the wrong side of the road, but as a result of their slow speed they are able to swerve off the road and avoid the otherwise inevitable collision. In this type of scenario the action is such that the *event of the dream* (a head-on collision) *would certainly have taken place but for the avoiding action* taken as a result of the precognitive dream.

Let's take the event of the head-on collision as event E in Condition 1. We assume that the event E and the precognitive perception P are linked in some causal or acausal way. I am not going to get into speculating how except to mention that backward causation from the future to the past is not ruled out by modern physics. In Condition 2, O has taken action to avoid E, and E is not there. Instead the event E is replaced by other events E_2. The paradox is the *logical contradiction* between the event E being both there and not there.

Note that we are also assuming that it is the event E that causes or is linked to the precognitive perception P and that therefore P would not be there if E is not also there. If that is not the case then it is possible that the observer O could have had P which then results in O slowing down at the curve in the road and missing the truck, but the event E (the head-on collision) does not exist. We would have to explain P as an imaginary construction of what would have happened if O had not slowed down. But the actual event which would have been the consequence of not slowing down is not there. This would be a perplexing state of affairs because O would seemingly have had divine intervention in the form of P to manipulate O into staying alive. But *no logical contradiction* would be involved in this state of affairs and therefore no paradox over existence. The story under this scenario is self-consistent. (see fig. 5).

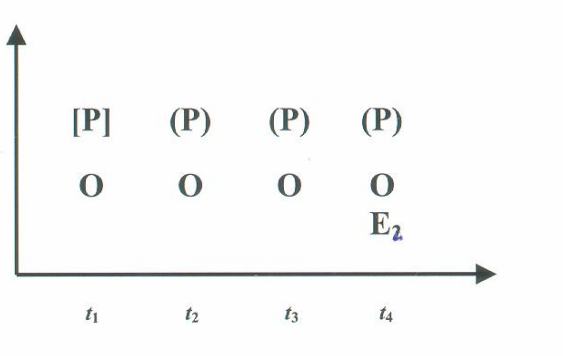

Figure 5. Precognition without E.

Or if one wants to avoid 'divine intervention' in the above scenario one could assume that the *cause* of P is the act of slowing down and the startling event of seeing a truck come around the corner on the wrong side of the road and being able to swerve off the road and miss it. This event (E_2) causes or is linked to a precognitive dream P which incorporates an imaginary construction of what *would have* happened if O had not slowed down. P then causes O to slow down at the bend in the road and as a result E_2 occurs (see fig. 5). As above there is no logical contradiction here and the story is self-consistent. So this scenario also does not involve the Intervention Paradox. The strange aspect would be "what caused the deviation from normal behaviour in the first place?" It is a chicken and egg problem. Who laid the original egg? There is a closed causal loop in which P causes E_2 which causes P, but how did this cycle come to be in the first place, given that under normal conditions of habitual behaviour O would have speeded around that corner and been involved in a head-on collision? However, in spite of this perplexing aspect, there is no logical contradiction here and the scenario is therefore allowed by physics. There is no paradox involving a contradiction about existence and non-existence.

Now back to our 'hard-core' Intervention Paradox—here the event E is straightforwardly depicted in the precognitive perception P. The action taken to avoid it results in not-E. Condition 1 and Condition 2 are on the face of it mutually incompatible. How can we avoid the contradiction of E both existing and not existing?

MANY FUTURES

One way would be by allowing both worlds to exist. Have a bifurcation at some point which will still allow E to cause P (by some as yet unknown mechanism) but will result in two futures—one in which E is placed, the other in which action is taken to avoid E and E is not placed. This situation is illustrated in fig. 6. In this illustration we have to reduce 3D space to a point so that we can use the vertical axis to illustrate bifurcation. The time dimension extends along the horizontal axis as before.

There are two possible points of bifurcation illustrated, but this could happen anywhere between when O receives the precognitive perception, to just before E and E_2 occur. Both these points of bifurcation (and any in between) allow for backwards causation from E to P (if that is how they are linked) but two different courses of action take place at some point which lead to two different results. We would have to explain these different courses of action. Perhaps O forgets about the precognitive dream

in one path and keeps it in conscious mind in the other (I have still shown P as stored in the brain somewhere in both paths). Perhaps O becomes distracted by other things in life in one path.

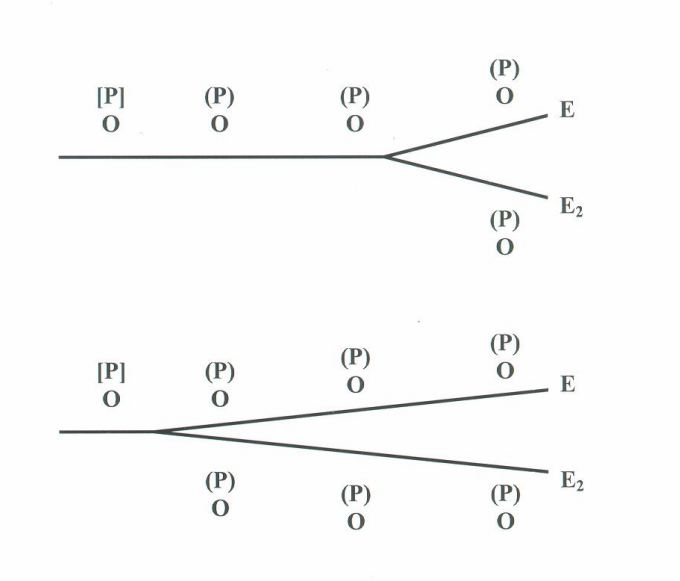

Figure 6. Two futures.

There is a way to avoid the problem of O ignoring P. It is illustrated in fig. 7.

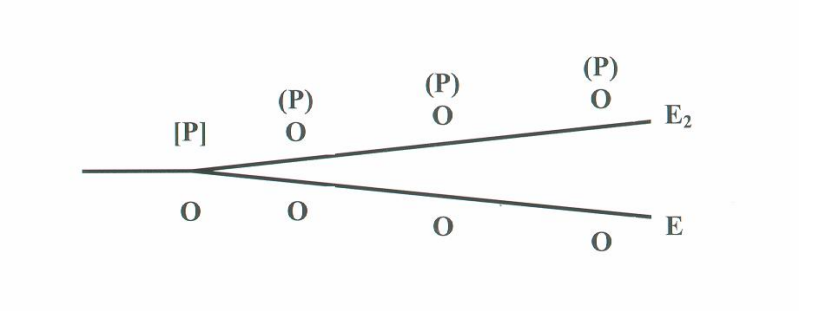

Figure 7. Precognition only carried into one future.

Here, although receiving the precognitive perception is related to E in one future, the perception is only remembered and carried with O in another future. Another way of saying it could be that when O receives precognition of E the universe immediately splits off another future in which that precognitive impression exists. In the future with E the precognitive impression does not exist.

There is yet another way. Strictly speaking with the block universe model there is no reason why communication between different futures cannot be built into the system short-circuiting the actual paths taken by O. This is illustrated in fig. 8. By some as yet unknown mechanism E in one future influences or causes a precognitive impression P in another future *after* a bifurcation in the history of O has taken place. This takes place across the space between the paths O takes through the block universe (later we will see that this can be regarded as a 5th dimensional space—the block universe in this case is a 5-dimensional structure). We may suppose that the bifurcation in the history of O is minor enough that it will not affect the fact that O will still be driving around the corner and encountering the truck due to O's habitual driving schedule. This scenario also allows the precognitive impression to affect only the future without E in it, the future with E in it has no precognitive impression.

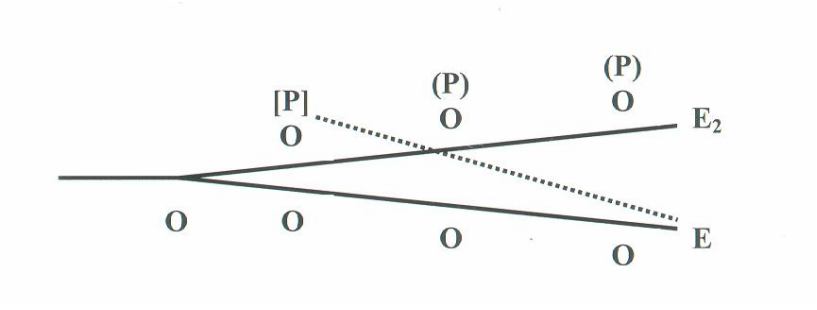

Figure 8. Precognitive perception 'across futures'.

There is no need to worry unduly about what may 'cause' these bifurcations. A block model can incorporate bifurcations as needed—they are simply 'there'. As long as there is a chain of cause and effect from the viewpoint of each observer within the block universe then causality reigns supreme for that observer. I could however point out that some quantum processes are thought to be 'random' and without any specific cause. We don't know how the block universe may be constructed. It may be perhaps

that bifurcations happen according to definite 'laws' in a regular pattern. For example, every time a precognitive impression occurs. In the case of the situation illustrated in figure 8 we would need another reason apart from a precognitive impression. Perhaps a bifurcation in O's history occurs when O comes to a knife-edge decision which goes both ways. Or some quantum event happens in one of O's neurons and sends O's life off in two different directions.

Obviously the actual picture may be much more complicated than in fig 6. There may be many different futures and a very complex branching 'tree' of paths corresponding to all sorts of minute variations in the future of O between when O receives P and the encounter with the truck (see fig. 9).

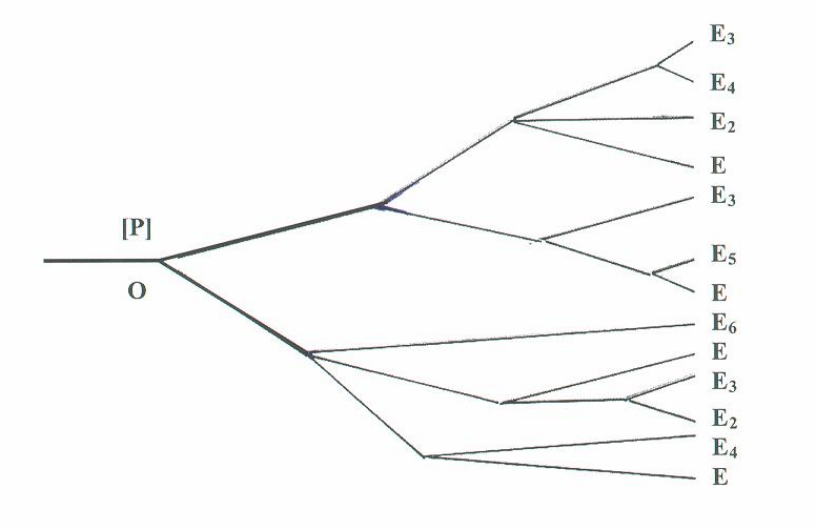

Figure 9. Many futures as a complex branching 'tree'.

The block model can accommodate as many futures as we want—it just makes the structure more complex, that's all. All futures co-exist from our god's eye viewpoint outside the block universe—they are not 'possible' futures, they are all there. But from inside the structure to O they may be regarded as 'possible' futures, even though they all actually happen. They are 'possible' because O does not know which future he or she will end up in. The observer O is split into two very similar individuals in each

of the two futures, or in the case of a multitude of futures a multitude of differing individuals. Each individual experiences themselves as the only individual and is unaware of the others (unless perhaps they could receive a precognitive perception by backward causation from another self).

What I have just described resembles the many-worlds interpretation of quantum mechanics (or more exactly one interpretation of the many-worlds interpretation). In the conventional or 'Copenhagen' interpretation of quantum processes the wave-function of a process, which embodies within it many different possible states, 'collapses' when observed or measured into one particular state (the exact state cannot be predicted although there are probabilities attaching to the various states) (Davies & Brown, 1986, pp. 26-34; Tegmark & Wheeler, 2001, p. 7). In the many-worlds interpretation of quantum mechanics when a measurement or observation is made (or when equivalent quantum processes take place in the universe) the universe splits into a multitude of paths corresponding to all the possible states. Which one we observe depends on which one of these worlds we end up being in. The observers also split so in each world there is an observer to observe the particular result (Barbour, 1999, pp. 221-227; Davies & Brown, 1986, pp. 34-38; Tegmark & Wheeler, 2001, pp. 57-58).

One objection to the many-worlds interpretation is parsimony (or Occam's Razor)—there are an *awful* lot of many worlds (depending on the interpretation this could be an infinite number or just a very large finite number). On the other hand supporters of the many-worlds interpretation argue that the 'collapse of the wave-function' is an arbitrary imposition on quantum mechanics (to force theory to fit observation), which does not follow from the mathematics describing the evolution of the wave-function. They say that it follows naturally from the evolution of the wave-function that all possibilities should manifest. Therefore, they say, their interpretation involves less assumptions than the Copenhagen interpretation and is more parsimonious in that respect (Davies & Brown, 1986, p. 37). In any case our block model can certainly accommodate many futures—it just makes the structure much more complicated (but a lot richer).

However, we should note that Quantum Mechanics and General Relativity have not yet been married together. Physicists are currently searching for a new theory that will do that. The block model derives from a perspective that comes from General Relativity. General Relativity is a theory which proposes space-time and explains phenomena in the universe in terms of the geometry of space-time. From this has arisen the block model, which has been elaborated on by philosophers. Exactly how the phenomena of quantum physics would fit into this model, or how the model itself may have to be modified, is not yet clear. Quantum physics is

probably going to undermine the continuity of time and space and also the view that time and space are *fundamental* properties of the universe. That will not necessarily invalidate the block model—it will just put a new perspective on it. The model may still help us to understand the conundrums of time.

We should also note that there has been no indication from quantum physicists that I am aware of that any of the many worlds of the many-worlds interpretation could communicate with each other or affect each other with forces. Whether this rules out backward causation from 'another world' I don't know. But this would still not affect the fact that 'many futures' can be used to circumvent the Intervention Paradox. What it may be problematic for is the mechanism for the operation of precognition. There would have to be some way of linking an event in one of many possible futures with a precognitive perception. If influences could flow in reverse through the branching tree of worlds this could perhaps do the job.

At this point it may be a good idea to remind the reader that talk about 'influences flowing' or causation does not conflict with the 'static' nature of the block model. All motion, forces etc., are to be viewed as incorporated within the marvellous intricacies of the 'static' sculpture of the block universe.

Regardless of whether the many-worlds interpretation of quantum mechanics fills the bill for a branching block universe with many futures, such a block universe with many futures is still a perfectly valid hypothesis in itself. I want to emphasise this point. The idea of 'many futures' is not tied to the validity or otherwise of the many-worlds interpretation of quantum mechanics. A block universe with a branching 'tree' of futures is hypothesised as a way of circumventing the Intervention Paradox.

The great thing about the block model is that you can twist it and mould it and build anything you like into it. This includes closed causal loops, even ones that appear to have no prior reason for their existence (such as the situation illustrated in fig. 5). Closed causal loops that are self-consistent involve no logical contradiction and therefore no paradox which would ban their existence. Time-travel is not ruled out by physics for this reason.

One concern may be the 'cause' for the bifurcations illustrated in figures 6, 7, 8, and 9. The block model itself does not have to explain or justify itself—it just 'is'. But as observers within the universe we notice patterns in the construction, which we interpret as 'cause and effect'. Could observers going into different futures maintain a consistent account of their history in terms of cause and effect? We normally think of each cause as having only one outcome, especially on the macro-level. How could this diverge into different outcomes?

It would seem that the only way this could happen would be for it to be possible for one cause to give rise to alternative results. The only level at which we observe this to be possible is at the quantum level. We could perhaps speculate that quantum level effects could multiply to produce macro-level effects. There has been some speculation that quantum processes could be important at the level of neuronal function in the brain. If so, perhaps a precognitive impression in the brain could be the 'cause' for a divergence of futures. Or any mental knife-edge decision to be made by O, depending on properties at the quantum level of a particular neuron, may act as the 'cause.'

However it is to happen, the alternative results that may come from a single cause must *all* actually manifest, not just one of them. At the quantum level this is the many-worlds interpretation. According to the Everett version of the many-worlds view (Everett was the originator of the many-worlds interpretation) the effect of this constant splitting of the universe with each quantum interaction is to create versions of the observer which gradually become more and more different to each other over time (Bryce De Witt, 1973, quoted in Barbour, 1999, p. 225). In this way quantum-level effects could indeed build up rapidly over time to create observers who are different (in different futures) on a macro-level. This could perhaps explain how a small cause (a quantum event) giving rise to a number of different small results could result eventually in macroscopically different futures, without violating causality as it operates within quantum processes. Speaking of each branch of the Everett many worlds 'tree', Julian Barbour says "there is nothing within the branch as such to indicate that it alone does not constitute the entire history of the universe" (Barbour, 1999, p. 225). In other words, there is a completely consistent causal chain of events in each branch of the tree and the answer to our question above is that observers going into different futures can indeed maintain a consistent account of their history in terms of cause and effect.

So, we could speculate that diverging futures, although they go their separate ways on a very small scale initially, build up over time and over many more such small divergences into futures which are macroscopically different. This could give us our original cause for 'bifurcations' but the 'bifurcations' in this picture would be a gross simplification of a vastly more complex branching tree. We should be aware also that some quantum processes are regarded as spontaneous and without a cause, so causality does not reign entirely supreme in our world. This may open up the possibility of branching futures without a cause.

CHANGING THE FUTURE—TWO TIMES

There is another way of circumventing the Intervention Paradox, which involves introducing another time dimension. Because this is relevant to the general issue of 'changing the future', I want to consider this as well and kill two birds with one stone.

So far we have assumed that since there is only one time dimension if an individual has a precognitive perception then this means that in the future history of that individual there 'already' exists (from the viewpoint of the block model) the memory of that perception in that individual's mind. This was depicted in figures 4, 5, and 6. The closed causal loop is 'already' in place.

But a common view of time is that although the future may be set given the present circumstances if we change those conditions then we can change the course of the future. How could this be modelled?

The only way is to introduce another 'higher' time dimension within which our time dimension operates. That way our future could be one way at one time in the 'higher' time dimension and another way at a later time in the 'higher' time dimension. In terms of the block model this is depicted in fig. 10 where 3D space is represented as a point, our time (Time 1) is the horizontal axis and the 'higher' time (Time 2) is the vertical axis. Time 2 is a 5^{th} dimension at right angles to Time 1 which is the 4^{th} dimension.

The illustration shows how our precognition scenario from before could be laid out in this type of block universe. There are different ways it could be laid out and I show two of them. They have the common feature of circumventing the Intervention Paradox because both E and E2 exist. As to which O is the real observer—they all are and they all feel that they are the only one. In one part of the block universe O is involved in a head-on collision. In another part due to a precognitive perception O avoids the head-on collision.

This 2-time model has the advantage that we don't have to invent reasons why, in one future, O did not act on P to avoid E (as we had to for some types of the multiple futures model). In some types of the multiple futures model one of the futures has E in it even though O has precognition of it. But in the 2-time model that need not be the case. If O has precognition O avoids E.

Remember when we tried to add extra time dimensions before to account for a 'moving present moment'. We ended up with an infinite regression of time dimensions. That isn't happening in this case because we are using the block model—there is no 'moving present'. We have a 'static' model with two time dimensions only.

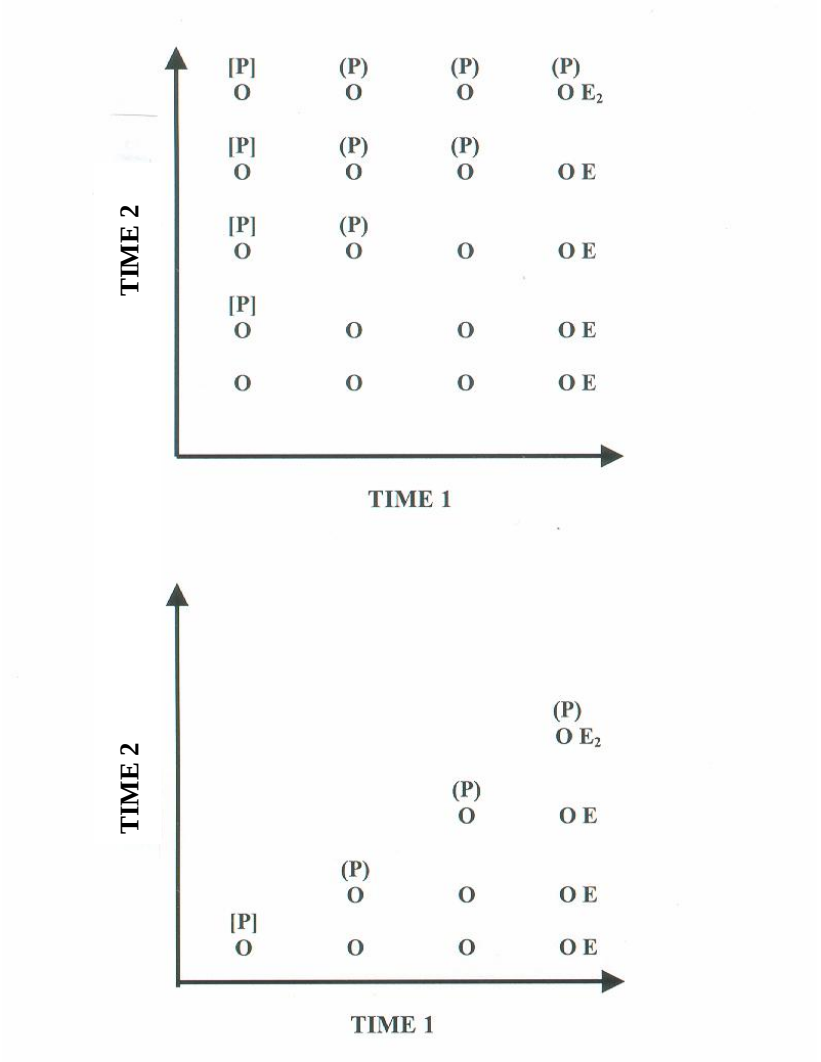

Figure 10. Two-times Block Universe.

It may be objected that there is no evidence in physics for another time dimension. My reply would be that the nature of time is far from

settled within physics and that I feel free to speculate to account for any data suggesting the existence of the type of precognition mentioned in the Intervention Paradox. Any such data can themselves be regarded as evidence and it is a normal process in science to generate hypotheses to account for data. Physicists have hypothesised the existence of many extra space dimensions to account for the phenomena of the universe for example (in String Theory).

If it is objectionable that we only experience one time dimension this is easily answered. There is no reason per se that human beings should be constructed to be aware of another time dimension—our awareness of time is a function of how our memories and mind are configured in the block universe. Human beings are not automatically aware of all the features and properties of the universe. We are not aware of the hypothesised extra space dimensions, but this does not mean they cannot exist.

I will mention one concept from modern physics, which *may* relate to the idea of an extra time dimension. It is the concept of 'imaginary' time originally concocted by Stephen Hawking and James Hartle in an attempt to create a quantum description of space-time (Davies, 1995, pp. 188-192; Hawking, 1988, pp. 141-148; 2001, pp. 58-64). 'Imaginary' has nothing to do with the psychological process—it is purely a technical term indicating that the mathematical description of this time involves 'imaginary' numbers (numbers based on the square root of negative numbers), which are as 'real' as normal numbers, just different. The mathematical model for this 'imaginary' time is a dimension at right angles to ordinary time (Hawking, 2001, pp. 58-59). Could this correspond to the 5^{th} dimension (Time 2) we have been considering above? I am not sure because imaginary time is presented as just an alternative way of describing our time. It has mathematical advantages because it behaves as a space dimension rather than having a particular direction as our time does.

But I note that one of Hawking's models using imaginary time is that our 4-D space-time could be the membrane-like surface of a five-dimensional 'bubble' enclosing a five-dimensional space. The shape of the 'bubble' describes the history of the 4-D universe in imaginary time—i.e., the fifth dimension is the imaginary time dimension (Hawking, 1988, pp. 145-148; 2001, pp. 196-199). The history in our time (the 4^{th} dimension) is related intimately to the history in imaginary time (the 5^{th} dimension) and vice versa. This is very reminiscent of the way I have used a 5^{th} dimension in the 2-time block universe model. The 2-time block universe is itself a five-dimensional structure. Is Hawking's model here essentially a block universe model? It seems to me that it is—it is a 'static' representation of the history of the universe depicted in five dimensions.

A 2-time block universe can resolve another issue about 'changing the future'. Intuitively it may be felt that precognition is a problem because it is changing a future which otherwise would have gone in a different direction. And in fact precognition 'changes the future' regardless of whether the precognitive impression is acted on or not. Why? Because the precognitive impression has changed the individual's mind. But in the 2-time universe changing the future is no problem. There can still be a future in which the individual's mind has no precognitive impression. That future remains unchanged. Then there is another future (a 'later' future in Time 2) in which there is a precognitive impression and that future is different. All this is shown in fig. 10.

Further thought reveals the possibility that both these alternative models of time, many-futures and 2-times, may really be describing the same thing. Notice that in drawing the splitting of time into multiple futures in figures 6, 7, 8, and 9 I have used the vertical axis, representing a fifth dimension. This could be regarded as equivalent to the time-2 dimension in fig. 10. So the splitting into multiple futures may be equivalent to extension into another time dimension. For example figure 7 is equivalent to one of the alternatives I have drawn in fig. 10 if you join up the Os along the horizontal and diagonal in that alternative. I've shown this in fig. 11. Figure 7 depicts an interpretation of a splitting into 2 futures in which the precognitive impression from E is only carried forward into one of the futures (resulting in E_2) and the other future with E remains without the precognitive information. This is equivalent to the situation depicted in fig. 10 for a 2-time universe.

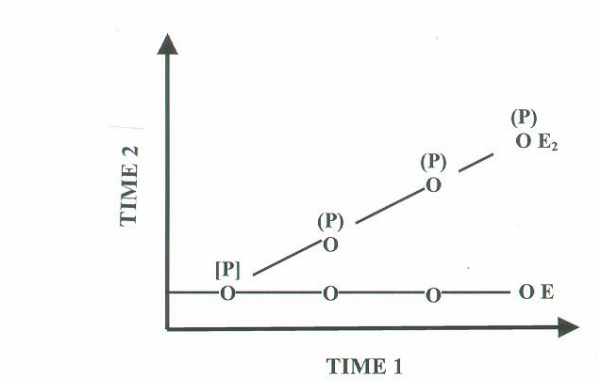

Figure 11. Two-times model equivalent to multiple-futures model.

Finally, I haven't said anything about 'possible futures'. It has been speculated that precognition could be a process of accessing one of a number of 'possible futures', and action may be taken to select another future than the one precognised. What kind of status of existence would 'possible futures' have? From the point of view of the block universe model I don't see any status for existence other than 'full-on' existence. There are no half-measures or 'ghostly realities'. But multiple futures (or 'many worlds') could fill the bill as possible futures perhaps. The qualification is that all the possible futures do actually exist. They are 'possible' in the sense that you don't know which one you are going to end up in (and which your other 'split-off selves' are going to end up in). But perhaps if you had precognition from one future you could take action to make sure you take an alternative path into another future.

I suppose another possibility is that the block universe structure incorporates (as a really existing structure) a kind of 'map', which approximates or mirrors the multiple futures. Precognition would then be accessing part of this map.

In summary, here are what I think are three assumptions contained within the Intervention Paradox and the response of a block universe model to them:

ASSUMPTIONS	BLOCK UNIVERSE MODEL
The future exists	Confirmed
There is only one future	Not necessarily
There is only one time dimension	Not necessarily

I hope I have shown that there are possible models of time in which the Intervention Paradox is not a paradox—it ain't necessarily so.

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