THE IMPOSSIBILITY OF TIME TRAVEL

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by

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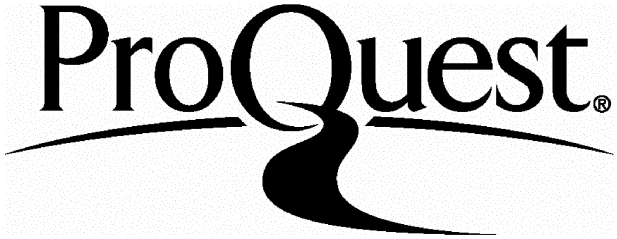

Thesis Abstract

The aim of this thesis is to prove that time travel is impossible. The discussion, which is divided into four parts, is introduced with a history and a definition of the notion of time travel. Included in the introduction will be a discussion of some initial objections to the possibility of time travel. Part Two will introduce and discuss the problem of changing the past; if the past is changed then there is a contradiction: something both was and was not the case. I will discuss some attempts to counter this problem, concentrating on the theories of Lewis, Harrison and Horwich. The conclusion to Part Two will be that none of these attempts are successful thus the problem remains. In Part Three there will be a discussion of what I term "strange loops." These are the strange, though not blatantly contradictory or paradoxical, implications of time travel. Part Three is not intended to provide a refutation of the possibility of time travel, rather to expose it as being a possibility which contains incoherence. The final part of the thesis will discuss the paradoxes of time travel, specifically "autofanticide" (which is returning to the past and killing your younger self). I will state the common solution to this paradox, which I term the "thwarting coincidence" view. Following this I will argue that the thwarting coincidence view does not remove the paradox and thus time travel is impossible. In the final section of Part Four I will discuss Horwich's argument for the possibility of time travel to the "spatially distant past." This argument is supposed to remove the possibility of paradox from the possibility of time travel. However I will show that Horwich's argument is mistaken and does not remove the possibility of paradox. Therefore time travel, even to the spatially distant past, is impossible.

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Part One

Time Travel - An introduction

A Brief History of Time Travel

The first recorded cases describing "oddities" in time can be traced back as far as Plato, the Koran and the Old Testament. In the Book of Isaiah, God answers King Hezikiah's prayer by allowing him to go back in time:

"Behold, I will bring again the shadow of the degrees, which is gone down in the sun dial of Ahaz, ten degrees backward. So the sun returned ten degrees, by which degrees it was gone down." (Isaiah 38,8)

This is the first recorded case of manipulating time. The sun dial of Ahaz can be though to be the first time machine - four thousand years before H.G. Wells! From antiquity onwards such "oddities" of time manipulation were discussed by philosophers, theologists, scientists and story tellers. For the bulk of history since antiquity, these accounts have involved time being manipulated not on the grounds of scientific reason, but through unexplained or mystical means. Dickens' "Christmas Carol" (1843), Irving's "Rip Van Winkle" (1819) and Twain`s "A Connecticut Yankee in King Arthur's Court" (1859) are all examples of this kind of foundationless time manipulation. It was not until the mid 19th century that we find the "explainable" accounts of these "oddities" become written. Following Wells' "The Time Machine" (1865) and especially the theories of Einstein forty years later, there was an "explosion" of this kind of story. Writers now felt they had reason, beyond just their imagination, to tell tales of the strange occurrences brought about by manipulating time.

The time travel story became a sub-genre of science fiction as it rolled hand in hand with the "new physics." It was soon realised that not only was time travel an oddity itself but its implications were even odder, to the point of being paradoxical. Thus solutions were presented to these paradoxes, some of them predating the same philosophical versions of the solutions by decades. In the last fifty years time travel has become an important issue not just in science fiction but in physics and philosophy. Interestingly it is one of the only subjects where many disciplines seem to be working in conjunction. In speaking about time travel we can refer to Lewis, Gödel and Asimov in the same complimentary breath.

Let me include in this historical survey of time travel in literature a few interesting statistics. There have been roughly thirty accounts of time travel in the philosophical literature. In science fiction there have been over fifteen hundred accounts. This ratio should not depress the philosopher. Of the philosophical accounts all have been well thought out, interesting and to differing degrees, persuasive. However, within science fiction many stories use time travel just as a means for conveying a story without any regard for its implications. Others attempt not only to use time travel as a means to a story, but also to introduce the philosophical/scientific implications. It is this latter type that should be of interest to the philosopher. (In this thesis I will avoid straying into the domain of science fiction simply because the plausible solutions presented in science fiction are duplicated in philosophy with a greater clarity and precision.)

Time travel in literature has traditionally had a selective audience, however, once it arrived on the cinema and television screens its accessibility bloomed. From the "Saturday Morning" shows of the fifties to some of the highest budget films ever made, the idea of time travel on screen has had great appeal. A large part of this appeal, other than the fact that it is easier to watch than to read, is that the descriptions of time travel on screen are seemingly plausible. This is because there is no contradiction involved in the description of the time travel experience, even though there may be contradictions in the

implications of the said experience. Thus, an audience can watch the "Back to the Future" films without being confronted by absurdities and contradictions in the presentation of the film. In one scene the hero is a young man in the present, in the next scene he is shown as a young man in the "Wild West." We do not need to understand anything about how he got there - it is enough for the plot just to know that somehow he has gone back in time. If we were to watch the film with a philosophical "eye" we would be able to pick out the absurdities and contradictions in the plot. However, if we just sit back and watch the film as a series of episodes from different times, then I suggest we would not leave the cinema with a profound inkling that something was amiss. The same would not be true of an audience watching "The Quest for the Round Square" (of course, there is no such film), for here the very experience of finding a round square would be contradictory. The fact that the experience of time travel appears plausible is the wave on which all science fiction stories ride. Where does this plausibility come from? Well, relative to science fiction, I suggest it originates from the distinction between action and effect. In a film all we see are actions which are linked, as it were, not by nomological causal connections but by the connections of plot. It is when we try to analyse how the actions would be linked if they were linked by causal connections, that is, where we try to deduce the effects, that the implausiblilities become evident. If we follow the plot and not the aetiology then time travel on screen may seem plausible.

There is a further fact that explains why time travel appears to be plausible, not just on film but in all its descriptions. This is that the bounds of imagination need not be constrained by the bounds of reality. A simple example of this is the case of the Lilliputians from "Gulliver's Travels." We, the reader, can accept the possibility of there being people just like us only much smaller. However such a down scaling of a functioning person would not be possible on physical grounds. Our physiology could not function at that level of reduction. In addition there would be a decrease in the number of neurons by many orders of magnitude and this would prevent anything resembling human consciousness from taking place.

In Philosophy there are cases were the imaginable may transcend the possible. The idea of Cartesian disembodiment, that is being able to exist without a physical body, is considered by some to be an imaginable and a plausible idea. However, it may just be that although we can imagine disembodiment, it is simply not possible, no matter how convincing our imaginings may be. With time travel the same is the case. We can imagine and describe examples involving it that are plausible, or rather, that we imagine are plausible, without needing to know if what we imagine is possible.

I am going to conclude this "brief history" with an explanation of the scientific reasons for believing in the possibility of time travel. Before I do this, I must point out that I am not a theoretical physicist. Much of the theory that implies the possibility of time travel involves complex mathematics and an in-depth understanding of physics, I will not even attempt to explain such things. However, we can get some way without getting out of our depth.

It was a generally accepted feature of Einstein's Special Theory of Relativity (1905) that one could, by travelling at speeds nearing that of light, travel in time to the future - or rather one would age at a rate slower than that of stationary things. Once this principle was acknowledged it gave license to writers to speculate about time travel to the past; this license did not get a stamp of authoritative approval until 1949 when Kurt Gödel suggested that time travel to the past may be possible. His reasons for this claim were that the results of some equations of Einstein's General theory of Relativity seemed to allow for the existence of closed wordlines. A short diversion will explain the idea of wordlines.

A worldline is a tool for describing the spatial and temporal history of an object. On a graph, with the vertical axis representing time and the horizontal axis representing space, a worldline could be drawn for any object such that each point on the graph represents the location of the object in space and time.

Thus, assuming I am not a time traveller, my worldline on a graph would consist of a line constantly increasing in the vertical axis, with changes in the horizontal axis representing my spatial movements. For any period where I am stationary my worldline will go straight up. During any period of motion at a constant speed my worldline will be at forty-five degrees and for periods of acceleration and deceleration my worldline will tip below and above the forty-five degrees constant respectively (Fig 1.1). The crucial point about my worldline that is of interest to the discussion, is that at no point does it tip below the horizontal, for this would depict a return to the past.

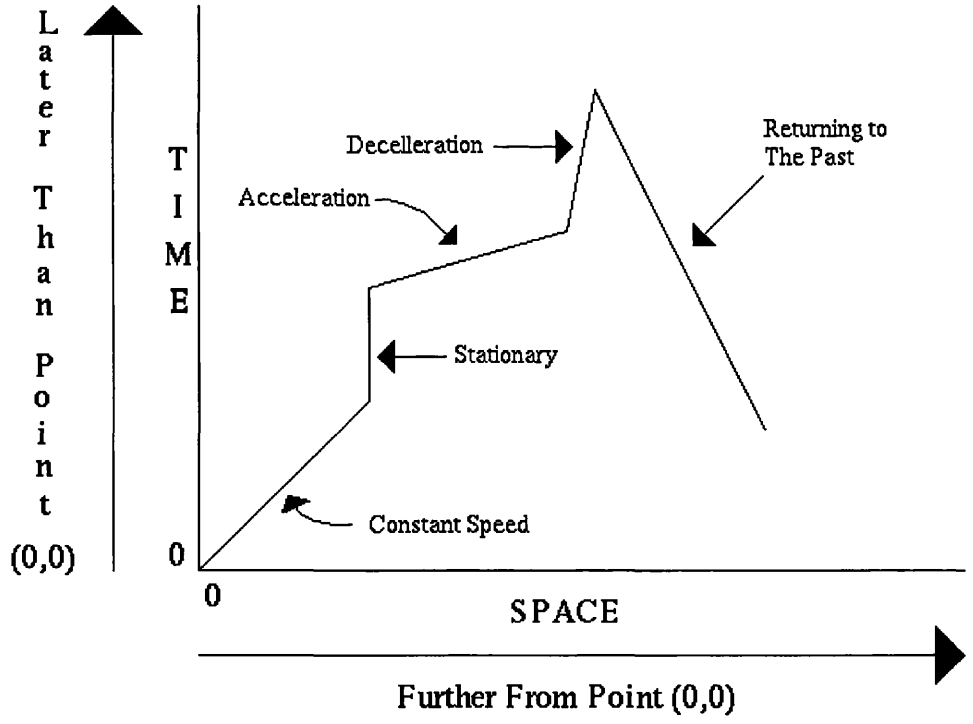
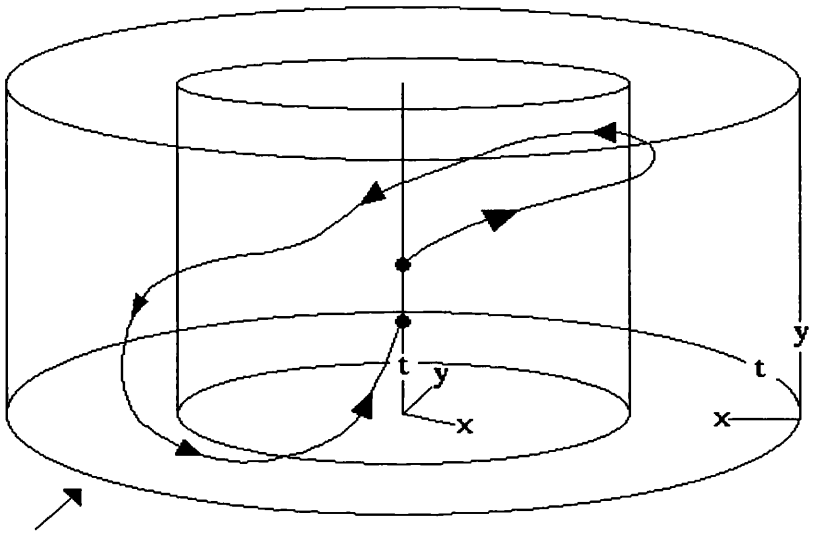


Fig. 1.1 - An example of a worldline diagram.

Gödel's claim is that by travelling fast enough into the local future one could, in theory, arrive in one's past. The best way to explain this is to take the world line graph described above and imagine it being wrapped around a cylinder where the vertical axis aligns with the circle of the cylinder. Thus one`s worldline could continue into the future but by circling the circle arrive at a point earlier in the worldline (Fig 1.2).



This outer cylinder represents curved spacetime.
By "crossing over" into it, one can travel into the future but arrive earlier than the point of departure.

Fig. 1.2 - A closed worldline diagram depicting a return to the past. [1]

It is not for us to criticise this conclusion on the grounds of the calculations involved or on the theory that allows these calculations. But there has been a large amount of argument and counter argument concerning Gödel`s conclusion, even today it is a "hot topic" in theoretical physics. So among the experts of the field it is in no way conclusive that time travel to the past is possible. Although inconclusive, the interest that Gödel created in time travel has prompted serious attempts to establish its possibility. For instance, research teams at the California Institute of Technology and the P.N. Lebedev Physical Institute in Moscow are continuing studies into the construction of "time machines." Although

[1] An element of caution is suggested when interpreting the above diagram as depicting time travel. We can, on paper, depict possible spatial structures which are impossible in the real world. Esher's Paintings and Klein Bottles are well-known examples of this. The fact that something can be drawn does not entail that it can exist

we cannot conclude that time travel is possible on physical grounds there are enough people who attempt to prove it's possibility to warrant the discussion that will follow.

It can be argued that if Gödel's equations are correct then time travel is possible and there are no grounds for continuing the debate. This conclusion is not sufficiently justified for it could be that Gödel's solution is just a mathematical quirk. Horwich (1987) provides an example of such quirks, "using the equation, "distance (in feet) = 16 * time (in seconds) squared" to find out how long a stone would take to fall, say, 64ft, we obtain t2 = 4, and one of the solutions, minus 2 secs, is dismissed out of hand." The relevance of this is that Gödel's solution could be correct in the sense that no mistake has been made, but, incorrect because it does not actually lead to the possibility of time travel. We are now in the position of holding that there is theoretical evidence for time travel but that it is by no means an indisputable conclusion. This thesis will argue that whatever evidence there is for time travel, time travel is not possible.

The Notion of Time Travel

Having outlined why we should discuss the possibility of time travel we are now ready to begin the discussion itself. I think that caution at the beginning of this discussion will be beneficial when we enter the crux of the issues involved later in the thesis. One trend in the philosophical literature on time travel is to jump straight into the problems without discussing what is actually meant when we speak of time travel. For this reason, before discussing whether or not time travel is possible I shall discuss the notion of time travel itself.

Before proceeding to defining "time travel," let me state that this thesis is deals specifically with time travel to the past. There will be no discussion of time travel into the future simply because philosophically the problems concerning past time travel do not confront future time travel. Thus the latter is not taken to be as problematical nor, I suggest, as interesting. With this in mind "time travel" as used in this thesis shall refer only to time travel into the past.

Another caveat that needs stating is that there have been accounts of time travel (especially in science fiction) that rely on alternative realities/multiple pasts. Such accounts claim that there are number of realities that are all possible destinations of a time traveller. Hence when I travel to the past I am travelling to another reality (dimension, world, universe...). If true these accounts would be able to avoid the problems that we shall be discussing in the thesis, but, I find them to be just an easy way out. There is no reasonable evidence to suggest the existence of alternative realities nor do we have any real notion of what an "alternative reality" would be. The time travel I am to discuss involves but one reality.

I will begin with an account of what it is to travel, that is, to provide an account of travel in the standard sense of travel in space. As a starting point we can define travel as a move between one place to another place over time. We can, using this, define "travel": if x is to travel from A to B then at one time x must be located at A and at a subsequent time x must be located at B. This captures the basic idea behind travel, but it is not satisfactory, because we can imagine cases where x is at A and then x is at B but x has not passed through any intermediary points between A and B. As an example of such a case we may cite a situation where we have the destruction of x at A followed by the creation of x at B. (There are examples of this kind in the literature on personal identity.) The point is that in such a case there is no continuity between x at A and x at B, and so it is incorrect to say that x has travelled from A to B. Using the idea of wordlines discussed above, we can say that in this case the world line would be severed although in an ascending vertical direction.

We need a definition that recognises the continuity of the travelling thing over the distance travelled. Thus: x has travelled from A to B if x was at A and at a subsequent time x was at B, having been located at all the points between A and B. This definition only works with a one dimensional linear travel between A and B it does not work with travel between A and B in three spatial dimensions. The problem is that the number of the points between A and B will be huge because there can be more than one route between A and B, as A and B will be located in more than one spatial dimension. This can be explained as follows. If A and B are located along a line then to travel between A and B one must cross all the points in between. However, if A and B are points located on the surface of a sphere then one can travel between them on the surface or through the sphere without crossing all the points in between. Because of this our definition needs to be amended: x has travelled from A to B if, x was at A and at a subsequent time x was at B, having been located at a continuum of points between A and B. So on the above definition, for me to travel from London to Brighton, I must be in London at one time and be in Brighton at a later time, having been located at a continuum of points in between London and Brighton. It does not matter what this continuum is composed of - it can be the shortest route between London and Brighton or it can be a continuum that includes Glasgow as one of the locations.

We now have some idea of what is meant by travel in the spatial sense. What I want to do is to adapt the definition of spatial travel to time travel; but prior to this we need to make a distinction between what is termed "external" time and "personal" time (These terms are taken from Lewis, 1976). External time is time as an absolute feature of the universe, time as measured by the frame of reference of the universe as a whole. Personal time is the time that is measured relative to the frame of reference of the time traveller himself. Lewis uses the admittedly rough definition that the personal time of an individual is that which is measured by his wristwatch.

When we reflect upon this dualism of frames of reference, its credibility becomes dubious. As Godfrey-Smith exclaims, "This intolerably mystifying temporal dualism - quite devoid of any empirical foundation - is never satisfactorily explained." (Godfrey-Smith 1980). This point is worth consideration, but it can be argued that in fact there is empirical foundation for such a dualism. The foundation comes from a feature of the Special Theory of Relativity: time is relative to a frame of reference. Accordingly, if a space ship were to travel at speeds approaching the speed of light there would be a noticeable difference in the time measured by a clock on the vessel and that measured by a clock that relative to the ship that has been stationary. Not only would there be a discrepancy between clock times but there would be a discrepancy between the duration traversed by every object on the ship, including any people. We can think of every object in the vessel as being in a sense just a type of clock: that is, heart beats, electron orbits and so on, can all, in theory, be assumed to measure, to differing degrees of accuracy, time. As Macbeath states, "If any object in a time machine manifests - perhaps only at an atomic level - characteristic rhythms which, during the voyage, show the same regular correspondence with the time traveller's watch as they did before the voyage, then the watch will provide a measure of that object's particular time." (Macbeath 1982).[2]

If we can accept that there is evidence for the temporal dualism in cases of fast travel into the future then the gap is not too big if we want to apply this dualism to time travel into the past. There is then the possibility of making sense of this temporal dualism, at least between stationary and very fast frames of reference. Of course, the strangeness of the notion remains. We must not forget that the notion of time travel is strange, thus it is likely that some of its elements will be strange and may seem "intolerably mystifying."

[2] Note that Macbeath uses the term "particular time" instead of Lewis`s "personal time," this is because he wants refer to, "time scales that render coherent the histories of inanimate objects as well as of persons." To avoid confusion I will just stick with Lewis`s terminology and use "personal time."

The Definition of "Time Travel"

We are now ready to modify the definition of spatial travel to being a definition of time travel. Let A be the point in external time at which the time traveller x begins his journey. Let B be a point in external time earlier than A. Using this, we can construct a definition of "time travel": x has time travelled from A to B if x was at A and at a subsequent personal time x was at B, having been located at a continuum of external times between A and B. An example will clarify this definition. Our time traveller x was located in 1995 (A) and his wristwatch read 12.00. At a point in his personal time one hour later, hence his wristwatch reads 13.00, x was located in 1985. Further during the hour of personal time x has been located at a continuum of external times between 1995 and 1985. Assuming we can accept the above definition, x has time travelled from 1995 to 1985. The definition just offered will be accepted and used when we discuss time travel in the sections that follow. There are, however, other possible candidate definitions of "time travel" which differ from the above definition both in method and result. These are "time jumping" and "time reversal." I shall define each of these. Time Jumping will be discarded from discussion on the grounds that it is overtly problematical and implausible. Then there will be a detailed discussion of time reversal, showing that time reversal may be an interesting notion, but one that can in no way be construed as a type of time travel.

Time Jumping

Time Jumping can be defined as follows: x has time jumped from A to B if x was at A and at a subsequent personal time x was at B, without having been located at a continuum of external times between A and B. Hence time jumping involves somehow leaving external time and returning into external time at a point earlier than the point left. The worldline of a "time jumper" would be severed and have periods angled below the horizontal. This type of time travel relies heavily on the metaphor of

leaving external time, without any account of what the metaphor actually implies. Time Jumping is a common means of time travel in science fiction, often used to explain how interstellar distances can be crossed and so forth, but that is as far as its explanatory value goes. In addition there is no credible theoretical support for time jumping. Even the "far-fetched" theoretical accounts of time travel maintain that the traveller remains in space-time throughout the journey. Not only is there no theoretical evidence for the possibility of time jumping but as a philosophical concept it should be rejected in line with Ockham`s Razor. This is because the phenomenon can be explained in a simpler way - without resorting to things leaving external time and the problems created thereof: problems such as the personal identity of the time jumper, or the question as to where and when is the time jumper when she is mid-jump. So for reasons of both science and philosophy the idea that time travel involves time jumping shall be discarded in favour of simpler more plausible alternatives.

Time Reversal

As with the Biblical time machine, the idea of time being reversed is ancient. In Plato's "Statesman," the idea of time reversal is introduced by the "Stranger" when he tells of a case where:

"All mortal beings... began to grow backward... they... faded into non-existence and one by one they were gone."(Plato, "Statesman" in Hamilton 1961)

Time Reversal will be defined as follows: x has time reversed from A to B if x was at A and at a previous personal time, Bp, x was at B, where Bp is the same external time as B. In addition the time reversal must have taken place over a continuum of external and personal times between A and B. This definition represents an equal reversal of both personal and external time. The worldline of an object that undergoes a time reversal would simply a consist of a line ascending in the vertical axis to the point at which the reversal began and then descending back along itself occupying the same points that it did on its ascent.

An example will clarify the definition. Imagine that on the 20th of November 1863 Abraham Lincoln underwent a time reversal of one day. One day previous to undergoing this reversal Lincoln stood in the American national cemetery and presented the Gettysberg Address. Thus after reversing in time by one day Lincoln would find himself standing in the national cemetery preparing to give the Gettysberg Address. He would be one day younger in all respects - for instance if he had not shaved after giving the address then he would be as a reversee (i.e., the person who has undergone a temporal reversal) clean shaven. The point is, after undergoing a reversal, the reversee will be in a situation identical to the original situation that is reversed to; it will be the same situation. If the situation reversed to is identical to the situation in the "original"[3] case then, if determinism is true, the reversee will be unable to do anything other than what he did in the "original" case. I will explain.

A definition of determinism applicable to the discussion is: for two possible worlds, W1 and W2, which are identical at time t, if at time t1 there occurs an event in W1 then if determinism is true, at t1 in W2 the same event will occur. Such that, if there is a world exactly like our own at this time, then, if determinism is true, whatever happens in our world will happen in this world. Using this definition the next move is obvious - the world reversed to by Lincoln (in the above example) is exactly similar to the "original" world (it is the "original" world). If determinism is true, Lincoln as a reversee could not do anything other than what he did. Take a case where Lincoln is critical of his presentation of the Address. Suppose he is unhappy ending the speech with the words "..shall not perish from the Earth," and decides that he should have said "...bye, and thanks for coming." On realising he has the means of time reversal he decides to reverse time and end the Address with those new "immortal" words. Time is

[3] I am using the "scare quotes" around the term "original" to avoid any confusion that would be created by thinking of the "original" case as being somehow different from the case reversed to. The two cases are identical, but because one of them is reversed to there is a sense in which one is the "original" case.

reversed one day, but because things are exactly as they were, Lincoln's intentions to alter the address and his memories of what needed to be altered have gone - they were not present in the "original" case and thus they are not present in the case reversed to. Thus, if determinism is true then, even if time reversal is possible, it would have no "practical" use; time reversal would be futile because nothing could be achieved by it.

Let us suppose that determinism is false. In this case there is the possibility of making something happen that did not happen in the "original" case; as with Lincoln changing the wording of the Address. But, should this be the possible, then we will find that we unavoidably enter the problem of changing the past. This problem will be discussed in detail in Part Two, but a brief outline will be helpful to the present discussion. If a fact about past is changed then there is a contradiction: something both was and was not the case. This contradiction must be avoided if any account of time travel is to succeed. As I will discuss in Part Two, there have been a number of attempts to remove the contradiction of changing the past from the possibility of time travel. However, even the most tenable of these attempts fail to remove the contradiction from the possibility of "determinism free" time reversal. For example, take the attempt to remove the contradiction of changing the past that uses the distinction between change and influence (as discussed and criticised in Part Two). Irrespective of the success of this attempt, it simply will not solve the problem when it comes to time reversal. The reason for this is that with time reversal without determinism, if a fact about the past is changed then there is a contradiction, and this contradiction cannot be removed by making claims to a distinction between change and influence. This point will become clear once the change/influence distinction has been discussed.

If determinism is false, then time reversal is open to the charge of being impossible because it would allow for there to be contradictions. Let us ignore this problem so that we can discuss another important objection to the possibility of time reversal.

It can be argued that if there are nomologically irreversible processes then time reversal is nomologically impossible. There are nomologically irreversible processes therefore time reversal is nomologically impossible. Horwich (1987) gives the definition: "A type of process, P, is nomologically irreversible if and only if the temporal inverse of P... is incompatible with the laws of nature." A standard example of a nomologically irreversible process is that of light radiating from a point. A light source will radiate a spherical beam in all directions but the reverse of this process, a spherical beam converging upon a point, does not happen. Nor, in compliance with the laws of nature, could it happen.

We can depict this in the following way. Take a light source and suppose that at t1 the diameter of the radiant sphere is 1 arbitrary unit. Suppose that at t2 the diameter is 2 units and at t3 it is 3 units and so forth. This can be expressed by the following diagram (the number in the ellipses is the diameter of the radiant sphere at the corresponding time):

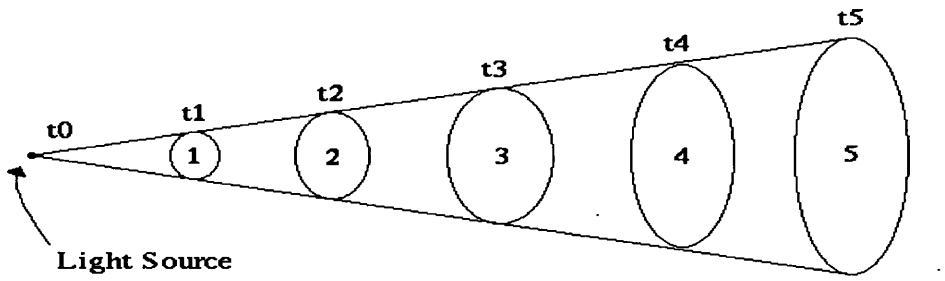


Fig. 1.3 - The expansion of the radiant sphere over time.

Because the expansion of the radiant sphere is nomologically irreversible it could not be the case that at say, t4, it's diameter is 2 units, at t5 it is 1 unit, until at t6 it's diameter is zero. This would be the convergence of the radiant sphere ovetime:

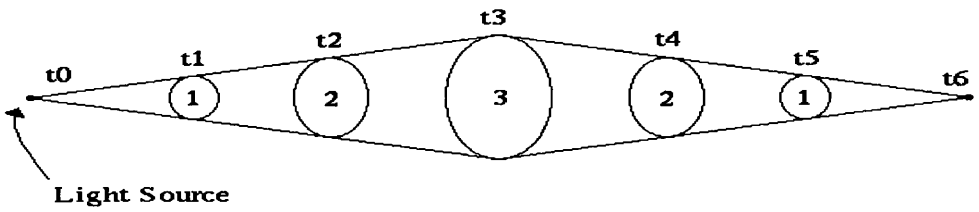


Fig. 1.4 - The convergence of the radiant sphere over time.

What is taking place in Fig. 1.4 is nomologically impossible. However, I think that to argue that this entails that temporal reversal is nomologically impossible is to confuse two issues: that of process irreversibility and that of temporal reversibility. The presence of nomologically irreversible processes does not exclude the possibility of time reversal. What would happen in the case of temporal reversal is not what has been depicted by Fig 1.4, for this depicts a process reversal over time and not a process reversal with time. Imagine that the radiant sphere expands until t3 at which point time is reversed, in this case we would have the following series:

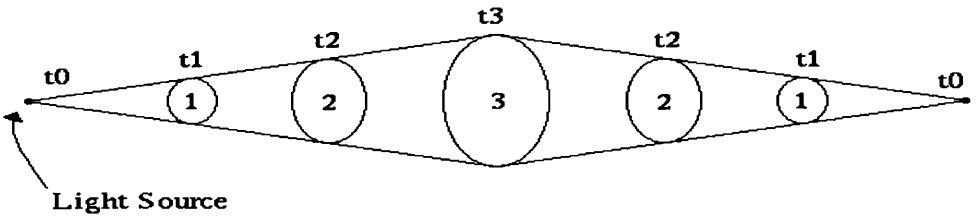


Fig. 1.5 - The convergence of the radiant sphere with time.

It can be seen that in Fig. 1.4 the reversal takes place over time whereas in Fig. 1.5 the reversal takes place with time. If at t2 the diameter was 2 units then, if time is reversed to t2, the diameter will be two units. When we differentiate between process and temporal reversal I think the objection that temporal reversal is nomologically impossible is silenced.

So far we have been discussing the problems that face ime reversal. I now want to highlight an important difference between time reversal and time travel. A difference that favours time reversal when it comes to avoiding a range of problems and paradoxes that have been the core of the time travel debate since its beginning. Time travel, as we shall see, has a number of absurd and paradoxical consequences. These consequences do not confront time reversal. The reason why this is so is because two of the central implications of the cases of time travel are what can be termed the possibility of "temporal reduplication" and the possibility of "prenatal existence"; these are not features of time reversal. I will explain:

Temporal Reduplication: In time travel, if the time traveller can return to his past then he could meet himself as a younger person. Because of this he can seemingly perform actions that result in absurdity or contradiction, such as killing himself or giving himself a memory he has never had.

Prenatal existence: The time traveller is able to return to times before he was born, thus it may be possible for him to be his own father and to witness his birth.

Macbeath`s version of "Jocasta`s Crime" (Macbeath 1982) provides a marvellous depiction of the problems caused by temporal reduplication and prenatal existence. In his descriptive telling the time traveller is able to, "..father himself, bring himself up, kill himself and eat himself." (Macbeath 1982). The possibility of such occurrences in time travel will not be discussed in this part of the thesis - but we can demonstrate that such problems do not plague the idea of time reversal.

Our definition of time reversal does not allow for the possibility of temporal reduplication or prenatal existence. When the reversee undergoes a reversal to her childhood there is only one person involved, that is the reversee as a child. When a reversee undergoes a reversal to before her birth there is simply no reversee, as Plato expresses it, the reversee would fade into non-existence. For these reasons there cannot be any of the absurdities or contradictions found in time travel. Is time reversal the solution to the problems and paradoxes that have so interested those who reflect upon time travel? No, because, simply put, time reversal is not, nor can it be construed as being, a type of time travel.

In time reversal the whole of time, and everything that has occurred in that time, is reversed, that is, nothing "moves" relative to anything else; there is no disparity between any frames of reference. In time travel there is, by definition, a disparity between the frames of reference which are personal time and external time. Unfortunately this point cannot be clarified by analogy. We can have a spatial analogy of time travel but not of time reversal. We can fumble around with descriptions like "Going on a journey with the entire universe moving with you." But this does not capture the distinction between time reversal and time travel. Thus we are forced to conclude that time reversal is not a type of time travel. Time reversal is an interesting notion, one that perhaps has not received the attention it deserves, but as it is not time travel it shall be left out of the core discussions of this thesis.

So far the history of the idea of time travel has been examined, the notion of "time travel" has been defined and we have shown what time travel is not. In the following sections of the thesis we will discuss and criticise the possibility of time travel.

Silencing some Initial Objections to the Possibility of Time Travel

Before moving on to discuss what I believe to be the serious objections to the possibility of time travel there are a number of objections which stem from a mistaken interpretation of what is involved in time travel. I will now discuss these, partly to remove them from the fray and partly to aid as a final clarification of the notion of time travel.

The past, There is nowhere to go.

There is an objection to the possibility of time travel that claims that time travel to the past must be impossible because there is simply nowhere to go. Godfrey-Smith opens his short paper with this argument as he states (Godfrey-Smith 1980):

"A journey to the past presupposes that past 'times' are still 'there' like hidden places...logically possible destinations to which one might travel. The blunt objection to time travel is that there is just nowhere to go."

I think this objection has a massive appeal: so much so that I am partly inclined to "drop everything" and conclude my thesis here and now. The claim is that if you are going to travel anywhere (or in this case "anywhen") then where you are travelling to must exist. Because the past has gone, it no longer exists and thus cannot be travelled to. In which case saying you are going to return to yesterday is as impossible as taking the elevator to the two hundredth floor of the Empire State Building. In both cases there is simply no destination. If this argument is true then it will be for a metaphysical reason concerning the non-locality of the past. The reason being that the past is metaphysically inaccessible - it can be described, we can imagine returning to it, we can make our sums show that it can be returned to, but ultimately we cannot return to it. The view that past (and future) times are somehow "there" is termed the block universe conception. This holds that the world is extended in time just as it is in space. Godfrey-Smith finds the block universe conception to be, "a preposterous (if perennially seductive) metaphysical conception..." (Godfrey-Smith 1980).

It was shown above that the plausibility of time travel derives from both our imagination and theoretical physics. The background for the theoretical possibility of time travel, is, as we have seen, the idea that space and time are curved. This was depicted by the tubular space-time diagram on page 9. Perhaps such diagrams do depict something approximating a block universe; in that all times are possible destinations of time travel? If this is so then Godfrey-Smith can be accused, in his rejection of the block universe, of also rejecting the possibility of curved space-time. And to reject this is to reject one of the generally accepted tenets of theoretical physics.

There is a more persuasive reason for not siding with Godfrey-Smith's denial of the block universe to reject the possibility of time travel. If we want to refute time travel by rejecting the block universe conception then we are stopping the discussion too soon, because more can be achieved in the way of silencing the supporters of time travel if we can make arguments which at least begin with principles that they accept. If we wish to end the discussion of time travel with the assumption that there simply is nowhere to travel to, I think that however convinced we may be in our conclusions we would take no time travel supporters with us. In a sense the rest of this thesis is for them.

Time Travel involves an Inescapable Contradiction.

In his paper "The Myth of Passage," Williams highlights a feature of time travel whereby contradictions are supposedly inevitable. His argument claims that any account of time travel will produce the contradiction whereby: "at each different moment we occupy a different moment from the one we are then occupying - that five minutes from now, for example, I may be one hundred years from now." (Williams 1951). The gist of the argument is that a time traveller will be designated by two contradictory times and therefore time travel is impossible. Meiland clarifies the argument with the

following example. A time traveller begins his journey into the past at 2pm and returns from the past at 6pm. Thus Meiland states: "between 2pm and 6pm he was in the past...for example, at 4pm he was one hundred years in the past..."(Meiland 1974). When expressed in this way the argument is convincing, it seems inescapable to conclude that the time traveller is designated by both "4pm" and "one hundred years in the past." Such a dual designation of times is a contradiction - one that leads Williams to deny the possibility of time travel and that leads Meiland to propose an obscure two-dimensional model of time. I do not see that such measures are required. The point is that the argument that leads to the contradiction is mistaken because it explains the story by unnecessary forcing a dual designation of times upon the time traveller. This mistake obviously misses the point of time travel, namely, that a time traveller can exist at one time, then exist at a time earlier than that time and then exist at a time later than the original time. "Existence" in this case can be taken to mean: if x exists at time t and location l then the worldline depicting x has a point on it that occupies the location (t, l). Conversely if x does not exist at time t and location l then the worldline will not cross the point (t,l). Thus, the correct way to explain the story is: At 2pm the time traveller existed. At 4pm the time traveller did not exist. One hundred years in the past of 4pm the time traveller existed. At 6pm the time traveller existed. On this explanation there is no contradiction.

Where are the Time Travellers?

If time travel were possible, then we can assume that there would be some "must see" events in history to which time travellers would flock in droves: the birth of Jesus, the death of Socrates, the moon landings and so on. However, at none of these events were there recorded hoards of onlookers, let alone hoards of time travellers. This prompts the question, where are all the time travellers? Stephen Hawking, Arthur C. Clark, Robert Silverberg and many others (even the early sci-fi writers) find the lack of any time travellers to be conclusive empirical evidence for the impossibility of time travel. As a piece of philosophical artillery against time travel, the argument is weak. It is based on the assumption that if

time travel is possible there will be time travellers at the great events in history. This assumption is flawed because the logical possibility of time travel does not entail the practical possibility of there being time travellers. Just as it is logically possible to toast muffins on the Sun, we cannot conclude that this will ever be realised as a practical possibility.

Equally there are contingent principles which could answer the question about the missing time travellers. An example would be the claim that, due to huge fuel requirements, only short trips to the past would be possible. Because a time machine has not yet been invented then we cannot expect there to be time travellers present in our past, present or "near" future. Or we may say that although time travel is possible it can only be carried out very infrequently because of the massive preparation involved, the fuel requirements and so forth. Thus the argument that claims the lack of time travellers is evidence for the impossibility of time travel is not persuasive. The most it can be used to achieve is the conclusion that there will not be hoards of time travellers leaving the future for the "great events" of the past.

Now we should have an idea of what time travel involves. Further a number of "initial objections" have been made and silenced, with the exception of the block universe issue which has not been silenced but put aside. The next stage is to discuss the serious problems that fact the possibility of time travel.

Part Two

Change and Influence

The Problem of the Changing The Past

In this section of the thesis I will discuss one of the fundamental questions that concerns the notion of time travel; the problem of changing the past. If time travel is possible then a time traveller can return to the past. Once in the past, it makes sense to suppose that he would be in an environment that is like any other; he can witness events, move objects and talk to people. In fact we can suppose the time traveller is as able to do anything in the past that she would be able to do in the present. After all, when in the past, the past becomes, for the time traveller, the present. This supposition is the principle on which all time travel stories rely. Time travel is taken to be just the presence in the past of someone from the future, without any stipulation that the person in the past is somehow different from the people in the past. Thus the definition of time travel in Part One does not entail any restraints on the time traveller. We can conclude from this that if time travel is possible then the past can be changed. One of the main objections against time travel is to take this conclusion and then to couple it with the premise that it is logically impossible to change the past and from this form the reductio that time travel is logically impossible. This can be expressed as:

[1] Assumption: Time travel is possible.

[2] If time travel is possible then a time traveller can change the past.

[3] If the past can be changed then there would be a contradictory state of affairs.

Therefore:

[4] It is possible to bring about a contradictory state of affairs.

The reasoning for [2] is that which was stated above: if a time traveller were in the past he would be free to act just as if he were in the present. The reasoning for [3] is that if the past were changed something both would have and would not have been the case and this is a contradiction. For example, suppose that this morning my hat was on the hat-peg. I return to last night and take my hat off the hat-peg. Thus this morning my hat was both on and not on the hat-peg. Both conditions [2] and [3] can be justified as being true. Thus it seems that from the assumption that time travel is possible we arrive, by valid reasoning, to the logically impossible conclusion that there could be a contradictory state of affairs. If we cannot reject [2] and [3] then it follows that the assumption must be rejected. Hence by reductio ad absurdum, time travel has been shown to be impossible.

If we want to avoid this conclusion then we must either show an error in the reasoning or reject premise [2] or [3]. The reasoning is valid, it is basically negation introduction ($p, q \wedge \neg q \vdash \neg p$) and cannot be faulted on deductive grounds. This leaves us with the possibility of rejecting the premises [2] or [3]. Starting with [3]. To reject this we must show that the past can be changed without there being the contradiction that something both was and was not the case. In the philosophical literature it is taken as given that this cannot be done. If you make that was the case not the case then there is a contradiction and this cannot be avoided. Essentially I agree with this, however I will suggest a possible way in which the contradiction can be avoided.

Acquinas makes the distinction between change and creation in "Questiones Disputatae de Potentia" (Mc Dermott 1993): "...what is not now as it was earlier has changed... what is created is not now as it was earlier, for first it did not exist." So according to Acquinas, creation is a kind of change, but it is a change whereby something comes to be instead of something else. The idea behind this, as applied to the past, is that if a fact is replaced by a contradictory fact there need not be a contradiction. Rather the

"new" fact is created in the place of the "old" fact such that the new fact becomes what has always been. So, with the hat peg example, I return to the past and take my hat off the peg. But there is no contradiction because the "new" fact - hat peg minus hat - replaces the "old" fact - hat peg with hat. This can now be used to remove the contradiction of changing the past because it is not the case that something both was and was not the case. Is this successful in removing the contradiction of changing the past? I think that it is plausible that it is but it remains hard to make sense of the view's corollaries. For instance, what does it mean to say that a fact is "replaced"? Or, how can the view avoid the charge that the past is changed and all we have done is termed it "creation" instead, thus the contradiction remains? Even though I think the view may offer a way out, it carries many questions and problems that need to be answered. Because of my suspicions that these problems will not be able to be convincingly resolved I will drop the view from discussion. Another reason why the change/creation distinction will not be discussed is that even if it can be made to work it will not be able to remove the paradoxes to be discussed in Part Four. Ultimately it will make no difference to the possibility of time travel.

If we cannot reject premise [3] then to refute the reductio the remaining possibility is to reject premise [2]. We must argue that even if time travel is possible the past cannot be changed. There are, in the philosophical and science fiction literature, a number of suggestions made as to how we could argue for this and thus refute premise [2]. As we may expect, many of the science fiction solutions fall short of credibility, however some do have an amount of credibility. We may argue that although time travel is possible the past cannot be interfered with by time travellers. With such an argument the time travellers would be restrained from changing anything by "mysterious forces." Another approach is to use the idea of "time TV," whereby we can witness events as they took place in the past but be unable to alter them in anyway. This is an interesting idea in itself, but, it cannot really be construed as being a type of time travel. The users of "time TV" would be historians, not time travellers.

The attempts made by philosophers to refute premise [2] come closer to the success margin. Even so, some of them are equally as implausible as the science fiction attempts. Jack Meiland's (1974) "continuant past" view removes premise [2] from the reductio by stipulating a dual passage model of time. Whereby the past is taken to be not fixed but eternally changing because each present moment has a qualitatively different past. This makes sense, but Meiland's error is to confuse the fact that the past is changing because it is "getting bigger" with the claim that there are numerically different pasts. Indeed the past is changing because it is being augmented by present moments becoming a part of it, but this does not mean that there are numerically different pasts. Meiland's argument cannot work. Let's move on to discuss the reasonable attempts to remove premise [2] and thus refute the reductio of the assumption that time travel is possible.

There are only two attempts to remove the premise [2] that I think deserve consideration. Firstly, David Lewis has argued - with an imagination befitting the most inspired sci-fi writer - that the crux of the discussion should concentrate on the use of the word "can" in premise [2]. Secondly, philosophers such as Jonathan Harrison and Paul Horwich, and number of science fiction writers, claim that the problem with premise [2] is that it states that the past can be changed. To remedy this they reason that although time travel cannot change the past it could influence it. I will now discuss these attempts.

Lewis`s Argument

In his paper "The Paradoxes of Time Travel," Lewis presents an ingenious argument to avoid the conclusion of the reductio - and subsequently to remove the Grandfather Paradox. He describes the case of Tim who hates his deceased grandfather so much that, after acquiring a time machine, decides to return to 1921 and assassinate him. Tim plans the assassination meticulously - he becomes an expert marksman, he studies of his grandfather's daily routine and so on. On the day of the assassination Tim waits at a point where he is sure his grandfather will walk by. With the rifle ready his grandfather approaches...

Tim is as capable of killing his grandfather as anyone possibly could be - the conditions are perfect. However, "Tim cannot kill Grandfather. Grandfather lived so to kill him would be to change the past.... It is logically impossible that Tim should change the past by killing Grandfather in 1921. So Tim cannot kill grandfather," (Lewis 1976). Lewis answers the contradiction by claiming that however it may seem, it is not a contradiction. The apparent contradiction can be stated as: Tim can kill his grandfather because he is sufficiently able and Tim cannot kill his grandfather because it is logically impossible to change the past. The reason, so Lewis argues, that there is no contradiction is because we can equivocate on the use of "can" when stating what Tim can do.

He provides an analogy. To say that someone can do something is to say that his doing it is compossible with a set of facts. An ape cannot speak Finnish. There are facts concerning apes, namely their anatomy and cognitive capabilities which are not compossible with speaking Finnish. I can speak Finnish - facts concerning my anatomy and cognitive capabilities are compossible with speaking Finnish. But, it so happens, I cannot speak Finnish - the fact that I have sufficient cognitive capabilities to speak Finnish are compossible with the fact that I have never learned Finnish. In this case it is true that I can and I cannot speak Finnish, but because the use of "can" is able to be equivocated upon, there is no contradiction.

The next stage is to carry this analogy over to the case of Tim. That Tim can kill his grandfather is compossible with one set of facts, namely, that he is an expert marksman, the timing is perfect, he has the best possible gun and so on. But it is not compossible with the fact that in 1921 Grandfather was not killed. So, Lewis thinks, just as I can and I cannot speak Finnish, Tim can and he cannot kill his Grandfather. If this is the case we cannot claim that there is a contradiction because there are different senses of what can and cannot be achieved. Because Tim's grandfather cannot logically be killed by Tim, Lewis needs a method of preventing the assassination from succeeding. In many of the thought-out science fiction stories there is a principle that John Varley has nicknamed the "cosmic disgust theory" (Varley 1983). This holds that the universe has no tolerance for contradiction or paradox and thus it will do all it can to prevent such things from taking place. In the science fiction literature the cosmic disgust theory varies in its range of severity from simple coincidences to the destruction of the universe. Lewis (thankfully) chooses the first option, if Tim tries to kill Grandfather then a coincidence would thwart the attempt.

On these grounds, the story can be concluded: Tim has his target in sight, he tenses on the trigger, at the best moment the trigger is pulled. The gun jams. His grandfather sneezes. A thunderclap distracts him. In other words something will happen which thwarts the attempt. Whatever happens will not entail that Tim could not kill his grandfather relative to the facts about his abilities - all we need say is that an unforeseen coincidence prevented the assassination. This idea of using coincidences has its own problems which will be discussed in detail in Part Four. What is of interest to us at present is the idea, peculiar to Lewis, that by equivocating on the word "can," we can remove the contradiction created by changing the past.

How successful is this attempt to remove the contradiction? To answer this we need to clarify what the actual example attempts to achieve. Lewis tackles the problem on the historical level. It was not a fact that in 1921 Grandfather was assassinated and because it is logically impossible to alter this fact, his grandfather cannot be assassinated. What I shall do is show a critical error in Lewis's argument. Lewis states that it is: "logically impossible to change the past," and thus Tim's Grandfather cannot be killed in 1921. If we accept that it is logically impossible to change the past, then it follows that time travel is impossible. For just as there was no assassination of Grandfather in 1921 - this is a fact - there is also the fact that there was no time travelling assassin waiting to kill Grandfather in 1921. Time travelling to the past changes a fact about the past, therefore time travel is impossible. Imagine that these excerpts from Tim's journal refer to the first use of his time machine:

Day 1: *It is 12.00 exactly, I am sitting alone in the lab. The machine has been checked and all is ready to go. I shall make my first test tomorrow.*

Day 2*: It is 11.55 I am in the lab. The machine is primed and set to go in five minutes. I shall only make a short trip back in time twenty four hours..... I will now enter the machine. The countdown is on ten seconds, nine..... three... two, one....*

....It seems the machine worked... I have gone back in time exactly one day. I am opening the door... I can see the lab... I step out... I can see myself writing my journal.....

Let us ignore the prose and concentrate on the two important elements of the journal. In the entry for Day 1, Tim explicitly states that he is alone in the lab at 12.00. In the entry for Day 2, Tim successfully returns to the time that he was writing the journal in Day 1, but now there are two people in the lab. Let us call the initial Day 1, Day 1a and the other Day 1, Day 1b. Both Day1a and Day1b refer to the same time. We now have two contradictory facts:

Day 1a: It is a fact that there is only one person in the Lab.

Day 1b: It is a fact that there are two people in the Lab.

This contradiction prevents the possibility of time travel. We do not need to return to Lewis`s example, so long as we accept that it is a logical contradiction to change a past fact then time travel is impossible. Lewis`s example does not even get to the point where Tim pulls the trigger, for it is a fact that there is no time travelling Tim in 1921. Can we perhaps remove the contradiction in the way Lewis attempted; by holding that the facts of Day1a and Day1b are compossible with different sets of facts? No, these facts both refer to the number of people in the lab at a precise time. There is nothing we can equivocate on. The conclusion is this, if we want to hold that it is logically impossible to change the past, then time travel is impossible.

Influence, not Change

So far we have seen that to refute the reductio we must show that a time traveller does not change the past. Lewis attempted a way to do this, but failed. We will now discuss another manoeuvre against the reductio. This is to disagree with its first premises on the grounds that time travel need not involve changing the past. In his paper "On Some Alleged Paradoxes of Time Travel," Horwich takes up such a line of argument. The point of the argument rests on a distinction between change and influence, a time traveller cannot change the past but he could influence it. Before analysing this distinction in full, let us first see what its implications are to accounts of time travel.

Horwich asks us to suppose that Charles was not present at the Battle of Hastings: in addition we are to suppose that if he could return to 1066 he could: "undo the past and bring about a contradiction" (Horwich 1975 and similarly put in Horwich 1987). Horwich claims that if the reductio is to succeed we must get from the assumption that Charles was not at the Battle to the claim that he could not have been there because it would generate a contradiction. But this inference is mistaken, so Horwich argues because, "from the assumption that Charles was not at the Battle, it does not follow that he could not have been there." Thus we can allow that time travel entails that Charles could return to the Battle of Hastings whilst concluding that he did not in fact attend at the battle. If on the other hand he was at the Battle then it would always be true that Charles was present at the Battle, present that is as a time traveller from the future. The position can be interpreted as truth fatalism in both the future and the past direction. The slogan for this could be: You can only go back to where you have already been, you can only do what you have already done. Thus if Charles was at the Battle then he would not be changing the past because it would always have been true that he was at the Battle.

Jonathan Harrison used a similar argument to escape the contradiction of changing the past. Harrison describes his argument on the propositional level, he holds that it is logically impossible to alter the truth value of proposition about the past. Hence one cannot attend/change a past event if the proposition that he attended/changed that event is false. The point is parallel to propositions about the future: "...it cannot be that I will ever succeed in getting to the top of Mount Everest if the proposition "Harrison will one day get to the top of Mount Everest" is false..." (Harrison 1971). So in Horwich`s terminology we can say that even though Harrison will never get to the top of Mount Everest we cannot infer from this that it is impossible for him to do so. If he were to try he would fail but this failure does not entail any impossibility of the attempt. The same goes of a trip to the past, if Charles was not at the Battle then an attempt by Charles to attend the Battle will fail, but the failure will not entail that Charles could not arrive at the Battle; it does not entail the logical impossibility of Charles attending the Battle.

How would this conclusion seem to Charles? Well, suppose Charles' macabre curiosity or hearty sense of fun tempts him to witness the death of King Harold. He attempts to travel back to 1066 but if he was never there, he will fail - however diligent his attempts, they will all be failures. We can think of this in just the same way as we would of someone who has repeated failures to climb Everest. If Charles was at the Battle then his attempts would succeed. Importantly, if he does fail then he will not think of this as being some restraint placed on him. Rather it will just be thought of as being an unfortunate failure in the same way as he would think of his failures to climb Mt. Everest. Charles would not necessarily know before his attempt to return to the past whether or not he would succeed. This point is well expressed by Heinlein in his story "Farnham's Freehold." One of the characters replies to a question concerning the possibility of their time machine returning them to the past:

"We don't know whether it has already happened or not. If it did, it will. If it didn't, it won't." (Heinlein 1964)[1]

We can see now how using the distinction between change and influence is supposed to make sense of time travel. What is unclear is what exactly the distinction involves? We know that if we allow for the possibility of a time traveller changing the past then the result is a contradiction. However, there is no contradiction when we recognise, to use Horwhich's words: "...the distinction between changing the past and influencing the past. Time travel would allow one to influence the past but not to change it." (Horwich 1987). It is admittedly not obvious what this distinction is supposed to imply, as Nahin points out, "even Godel slipped on this point... "(Nahin 1993). The distinction is this: to change the past would be to act in such a way that history would be altered from what it was; to influence the past would be just to causally contribute to an event in history such that the event is brought about and always was brought about in that way. Nahin provides an example to highlight this idea: "You cannot prevent the Black

[1] This is a statement of the position seven years before Harrison. Even earlier than Heinlein, the position is stated by R. Dee (Dee 1954): "... anything you do in time must have been done already or you couldn't have been there to do it in the first place."

Death in the London of 1665 or the Great Fire the following year, but it is logically possible that you - a careless time traveller - could be the cause of either or both." (Nahin 1993). So, let us suppose that the Great Fire was caused by a careless time traveller arriving in Pudding Lane. The time traveller influenced the past because he was a causal factor of the Great Fire; suppose he accidentally knocked over a lantern. The past, however, was not changed by this accident. It would always be the case that there would be the Great Fire and it would always be the case that the Great Fire was caused by a time traveller. We can think of this in terms of the initial description of the relevant event being the only possible description. In this case we have a description something like: "In the year 1666 a man from the future knocked over a lantern in a bakery in Pudding Lane, and this started the Great Fire of London." If this description is the initial description then it cannot be changed for then there would be a contradiction.

The above account implies that all of history, past and future, is unchangeable. It would always have been true that a time traveller started the Great Fire, this fact cannot be changed. Nor can the fact that a time traveller would depart for the past where he would influence the beginning of the Great Fire be a fact which can be changed. We can now see how the distinction between influence and change permits time travel The following analogy is a final clarification of this distinction.

Imagine that the entire duration of time is represented by a series of boxes, each box corresponding to a particular instant and containing but one set of facts. A box cannot contain more than one set of facts, for this would represent a contradiction. We will assume that the part of time we are interested in is composed of ten boxes and that box one is earlier than box ten. Suppose that in box one there is a fact which is the arrival of a time traveller and that in box ten there is a fact which is the departure of a time traveller. When we observe this series as a whole we can see that there is no case where a box holds two contradictory facts; that is, nothing has been changed. Thus the departure of the time traveller in box ten could influence the facts in box one but this would not be changing any fact concerning box one. If in

box one there is no fact that is the arrival of a time traveller then, equally, in no box later than box one will there be a fact which is the successful departure of a time traveller to box one. The point of the analogy is that the contents of any of the boxes cannot be changed but that facts in one box could influence facts in earlier boxes. Having clarified what is meant by the distinction between influencing and changing the past, let us now consider some objections.[2]

The Possibility of Bilking.

If it was the presence of a time traveller in 1666 that caused the Great Fire then counterfactually, no time traveller, no Great Fire. Assume that the time traveller who influenced the start of the Great Fire came from the year 2066. Thus, if we could prevent the time traveller leaving 2066 we would be preventing the Great Fire four hundred years previously. This kind of argument is termed a "bilking argument." To use Horwich's phrase we are "robbing effects of their causes" (Horwich 1987) and this, in the case in question, entails that we would be changing the past. If the possibility of bilking cannot be refuted then the influencing of the past can be turned into the contradictory changing of the past. It remains for the supporters of "influence not change" to somehow prevent the possibility of the bilking going through. How could this be done? What they must argue is that whatever happens, whatever tries to intervene, the time traveller must enter the time machine and travel back to 1666.

With the view of time travel that uses the distinction between change and influence, no bilking attempts can succeed. The impossibility of bilking can be argued for by making claims to determinism and fatalism. I will define these terms. "Determinism" for present purposes can be defined as: for any event, that event will be determined by its antecedent causes, thus, each event is necessitated and could not have been otherwise[3]. "Fatalism" is the doctrine that nothing can be done to alter the future. The fatalist reasoning begins with an acceptance of the Law of the Excluded Middle. Then it reasoned that this law

[2] The argument I used on page pg. 34 to refute Lewis's argument would not have succeeded had Lewis used the distinction between change and influence. But, had he used this distinction, then his own argument would have been unnecessary.
[3] This definition is compatible with the definition of "determinism" on pg. 16.

will apply to all propositions irrespective of tense. From this we arrive at the conclusion that whatever will be the case in the future will necessarily be the case. Simply put:

[1] $N(p \vee \neg p)$

[2] $p > Np$

[3] $\neg p > N\neg p$

Hence, if p then necessarily p, if $\neg p$ then necessarily $\neg p$; whatever will be, will be, as a matter of necessity. Now, we can argue that the fatalist reasoning is based on a modal error in that from p you cannot get to Np. What the correct reasoning would show is that necessarily if p then p, and necessarily if $\neg p$ then necessarily $\neg p$. In which case the reasoning will be:

[1] $N(p \vee \neg p)$

[2] $N(p > p)$

[3] $N(\neg p > \neg p)$

From [2] and [3] it does not follow that nothing we can do can change the future in which case the fatalist doctrine is refuted. If we accept that the fatalist has made an error then can we drop the fatalist claim as a support of the impossibility of bilking? We could were it not for the fact that none of the philosophers who use the distinction specify precisely that they are using the fatalist reasoning to argue for the impossibility of bilking. Harrison skirts around the issue with statements like, "... I cannot get to anywhere where I am not already going to go." (Harrison 1971). Horwich ambiguously states in a footnote that: "This argument parallels the standard argument for fatalism." (Horwich 1975). However, in the revised version of this paper (Horwhich 1987), the "ambiguous" footnote is omitted and

"fatalism" is not mentioned at all in the discussion. We are even told: "There is nothing tricky about this (argument)." I have to disagree with the claim that there is nothing "tricky" about the argument. If it parallels the standard argument for fatalism then, unless it can be shown not make a parallel mistake as in the fatalist mistake, then it cannot succeed in proving the impossibility of bilking. Perhaps there is an argument for the impossibility of bilking that does not fall into the fatalists error. But if there is such an argument, why have none the relevant philosophers stated it clearly enough to show that it does not commit the fatalist error? I think that the answer to this question is that there is no such argument. However, giving the change/influence view a licence to use fatalist reasoning, or at least a reasoning that "parallels" it, I will now make three objections against the claim that bilking is impossible.

The first objection. Determinism and fatalism cannot, in the case of bilking, be reconciled with the fact that even if we knew that there was going to be a departure for the past we could do nothing about it. Assume that it was recorded in history that a time traveller from 2066 started the Great Fire. Everyone could be aware of this fact. In this case there would be many options available to the inhabitants of 2066 to prevent the time traveller from departing; they have four hundred years to plan. From the Herrodian tactics of killing any potential time travellers, to the subtler, more humane, method of simply persuading the builders of the time machine not to build it. Every person on the planet could know about, and want to prevent, the start of the Great Fire. However, the concerted efforts of mankind cannot prevent the time traveller from entering, and travelling in, the time machine. Even against the most extreme preventative overkill, the bilking cannot succeed. For this reason, the advocates of the change/influence distinction must reconcile these two positions:

(1) In 2066 a time traveller must depart for the past otherwise the Great Fire will be prevented and there will be a contradiction.

(2) Before 2066 everyone could know of the fact in (1) but be unable to alter it.

The response to this made by the supporters of the change/influence distinction will be that position (1) cannot be denied. Although counter-intuitive there is no reconciling needed with position (2). Both positions are true, they may not fit together as comfortably as we would like but, "Hey, that's time travel for you." If we think about it from the standpoint of those trying to prevent the time machine from leaving 2066 then this uncomfortable fit of (1) and (2) does not seem plausible. Remember, we can try so many methods to bilk the attempt but they will not succeed. The causal picture this leads to is not one that can be made sense of, especially from the position of these "ever failing bilkers." Positions (1) and (2) do not even "uncomfortably fit" together, they seem to be completely opposed to each other. There can be no intuitively plausible reconciliation of the incompatibility of positions (1) and (2).

The second objection. We have seen that if bilking is allowed to go through then we arrive at a contradiction. It is logically impossible that there can be a contradiction, thus it is logically impossible that bilking can succeed. But the method of preventing bilking must also rely on physical impossibility, that is, it is physically impossible for the time traveller not to enter the machine. On the change/influence distinction logical impossibility entails physical impossibility - the Law of Non-Contradiction drags our time traveller, kicking and screaming, into that machine. There is something wrong with this; how does logical impossibility entail physical impossibility? Nahin finds the criticism of the move from logical to physical impossibility to be mistaken, he suggests that there is no question that needs answering in the above case. His point is that the request for an explanation as to how logic "drags our time traveller... into that machine" is like asking "How do the laws of logic prevent the geometer from... squaring the circle? Do they, for example, cause his ruler to slip at a crucial moment every time he tries it?" (Nahin 1993)

Nahin's argument has an initial "shock" plausibility, but he is mistaken. There is a fundamental difference between the case of squaring the circle and the case of not entering the time machine. It is, we can assume, a law of logic that given any circle, that circle cannot be squared. It is not a law of logic that given any time machine, that time machine must be entered. Perhaps Nahin's question contains an even deeper error, one that parallels the fatalist's error in getting Np or N¬p from N(p v ¬p). Let p be the departure of a time machine and q be the presence of that time machine in the past. Bilking is represented as ¬p > ¬q. We know that it is impossible for there to be bilking because then there would be a contradiction: (¬p > ¬q) > (q ^ ¬q) therefore, N¬(¬p > ¬q). But from N¬(¬p > ¬q) the error is to deduce that, N¬(¬p). That is, from the impossibility of bilking the modal error is made that asserts the impossibility of not entering the time machine. Bilking is impossible, not entering the time machine is not impossible. Because it is possible to not enter the time machine it is therefore possible to bring about a contradiction. This not only refutes Nahin's objection, it also provides a compelling reductio of the possibility of time travel that uses the distinction between change and influence.

The third objection can be thought of as a piece of "unnecessisary overkill" in the refutation of the change/influence view. But because it attacks the distinction from a different angle I will include it. Often, in the discussions of determinism, the possibility of true randomness is used as a counter to determinism. Is it possible to use true randomness to refute the change/influence distinction? We may think that we can use true randomness to instigate bilking. For example, suppose a time machine has quantum mechanical guidance and cannot be determinably sent anywhere. Instead of "keying in." Hollywood style, the date you wish to travel to, you press a button and the date of your destination is chosen with true randomness - a "temporal tombola." If there were such a time machine then would it allow for the possibility of bilking? Suppose that the Great Fire was started by a time traveller in a randomly guided time machine. On pressing a button the time machine randomly picked out 1666 and travelled to that time. One may now think that if the machine is randomly guided then it could send him

Premises [1] and [2] are the accepted premises of the change/influence distinction. Premise [3] is true if we accept that there could be a randomly guided time machine. The contradiction of [4] is inescapable if the premiss are true. Hence we must drop one or more of the premises. If we drop either [1] or [2] then the view of time travel that uses the distinction between change and influence will be refuted. It cannot survive without them both. Premise [3] is enthymemic so let us expand it (for "guidance" read "destination picking"):

[3.1] There are truly random events.

[3.2] Truly random events are not necessary.

[3.3] If time travel is possible then a truly random event could guide a time machine.

Therefore:

[3.4] If time travel is possible then there could be unnecessitated guidance.

If we want to refute the conclusion [3.4] and subsequently [4], whilst still preserving the possibility of time travel, then we must reject either premise [3.1] or [3.3]. If premise [3.1] is true then the rejection of [3.3] could only be made on unconvincing contingent grounds; if we are going to accept the possibility of time travel and true randomness then the contingent coupling of the two is acceptable. So, the argument hinges on premise [3.1]. If [3.1] is true then the possibility of necessitated time travel reduces to contradiction. There is more evidence for the possibility of truly random events than there is for the theoretical possibility of time travel. We cannot reject the possibility of true randomness while still justifiably holding on to the possibility of time travel. The conclusion is that the type of necessitated time travel entailed by the change/influence distinction leads to contradiction and is therefore impossible.

to any time. But to argue for this is to partake in a fallacy which is very prevalent in science fiction. The fallacy in question is to construe particular times as "coming around" more than once. To say that the random picking of the destination time can allow for bilking is to say that the particular random picking can take place twice at the same time. But if we say this then if follows that at the time of the random picking a random event "chose" two contradictory times. For we would have to say that at one time the randomness sent the time traveller to 1666 and, to argue for bilking, say that at the same time it sent the time traveller to a different time in the past. Thus if randomness can allow for bilking it must be the case that at one time a random event both did and did not send the time machine to 1666. This contradiction rules out the possibility of using true randomness to allow for bilking.

So, we cannot use true randomness to instigate bilking. However by using true randomness we can show there to be a contradiction in the possibility of time travel that relies on the distinction between change and influence. The outcome of a truly random event is by definition not necessitated. The presence of a time traveller in the past at a particular time is, if we want to avoid bilking and thus contradiction, necessary. With these as our premises the argument can be made. Let S represent our time traveller, t a time in the past at which S was present and t1 the time at which a random event picked the destination t.

[1] At t S existed.

[2] At t1 it was necessary that S departed for t (due to logic).[4]

[3] At t1 it was not necessary that S departed for t (due to randomness).

Therefore:

[4] At t1 it was necessary and it was not necessary that S departed for t.

[4] It may be thought (although I am unsure) that this premise is based the error shown in my criticism of Nahin's objection above. If this is the case then, relative to my overall refutation of the change/influence view, it will work in my favour. Because if my objection to Nahin's argument can be refuted then this premise ([2]) will remain and thus justify the conclusion [4].

Assuming that the supporters of the change/influence distinction would not want to reject the possibility of true randomness then is their view unable to avoid the contradiction? I think that the only was to do so is to carry out an argument against premise [3.3]; the possibility of randomly guided time machines. Thus:

[1] If time is possible then randomly guided time travel is possible. [3.3]

[2] Randomly guided time travel leads to contradiction. (The argument [1] to [4] above).

Therefore:

[3] Randomly guided time travel is impossible.

This argument is intended to show the impossibility of randomly guided time travel whilst preserving the possibility of time travel under the change/influence distinction. However it does not save the change/influence view because it remains to be seen whether the conclusion [3] can be explained. The change/influence view of time travel would have to be amended to account for the logical impossibility of there being randomly guided time travel. The more convincing option is to reject the possibility of time travel that uses the change/influence distinction.

Three objections have been made against the account of time travel that uses distinction between change and influence to avoid the contradiction of changing the past. The first did not act as refutation of the view, rather it served to extract the implausibilities it contains. The second and third objections are successful refutations of the view. What these objections have shown is that the change/influence distinction simply shifts the problems from one aspect of time travel to another. The problems now lie not in the end but in the means. We cannot, as Horwich and Harrison do, accept the distinction between change and influence as being the answer to the problem of changing the past. Because none of the

alternative solutions (e.g., Lewis and Meiland) are successful either, the contradiction raised by changing the past remains a great threat to the possibility of time travel. Even so, there are other problems of time travel that deserve to be discussed in their own right. One point that needs to be stated is that although we have found no way to remove the problem of changing the past, we are going to ignore this problem so that we may be free to discuss the other problems that face time travel. I turn now to these other problems.

Part Three

Strange Loops and Other Weirdness

Introduction

In both science fiction stories and in the philosophical accounts of time travel there are situations which are not blatantly contradictory but which are very strange. I will define the term "strange" as being something which is not contradictory but which is inexplicable in terms of our general set of beliefs about the world. Relevant to time travel, the strangeness of a situation can be removed by either showing that what is thought to be strange is in fact contradictory and therefore impossible. Or by explaining what was strange and placing this explanation within the set of beliefs that contribute to an explanation of the world. Many of the strange situations in time travel accounts can be exposed as contradictions. Where we can do this the strangeness of the situation is removed - the contradictory is not, in itself, strange. There remain a number of possibilities which are produced by the possibility of time travel that are strange and that cannot be reduced to contradictions. It is these possibilities that we shall discuss in this part of the Thesis.

I am going to group these strange situations under the description "strange loops." A strange loop is a situation where the worldline of a thing (generally an object or concept) loops back upon itself resulting in a situation which is strange. This does not mean that if an object occurs before its creation then we have a strange loop - anachronisms are, by our definition, standard features of time travel. They are strange if they taken aside from the possibility of time travel, but when taken with time travel they become explained by it's possibility. However, if an anachronism somehow contributes to its own creation (as in the first example, below) then the situation will be a strange loop. (We can see a distinction here between strange loops and the paradoxes to be discussed in Part Four: in the former the anachronism contributes to its creation whereas in the latter the anachronism contributes to its own

destruction.) Later in this section there will be a discussion of some additional strange problems that confront time travel but which are not strange loops. To begin with here is an example of an strange loop.

The Strangest Story Ever Told?

We take photographs of Van Gough's paintings and by means of a time machine take them back to the artist as a ten year old, in 1863. He then spends the rest of his life painting them, that is copying what is on the photos onto canvas. The strange loop here concerns the inspiration for the paintings. When asked what inspired Van Gough's paintings we are compelled to reply that it was the photographs of his paintings. There seems to be no logical paradox here, we find no contradiction, no self defeating causal chains, just what is best described as a very weird situation.[1]

Lewis attempts an analysis and abstract solution to such strange loops, he states: "The parts of the loop are explicable, the whole of it is not. Strange! But not impossible, and not too different from inexplicableness we are already inured to."(Lewis 1976). The type of inexplicableness Lewis is referring to is for example the "Big Bang." The solution offered by Lewis, if we can deem to call it a solution, amounts to the conclusion that time travel is strange and that there is "simply no answer" to the question of strange loops. What I think is interesting in Lewis's account is the holistic or emergent nature of the strangeness; the whole is stranger than the sum of it's parts. Each of the individual parts of the story could be explained were it not for the presence of the other parts. For example, as a ten year old, Van Gough receives some photos and spends the rest of his life painting them. In this case there is nothing strange about the situation, in fact it is feasible that this is how things may actually have been. It is when the parts of the Loop are assembled that the strangeness enters.

[1] Another version of a "strange loop" would be: inventing a time machine and travelling to the past where you give the blueprint to your former self...

It can be argued that there is a contradiction involved in this story because something both did and did not inspire each of the paintings. For example the painting "Sunflowers" was, we can assume, inspired by Van Gough's artistic appreciation of some sunflowers. But in our story it was also not inspired by Van Gough's appreciation of sunflowers because it was inspired by a photograph of his painting. There is not a contradiction here. The story reads that Van Gough as a ten year old receives some photos and he spends his life copying them to canvas. He is not inspired by anything else and thus there is no contradiction. It was always true that Van Gough was inspired to paint "Sunflowers" by the photo of his painting. In this case at no point did any real sunflowers directly inspire Van Gough. Indeed, the contradiction has been removed, but we are still left with the awesomely strange question - where did the inspiration come from? A question to which we seem forced to adopt Lewis's resolution that the strangeness comes from our inability to answer the question. The problem here is that although there is no contradiction there is the fact that at no point in time were Van Gough's paintings inspired by anything other than themselves. There is no initial cause of the inspiration. I can accept that there can be things which are uncaused, but this acceptance applies to randomness in nature. It does not apply to things which are obviously not random and the inspiration for "Sunflowers" is "obviously not random."

Are we then to accept Lewis's resignation that where there is time travel there is strangeness? I don't think that we should. I suggest that there is something afoot which is of a deeper nature than the case being "strange." That what really takes place in the examples of strange loops is not merely "strange" but is nonsensical. To do this we need to enter into what is "going on" in the case of Van Gough's paintings.

The issue revolves around the inspiration for the painting, "Sunflowers." Lets term this inspiration, i. It is true that at no point did anything external to i, inspire i. If nothing external to i inspired i then it must have been inspired either by itself or by nothing. It could not have been inspired by nothing because by

definition inspiration requires some input which is the cause of the inspiration. Thus the remaining possibility is that i inspires itself. So the inspiration for i is i. This is absurd, it equates to saying that, "i was inspired by i." Inspiration needs a cause that is external to its content, if we have not got this then there cannot be any inspiration. But there is inspiration, something must have inspired "Sunflowers." An analogous case is where we would state that: "I believe that p because I believe that p." This does not make sense because beliefs require a justification which is external to their content (There may be problems with this claim, but I do not want to go into this as the example was intended to be just an analogy.) The same is true of the statement: "I was inspired i because I was inspired by i." This is not strange; it is absurd and nonsensical. We have no idea what the statement means, nor do we have any idea of what conditions would satisfy the truth of the statement. I think that the claim that time travel can be strange but that strangeness is acceptable, is just an attempt to disguise an absurdity inherent in certain time travel examples. We cannot make any sense out of strange loops.

Strange Loops of the Double-Helix

In both Harrison (1979) and MacBeath (1982) the accounts of time travel involve "autopaternity." This is a strange loop variation whereby an individual is his own father. MacBeath states the possibility as being: "If time travel were possible, then it would be possible for a man whose mother conceived a child only once (say, at 11 p.m. on 1 April 1984) to travel back in time to that day and share with her in the conception of that child at 11p.m." (MacBeath 1982). There is in such a case the problem that the product of autopaternity, we will call him Oedipus, is the product of an strange loop; just as in the example of Van Gough's paintings. And just as with the above strange loop, the case of autopaternity can be shown to be senseless absurdity disguised, euphemistically, by the term "strange." However, in addition to the strange loopyness of the case of Oedipus, there are contingent facts about conception which prevent autopaternity from taking place.

We need to explain how it could be that the sperm/ovum fusion could create a child who is genetically identical with only the male part of the genetic information, for this is the case with autopaternity. Some species are parthogenetic; they can produce genetically identical offspring without the need for any additional genetic input. If this was the case with Oedipus then he would be a she, genetically identical with his mother. But this would not work; Oedipus is genetically identical with his father, who is, as it happens, himself. Thus the mother of Oedipus has contributed none of her genes to her son because all of Oedipus's genes originated exclusively from his father. This raises the question of whether the mother of Oedipus really is his mother? Genetically she cannot be. Admittedly in a purely functional sense she is, after all she still carried him for nine months and went through hours of labour to give birth to him; this leaves her just a surrogate mother. The crux of the issue is that both the mother and the father of a child must genetically contribute to that child. This is not the case with Oedipus, his mother is, as far as his genes go, out of the picture. Harrison's paper, generally referred to as "Jocasta's Crime," ends with the question concerning incest and autopaterinity via time travel:

> "Did Jocasta commit a logically possible crime?" (Harrison 1979)

Irrespective of the logical possibility of Jocasta sleeping with her "son" it seems conclusive that Jocasta was not a genetic relation to her "son" and thus no crime of incest has been committed. MacBeath's paper is based on a similar case of autopaternity, it's title is "Who was Dr. Who's Father?" I think that a question of equal importance is (for Dr. Who read Oedipus): "Who was Dr. Who's Mother?" And just as MacBeath finds the answer to his question unanswerable, so do I for my question.

Finally, I want to use the case of autopaternity to create a novel type of paradox. There are a number of genetic disorders which when passed on to offspring render the offspring infertile. For example Turner's syndrome and Klinfelter's Syndrome (cited from Strickberger 1990) result in infertile offspring. Suppose that Oedipus obtained this disorder from his mother (whomever she may be?). In such a case

Oedipus would be rendered unable to produce children and thus unable to produce himself. In short, Oedipus would be able to exist so long as he did not father himself, but if he did not father himself he would not be able to exist. There could not be such a person. To answer the paradox we must therefore either argue that time travel would remove infertility or that the possibility of time travel does not allow for autopaternity. I will not try and argue for any of these claims. Instead I will conclude that such cases of infertile autofantiside are novel threats to the possibility of time travel.

Me, Myself and I - The Possibility of Temporal Reduplication.

One of the central features of time travel is that if it is possible it appears also possible that you could meet yourself. Any point on the time travellers world line where there is an intersection between different parts of that worldline would represent the time traveller encountering himself. Further there is no principle coherent with time travel that precludes an intercession of more than two parts of a time travellers worldline. Therefore there could be a nexus of twenty worldline parts which would represent twenty individuals who are all the same person together at the same place and time (We can assume here that they are not exactly in the same place). This can be depicted as in Fig. 3.1:

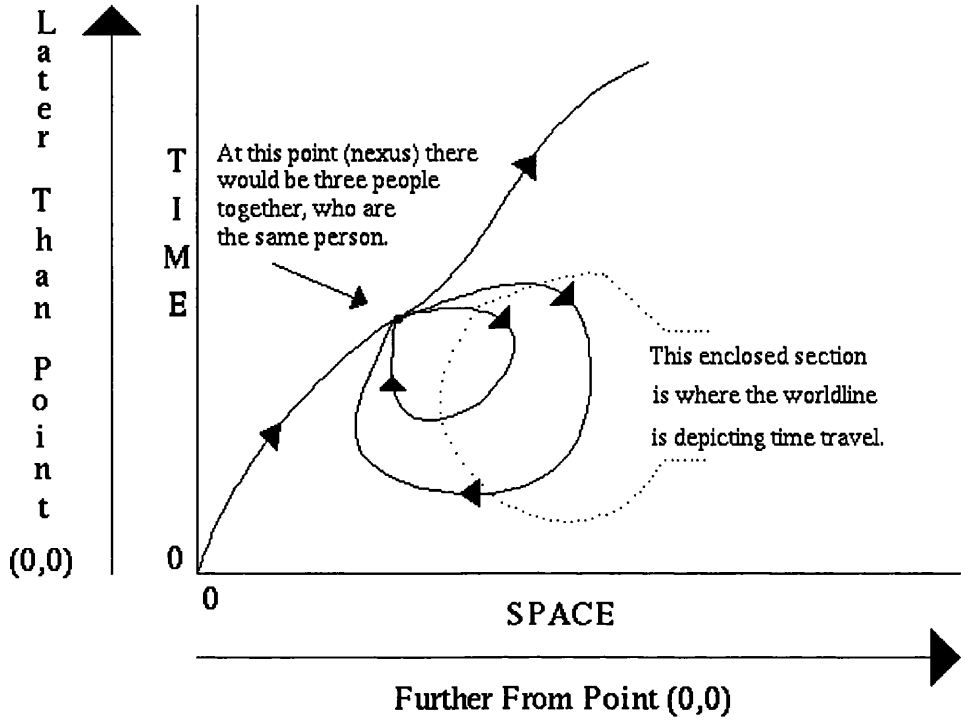


Fig 3.1 - A worldline diagram depicting temporal reduplication.

What kind of philosophical questions does such a "gathering of identicals" raise? We need not stray into a discussion of personal identity here, each of the individuals is psychologically connected in continuity with each of the others. In fact using Parfitian terminology, they are all literal survivors rather than "just" Parfitian survivors. If we said that, were the worldline not entangled it would represent the life of one person then equally we can say that there is no reason to assume that a temporally entangled worldline does not represent the life of one person. Albeit a strange life. Thus temporal reduplication does not offer the same features for discussion that the reduplication or fission cases found in the discussions of personal identity offer.

One criticism that can be silenced immediately is that temporal reduplication does not entail a prolonged reduplication of an individual. That is, it is not a means to making copies of one's self that persist beyond the stage of worldline entanglement. If I were to return to yesterday I would meet myself, there would be two people who were me existing at the same time. But this duplicity would only continue for one day at which point one of my selves, "the other one," would enter a time machine and travel back one day. When a time traveller retires there will only be one of him after he has passed the point in time where his last trip to the past was made. We can see in Fig. 3.1 that there is just a singular worldline that leaves the "nexus." Because of this can we claim that it is a principle of time travel that a time traveller can only die once?

It is true that a "retired" time traveller can only die once. When the worldline is out of the entanglement of time travel there is only one individual. However, when the worldline is still entangled by time travel there seems to be the possibility of a time traveller dying more than once. Imagine that due to temporal reduplication I meet two other people who are identical with myself. We are standing in a room talking about the things you talk about when you meet yourself twice over. Suddenly a huge bomb explodes simultaneously killing all three of us. The bomb is not a part of any causal chain that involves myself at any point - thus there is not the problem of any self defeating causal chains. The feature of this case is that three people are being killed when we would expect that it is only possible to kill one. If you think that the solution is to claim that only one person is killed because they are all "myself" this will not work. I can reply that what has happened is three individual sections of my worldline have been "taken out" by the explosion. To explain this reply take the death of the version of myself who's worldline section is before the others. When he is killed the other two "myselfs" can not exist; not even to die.

This example raises two problems. Firstly, there is the problem of how an individual can have more than one death. Secondly and relatedly, there is the problem of the impossibility of such a causal chain. If an individual dies at personal time t then he cannot die again at a later personal time, because at that time he will not exist. And yet this is what is taking place in the example; we have three people who are all

the same person at different personal times. The example is a product of the possibility of time travel: if time travel is possible then temporal reduplication is possible. If temporal reduplication is possible then the death of more than one reduplicate is also possible, but this would create a paradox. Hence it remains for the supporter of time travel to remove the paradox from this case. They may well use the same method to prevent this case as is commonly used to prevent cases of autofanticide. This is resorting the to claim that a coincidence will thwart the multiple-deaths of the individual. The problem with this reply (other problems are to be discussed in Part Four) is that it leaves us with time travellers who are indestructible. I will explain. In the case of autofanticide if an infant is killed by his later self there is a paradox. In the case of temporal reduplication if an earlier reduplicate is killed by anything there is a paradox. Thus the earlier reduplicate cannot be killed. It appears that time travel not only allows one to become duplicated but it also allows temporary immortality!

One possible way out of this problem is to maintain that when an individual dies, his worldline after his death is in effect removed. We could in this sense define death as being something like: the curtailment of an individual's worldline. If we can accept this then it can be applied to the case of the multiple deaths of the reduplicates. What we would claim is that the worldline succeeding the death of the earliest reduplicate in the explosion is removed [2]. Thus, any reduplicates after the death of the earliest reduplicate will cease to exist - and they do, for they are all killed in the explosion. Then we claim that it follows that the case of the explosion amounts to nothing more than the death of the earliest reduplicate. I think that trying to argue out of the paradox in this fashion is essentially a sophistry that is disguised by equating death with the end of an individual's worldline. The point being that after the explosion there remains three individuals, three worldline parts, who are dead. There will be three corpses of the same person in the room. This cannot be explained by equating death with "worldline curtailment." There also remains the important question concerning the life of the time traveller after the death of the earliest worldline section. On the above counter there was no life, but there must have been for there to be any later sections who can return to the time at which the earliest section was killed.

[2] It could be argued that the removal of the worldline sections will create a contradiction, but this problem belongs in Part Two.

Conclusion to Part Three

In this part of the thesis we have branched out from the traditional problems of changing the past or autofanticide to concentrate on stranger examples which emerge when we apply our imagination to what the possibility of time travel would involve. The crux of Part Three is that when we really reflect upon what could happen if time travel were possible the very possibility becomes reduced. The "finger in the dyke" analogy applies here; as a solution is offered to one case we should be able to construct another case that is paradoxical. The reason for this is, I think, simply because time travel is impossible. It has a surface plausibility, but once we see through this, we realise that we just can't have enough fingers. None of the examples above have clearly refute time travel, rather their purpose was to show that we cannot accept time travel without accepting a host of strange examples, inexplicable conclusions and perhaps even absurdity or and nonsense. For some this may be enough to reject the idea of time travel, others may require the decisive conclusion that will follow in Part Four.

Part Four

The Paradoxes of Time Travel

Introduction to the Paradoxes

The position so far is this. We have discussed the problem of changing the past. It was found that none of the proposed solutions to the problem are sufficiently acceptable, because of this the problem still remains. We have also looked at some examples that are the product of the possibility of time travel and have shown that time travel can be more than strange, it can be nonsensical. We should have enough now to deny the possibility of time travel, but in this final part of the thesis I will try to show conclusively that time travel is impossible.

This argument will concentrate upon the "traditional" paradoxes of time travel: the paradoxes of autofantiside. The crux of the paradoxes of autofantiside (I speak in the plural to accommodate for the variations of the paradox) is that they initiate what Horwich terms, "self defeating causal chains" (Horwich 1987). For example, I enter my unique time machine, travel back an hour and destroy the time machine. In such a case the destruction of the time machine prevents the conditions which allow for its destruction - the completion of the attempt entails the failure of the attempt. These paradoxes now pose the highest threat to the possibility of time travel. We can waver over how to treat the reductio stated at the beginning of Part Two. We can accept the strangeness of "Strange Loops." If the paradoxes cannot be resolved then time travel is impossible.

The self refuting paradoxes of time travel appeared early in the science fiction literature. For example the editor of "Amazing Stories," Hugo Gernsback, published a brief essay on time travelling in 1929's December edition of "Science Wonder Stories." In this essay he states:

"Suppose I can travel back in time...200 years; and I visit the homestead of my great great great grandfather, and am able to take part in the life of his time. I am thus enabled to shoot him, while he is still a young man... From this it will be noted that I could have prevented my own birth..."[1]

This essay initiated a large response amongst science fiction fans and writers, a response that was not specifically met by philosophers until Lewis's paper in 1976. Indeed, the likes of Putnam (1962), Smart (1963) and Harrison (1971) discussed the problems of time travel, but it was not until the mid-seventies that the self refuting paradoxes were discussed explicitly. The paradox described by Gernsback has come to be known as the "Grandfather Paradox." In the modern literature it has been simplified to the point where all that is involved is killing yourself as a baby, this is what Horwich terms "autofanticide." It is autofanticide that we shall be discussing in this part of the thesis. This is because, as there is only one person involved, it is the simplest version of the paradox. Because it is the simplest version of the paradox the possibility is reduced whereby something "slips through" and removes the paradox - i.e., perhaps you are born even though your grandfather was killed prior to fathering one of your parents. For instance some other man may have fathered one of your parents, unknown to you (or for that matter, to your grandfather). The point being that if you are killed, you are dead. If your Grandfather is killed there remains the possibility that you may still be born. Although my argument will focus directly on autofanticide, in places I will discuss Lewis's example of Tim and his Grandfather.

[1] Cited from Nahin 1993.

In Part Two the method of resolving the paradox was stated when we were discussing Lewis's argument to avoid the contradiction that results from changing the past. Lewis's argument was that we can attempt to avoid the paradox by claiming that circumstances would intervene that prevent the completion of a self defeating causal chain. Horwich takes this claim and discusses it detail. He suggests, as do many others, that it is possible that any attempted autofanticide would be thwarted by often incredible, but conceivable coincidences. If the attempt at autofanticide is made again then coincidences will again frustrate the attempt. A series of attempt and coincidental attempt failure could continue indefinitely.

This argument claims that in cases of attempted autofanticide, the world would behave in a way very unlike the way it does behave in our common lives. Repeated, often uncanny, coincidences would thwart every attempt. However bizarre the coincidences may become, we cannot conclude that something impossible is taking place. A die may come up "six" a million times in a row, but this is just "a matter of luck," as would be, on the thwarting coincidence view, a million gun misfires in a row. When we account for this, the argument becomes plausible; at least more plausible than the paradox it is intended to resolve.

I will start the discussion by providing an analysis of the term "coincidence." After this I will highlight a problem that faces the thwarting coincidence view. This problem is that the thwarting coincidences are not, as claimed to be, normal, everyday coincidences. After this, I will argue for the stronger claim that thwarting coincidences cannot even be thought of as coincidences. At this point in the thesis, there will be, for some, enough reason to abandon the thwarting coincidence view. Even so, I will let the thwarting coincidence view remain tenable, so that in the last section of the thesis it can be refuted conclusively.

An Analysis of Coincidence

We encounter coincidences throughout our lives. They are unusual occurrences, but in general we do not think that when a coincidence occurs, something of a radically different causal nature is taking place. In this sense coincidences may be unusual but they remain exoteric. A "coincidence" is a relation between two or more events that have come together without any causal connection. In addition there is a certain pragmatic feature to coincidences, in that the related events do not, to quote Sorabji (1980), "... come together always or for the most part." Aristotle argued in the Metaphysics (Ackrill 1987. Book VI Chapters 2-4) that coincidences are uncaused because they do not have causal chains which stretch back. This is because the coincidence itself is a cause - it is the beginning of a causal chain, not the end or mid-point of one. The reason why he holds this is because the conjunction of two events which come together when they would not normally do so, is a matter of "chance." If the conjunction of x and y is a coincidence then it is just "chance" that x and y come together and "nothing else is the cause of it's coming to be." (Ackrill 1987). Each of the occurrences x and y can be caused and explainable but there is no cause and thus no explanation of why x and y occurred together. From the claim that coincidences are uncaused Aristotle concludes that coincidences are not necessitated. If x and y come together this is not as a matter of necessity.

We can now define "coincidence" as: a causally unconnected and unnecessitated, coming together of two events that do not normally come together. For example, suppose that I meet an old friend in a foreign country. This is a coincidence if the presence of myself and the old friend in the foreign country are causally unrelated and unnecessitated and if it is not normal for us both to be in that country. As to the explanation of coincidences, we cannot explain why the events that have come together have come together, but we can explain why the events themselves occurred. Hence, I was in the foreign country on a holiday, my old friend was their on business. These occurrences can be explained. But we cannot

explain why we were in the foreign country at the same time. This definition of "coincidence" applies to the coincidences that prevent the paradoxes of time travel in the same way. Gun jammings do not normally come together with trigger pullings, but, where they do, the coming together will be causally unrelated and unnecessitated. Thwarting coincidences are supposed to have no features above those stipulated by the definition of "coincidence." They are just thought to be "every-day" coincidences. This is the claim that the thwarting coincidence view is based on - there is nothing special or inherently unusual about the coincidences which thwart attempted autofanticide.

Thwarting Coincidences are not "Every-day" Coincidences.

A problem, that is suspiciously avoided in the accounts that use thwarting coincidences, is the lack of explanation as to why they occur. Imagine that time travelling Tim aims a gun at his grandfather and he pulls the trigger. If his grandfather is killed a paradox will be created, but there will be no paradox because a coincidence will thwart the attempt. Suppose that the gun jams. This event is taken as being an everyday coincidence, after all guns do jam. In any event which is a gun's trigger being pulled it is entirely possible that the gun will not fire. Those who argue for this point are satisfied with this explanation. They think it is as far as they need go in attempting to explain why there is no paradox. If we were to ask a supporter of the thwarting coincidence view, "Why did the gun jam?" they would answer "Due to a coincidence." This is a poor attempt to provide an answer - it just doesn't seem to go far enough.

It is reasonable to assume that the answer, "Due to a coincidence," does not provide sufficient reason for the events it is attempting to explain. Sufficient Reason is Leibniz's principle that, "... no fact can be real... without their being a sufficient reason for its being so and not otherwise." (Leibniz 1720). On the thwarting coincidence view, the answer, "Due to a coincidence," must provide sufficient reason for the coincidences. That is, it must be a sufficient explanation, and the only explanation, of why the thwarting

coincidence occurred. For if it is not a sufficient explanation, that is, if another explanation is needed, then the thwarting coincidence view will be confronted by one of two serious objections:

1. Causal Predating. This first objection is that the thwarting coincidences cannot be explained by offering an analysis of the coincidence's causal history. Take the gun jamming coincidence; this is composed of two causally unrelated events: the trigger being pulled and the gun jamming. Each of these events must have its own particular causal history. Thus we can explain why the gun jammed and why the trigger was pulled. Even the supporters of the thwarting coincidence view would not claim that the component events of the coincidence are uncaused. That is, guns do not misfire, grandads do not sneeze and genius surgeons do not appear, without any cause for them to do so. For any event that is a part of a coincidence we can explain the antecedent causes of that event. (What we cannot do is explain why the events that are part of a coincidence have come together.) Suppose that the gun jamming was caused by some grit on the firing pin. The presence of the grit was caused by the gun being dropped. And so on. Hence, we have two events (trigger pulling and gun misfiring) and for these events we have an analysis of their unrelated causal histories. The argument is that the causal history of at least one of these events will precede the arrival of the time traveller from the future. Suppose Tim arrives in the past where he knows his grandfather will be. Instantly he picks up a gun and attempts to shoot his grandfather. The gun misfires. The causal history of the misfire can be traced back to it being dropped. Assuming that Tim did not drop the gun, it must have been dropped before he arrived in the past. This means that the causal history of the thwarting coincidence predated the arrival of Tim from the future. This is problematical for two reasons.

Firstly, a thwarting coincidence must occur to prevent every attempt of Tim murdering his grandfather. Tim can have more than one attempt at the murder. For every attempt there will be a thwarting coincidence and for each thwarting coincidence, the component events will have analysable causal histories which predate the arrival of Tim. The gun misfires. He picks up another one. Likewise it

misfires. Suppose he is in an armoury! Each gun he picks up will malfunction (Of course there are other possible thwarting coincidences but for simplicity we will stick with guns misfiring.) Each of these misfires will have causal histories that explain why the gun did not fire: for example, grit on the firing pin, dud bullets and whatever else can go wrong with a gun. Because each thwarting coincidence will have a prior causal history then this leads to the situation whereby, "waiting" for Tim in the past, are all these causal histories. Are we now really supposed to accept that the thwarting coincidences are "everyday" coincidences? For it seems that when he travels to the past he is travelling into a aetiological "bear trap." This argument does not refute the claim that the thwarting coincidences are normal, "everyday" coincidences, but I think it brings out an implausibility in the claim. This implausibility will be amplified by the following argument.

The second problem raised the causal predating of the thwarting coincidences is that it is conceivable that there could be a case in which Tim cannot kill his grandfather, but he can, or must, kill someone else. I say "must" because it is conceivable for there to be a case where the time travelling will result in a self defeating causal chain if a certain person is not killed. Perhaps the presence of Tim in the past allows for another assassin to kill his grandfather where, had Tim not returned to the past, the assassin would not have killed his grandfather. In this case Tim must kill the assassin and he cannot kill his grandfather. But, we have seen that the causal history of the coincidence which will thwart the attempt at killing Grandfather is already there. If the trigger is pulled, the gun will misfire because the antecedent causes that entail the misfire are already "in place." Suppose that Tim is given the choice of either killing Grandfather or killing the assassin. Also suppose that the assassin and the grandfather stand side-by-side. Tim aims the gun undecidedly between both of them. If he shoots at Grandfather the gun will misfire because there cannot be a paradox. If he shoots at the assassin the gun will not misfire otherwise there will be a paradox. But this is a contradiction when we analyse the causal history of the coincidence which will prevent the killing of Grandfather. As follows:[2]

[2] Obviously this case is open to the charge that other coincidences could intervene. But we can get around this by stipulating the conditions whereby the only possible coincidence is the misfiring of the gun due to grit on the firing pin. This would be achieved through the use of a complex example along similar lines to the case of Dr. Cronos which is stated later in this section.

[1] At time t, the causal history of the gun is such that if the trigger is pulled it cannot fire. This prevents the paradox of killing the grandfather.

[2] At time t, the causal history of the gun is such that if the trigger is pulled it must fire. This prevents the paradox of not killing the assassin.

If we suppose that the causal history of the thwarting coincidence can be traced back to, say, grit on the firing pin, then the contradiction can be expressed in this way:

[1] At time t there is grit on the firing pin.

[2] At time t there is not grit on the firing pin.

This example shows that if we attempt to provide sufficient reason for the thwarting coincidences by analysing the causal histories of the events that constitute the coincidence, then, we will end up with a contradiction. At least in certain, possible cases. Due to this, sufficient reason for the thwarting coincidences cannot be provided by analysing the causal histories of the events that constitute the coincidences.

2. Question-Begging. We have seen that trying to give a causal explanation of the thwarting coincidences leads into the claim that the antecedent causes of the coincidences predate the arrival of the time traveller. Of a greater severity, the causal analysis of the thwarting coincidences can create the contradiction stated above. The remaining option is to provide sufficient reason for the thwarting coincidences by trying to state what is the real explanation of the coincidence. By this I mean an explanation that explains why the coincidence was the case and not otherwise. On such an explanation the question, "Why did the gun jam?" will be answered "Because there cannot be a paradox." It cannot

be denied that the employment of thwarting coincidences is specifically used to prevent a paradox from taking place. So, it seems that when we ask for an explanation with sufficient reason for the thwarting coincidence we can answer in this way. This begs the question against the very point that is under discussion - the use of thwarting coincidences to prevent a paradox. The question-begging charge cannot be avoided. For any explanation of why the thwarting coincidence was the case and not otherwise there will be the answer that it was the case because there cannot be a paradox.

This leaves us in the position whereby the explanation of thwarting coincidences cannot be provided other than by saying what amounts to, "coincidences happen." The reason why this is the case is because neither a causal explanation nor a "real explanation" can succeed without contradiction or begging the question. Unlike "everyday" coincidences, thwarting coincidences can be offered no explanation. We are not saying here that everyday coincidences can be explained completely, by definition, they cannot. The can, however, be explained to a much greater level than thwarting coincidences. For any "everyday" coincidence we can break it up into component events and analyse these events, but this, as has been shown, is not possible with thwarting coincidences. Thus, thwarting coincidences are not, as their supporters claim, "everyday" coincidences.

Thwarting Coincidences are not Coincidences.

The next stage of the discussion will take the assault on the thwarting coincidence view a step further. It has been argued that thwarting coincidences are not "everyday" coincidences. Now it will be shown that they are not even coincidences. It was stated above in the definition of "coincidence" that the two events that have come together are causally unrelated and unnecessitated. When we take this definition and apply it to thwarting coincidences we find that it is simply not the case that they are causally unrelated and unnecessitated.

Let us divide a thwarting coincidence into two parts: the "attempt event" and the "thwarting event." Examples of the former will be trigger pullings and bomb plantings, whereas examples of the latter will be gun misfires and people sneezing. For the thwarting coincidences to be coincidences then the attempt event must be causally unrelated to the thwarting event, but it is highly mistaken to think that this is the case, because the consequent of any attempt event will be a thwarting event. Conversely, wherever there is a thwarting event there will be an antecedent attempt event. Counterfactually, wherever there is no attempt event there will be no thwarting event. Whichever way we look at it, the attempt event is a causal factor of the thwarting event. It gets worse. Not only are the attempt and thwarting events causally related but they are related as a matter of necessity. For any attempt event it is necessary that there is the consequent thwarting event. That there is a consequent thwarting event to every attempt event is necessary because otherwise there could be a paradox.

It is now evident that it is necessary that every attempt event will entail a thwarting event. Therefore, the relation between the attempt event and the thwarting event cannot be one of coincidence. The thwarting coincidence view has been refuted. Perhaps, for some, it is now conclusive that if the thwarting coincidence view is false, then there is no way to prevent the paradoxes from taking place; in which case time travel is impossible. This failing of the thwarting coincidence view is a good reason for rejecting the possibility of time travel. But, as has been a common theme in this thesis, we can continue to discuss the possibility further: either to convince those who have not been convinced or to simply add strength to the general refutation. With this said, we can continue to grant the supporters of time travel the use of thwarting coincidences and show that, even if they still hold onto the view, it does not remove the possibility of there being a paradox.

How to Force the Paradox with "Certain Death."

In the section that follows I will argue that the use of thwarting coincidences does not remove the paradox. This will be achieved by describing an example where no possible coincidence could thwart the attempt at autofanticide. The example I will use is perhaps overtly elaborate, there is a reason for this. By stating the example in this way any objections can be localised within the example and can hopefully be refuted by simply altering a small part of the example.

The Case of Dr. Cronos

Imagine that at a time in the future that there is a brilliant scientist who invents a time machine. We will call him Dr. Cronos. One of the peculiar things about Dr. Cronos is that he was born and raised on a moon base. Further, when he was an infant there was an incident which nearly killed him. A huge asteroid was hurtling towards the moon base, only to be destroyed just in time by a space rescue missile ship.

The situation was this. The missile was fired at the latest possible time that would offer any chance of destroying the asteroid. If it was one fraction of a second later, then, even if it had destroyed the asteroid, the explosion and shock wave would have definitely destroyed the moon base. If the moon base was destroyed, the infant Dr. Cronos would have definitely died in the either the explosion or in the ensuing absolute vacuum. Luckily the missile was fired at the latest possible time and the infant Dr. Cronos escaped with his life. He grew up and became a pioneer in time travel.

Suppose that the adult Dr. Cronos decides to travel back to his past. As it happens he sets the space-time coordinates as being those of the bridge of the space rescue vessel, at a time one second before, in the events described above, the missile was fired.

He appears on the bridge in between the missile consul and the pilot. The pilot is unable to fire the missile in time and the asteroid destroys the moon base - resulting in a self defeating causal chain. The intended structure of this example is that no coincidence can thwart the accidental autofanticide. That is no coincidence that obeys physical laws. By this I mean that asteroids do not spontaneously destruct or change direction, fragile moon bases do not miraculously withstand huge impacts and infants do not suddenly develop anaerobic respiration or the ability to avoid explosive decompression.

We also need to stipulate, as a prologue to the argument, certain conditions which are pertaining during the example. Such as: there are no space suites or "escape pods" on the moon base, there are no errant asteroids which could collide with "our" asteroid and there are no rescue vessels sufficiently close to the moon base. We can be very detailed should we wish.

The example is intended to be open ended with regards to denying coincidence. I suggest for any coincidence offered to escape the paradox we can stipulate conditions to remove that coincidence from being a possibility. For example, suppose you reply that the missile just fires accidentally. Then I stipulate that in fact the missile is propelled by the nuclear fusion of element x. The fusion can only be triggered by manually inserting a core of element x into the missile, here it will combine with further element x in the missile. The mass of the element x in the missile will reach critical mass and thus propel the missile. Then I say that Dr. Cronos' untimely appearance prevented the core from being inserted in time in which case the missile could not be fired in time. In other words, the missile is not propelled by any mechanism that could accidentally fire. We can take it as a law that without the core of element x, the missile will not be fired.

Obviously the example could become very far fetched[3], this is not a problem. So long as the example removes thwarting coincidences, and can be altered to remove any offers of such coincidences, it will succeed in preserving the paradox. I shall call such an example a "certain death situation." If the situation occurs then it will result in the certain death of the infant Dr. Cronos.

Can we avoid the certain death situation, and thus the paradox, in another way? There is the option of claiming that claim that the "certain death" of the infant Dr. Cronos would be prevented by a coincidental transgression of physical laws. Such that asteroids do self destruct or that element x does reach a fusion state below critical mass. To try and argue for this leads us into a morass of absurdities. For instance any spontaneous transgression of physical law will not be spontaneous, it will be related to the prevention of the paradox. A corollary of this is that because the, say, explosion of the asteroid is not spontaneous,it must be explainable. We cannot explain how an asteroid spontaneously self-destructs. Finally, and of most potence, is the fact that we seem forced to admit that physical laws can be transgressed! This would lead us into a world which would be far stranger than any world in which time travel were impossible. We should rule out using the transgression of physical laws to escape the paradox.

One attempt at resolving the above paradox is to claim that a coincidence does occur that cannot be excluded by our stipulations. Because we can, in principle, respond to any suggestions of a thwarting coincidence, such a coincidence must be of a different type to the standard type of thwarting coincidence. The suggestion here is that if we cannot prevent the paradox, "at the scene," then we can prevent Dr. Cronos from arriving "at the scene" in the first place. By this I mean that "coincidentally" Dr. Cronos does not appear at the critical time and location. Perhaps he sets the space-time coordinates

[3] A less elaborate version of the example would be that the infant version of a time traveller is in the logically possible environment whereby the presence of any extra matter in the environment would cause the destruction of the environment. Then we say that the time traveller travels back to this environment and, by definition, causes it's total destruction thus initiating a paradox.

differently or his time machine is never accurate. However suppose that, for whatever reason, he wants to commit autofanticide. He determines the exact moment necessary and sets the time machine accordingly. It fails. He tries again, and again and again, each time he fails. We can conclude from this that there is a time and a place to which Dr. Cronos cannot travel to - thus, relative to this instant and location time travel is not possible. Let us call these particular space-time coordinates which cannot be travelled to by particular individuals "excluded points" - the reason for such a terminology is I hope obvious.

If we want to refute the possibility of time travel then we now have a problem. For it can be argued that time travel is possible except to excluded points; in which case there would be no paradoxes of autofanticide. Further, because the example involving Dr. Cronos is very contrived and unlikely, it can also be claimed that very few individuals would have excluded points regarding where and when they cannot travel to. This is because we can assume that if an individual attempts autofanticide then an "everyday" coincidence will thwart that attempt. If such coincidences are removed from play, as with the case of Dr. Cronos, then the autofanticide will be prevented by the presence of excluded points. Either way there will be no paradox.

I do not think that we can refute the possibility of there being excluded points to which as a matter of coincidence a time traveller cannot travel; unless that is we accept the conclusion above that the thwarting coincidences are not coincidences. For reasons stated above, I do not want to rule out time travel on these grounds alone. I will show that we can use the idea of excluded points to prevent a paradox, but, that this claim entails what will be termed "causal sentience." By "causal sentience" I mean a situation where the causes of an event appear to depend on epistemic features concerning that event. Such features as, for example, knowing that the baby on the moon base is the same person as the adult Dr. Cronos. The intuition that there is causal sentience is prevalent in all accounts that attempt to refute the paradoxes of time travel. We have people sneezing at the right time, guns misfiring and genius surgeons arriving on the scene. All of these thwarting coincidences are supposed to occur as

"everyday" coincidences; without recall to any sentience. There is something intuitively suspect about claiming that there is no sentience involved in these coincidences. It all seems too contrived. Intuitions are not enough to refute the attempts at removing the paradox. What I shall suggest is an example which shows that if we want to claim that the paradox is resolved by coincidence, including the coincidental presence of excluded points, then we must rely on the notion of causal sentience.

The example is as follows. Suppose Dr. Cronos, on realising he cannot kill himself by the methods he has attempted, decides to try another method. By now he is familiar with the situation concerning his childhood near miss with the asteroid. He has also concluded that if a thwarting coincidence can occur it will. He releases that if the situation he sets up when he returns to the missile ship does not create a certain death situation then the events will continue just as they did in the "original" case - the missile will be fired in time and the moon base will remain intact.

With this in mind, Dr. Cronos creates a device that he nicknames a "Shrodinger Bomb." This is a special type of atomic bomb which when triggered will, so long as the laws of physics pertain, detonate with a huge explosion. The Shrodinger Bomb can only be triggered by an atomic particle which needs to be present in the bomb's core for it to detonate. Now, the peculiar thing about the triggering of the bomb is that the required particle is emitted by a sample of some radioactive element, which, in the time span we are discussing has a 50/50 chance of emitting the particle.

Dr. Cronos is preparing to travel back to the past missile ship. He straps the Shrodinger bomb firmly to his chest and sets it. Within the next few instants there is a 50/50 chance that the bomb will detonate. I must stipulate again, if the particle is released it is certain that the bomb will detonate. Dr. Cronos travels back in time to the missile ship. He is there, unobtrusively upon the bridge a few instants before the missile must be fired to prevent the paradox. Within the next few instants the bomb will or will not

detonate. After these instants the same follows, the bomb will or will not detonate, but it makes no difference to the case if it does because the missile will have already been fired.

Suppose that the Shrodinger bomb explodes. The blast will be so huge that the missile ship will be annihilated, and, assuming the preservation of physical laws, the asteroid will destroy the base giving us the paradox. If the Shrodinger bomb does not explode then there will be no autofanticide and thus no paradox. What should we say here? We are at the stage in the discussion where the only feasible way out is to use the idea of excluded points. But if we take this way out we become forced to admit that we are attributing sentience to causation. This is why; our stipulations have allowed for only two possibilities concerning the case of the Shrodinger bomb:

(1) If the Shrodinger bomb exploded then there would be a paradox. Because there cannot be a paradox the only option is to hold that there would be excluded points to which Dr. Cronos could not travel - namely the missile ship at a time before the missile is fired.

(2) If the Shrodinger bomb did not explode then there would be no paradox. If there was no paradox then there would be no excluded points to which Dr. Cronos could not travel - thus he could arrive on the missile ship at a time before the missile is fired.

Whether there are excluded points or not depends on whether the bomb explodes or not. If the bomb explodes depends upon an unpredictable emission of a particle within a given time. Thus whether there are excluded points or not depends upon something being aware of whether or not a particle was unpredictably emitted. What are the candidates for this "something" capable of being aware of an unpredictable particle emission? Before suggesting the candidate bearers for causal sentience, I will analyse what would be involved in being aware of the unpredictable particle emission. Any awareness must take place before (in the personal time of Dr. Cronos) Dr. Cronos attempts to travel to the past missile ship. Assuming, as we have done, in line with current theories, that the particle emission is

unpredictable then this awareness must be of a sort that penetrates the insulation of true randomness. Such an awareness would have to be unlike anything that belongs to our standard epistemic concepts. All of this points to a candidate "something" that not only has omniscience but also the means to prevent Dr. Cronos from time travelling. The best candidate for this "something" that is aware looks like being God. Physicists may object that not even God could predict the emission of the particle, but, I think if we are going to use a God then we can make him omniscient regarding all facts through time. However recall to God is just an easy way out for those who wish to defend time travel. Further If they are willing to use him at this late stage then it is, in a sense, a shame. Because if he was used at the beginning of the discussion there would be no problems of time travel at all - God would see that the world would remain aright. Using God as a philosophical tool never really carries much weight; he may be great to believe in, but as a premise to an argument his existence is a big assumption. For this reason God shall not be used to suggest how there can be an awareness of whether or not the Shrodinger bomb will explode.

The next candidate is the suggestion that somehow the causal structure of the universe is aware of whether or not the particle is emitted. This claim to causal sentience cannot succeed because there is the issue of how causation can be aware of anything. In addition, there is no suggestion in any of the philosophical or scientific literature as to how this could be so. The nearest that I can suggest is a phenomenon in chemistry where rare synthetic crystals which are hard to form become increasingly easy to form; even when the process is duplicated exactly. This suggests that there is some form of memory in the causal structure of the process of crystal formation. Even if this phenomena does imply that causation has a memory, which is highly dubious, this would not answer the question of causal sentience, for two reasons. Firstly, the case of the Shrodinger bomb is not about memory but about knowledge of the future. Secondly, the knowledge, as we have seen, is of a type that concerns unpredictably. Anything that is aware of the partial emission must have a knowledge that is on a par with omniscience. To say this about the causal structure of the universe is nonsensical. Perhaps we could construct an argument whereby because the emission is uncaused there is no way, even if we had an

intelligible account of causal sentience, that the causal structure could be aware of whether or not the particle is be emitted. Such an argument would pick out a category mistake in the description of the causal being interactable with the uncaused. I am not sure if this argument would work, but even so it is unnecessary because the very premise that there could be causal sentience is nonsense. It is nonsense because it is inconceivable to ascertain in what sense there could be causes which are aware. To borrow Mackie's phrase, one might as well attribute sentience to cement.

This section of the thesis concludes that the attribution of causal sentience to explain the presence of excluded points is nonsensical, but that it is an attribution that must be made in order to remove the possibility of certain death situations. Because the move cannot be made, then the paradoxes of time travel remain unrefuted and therefore time travel is impossible. We could end the thesis here, but one, argument remains to support the possibility of time travel which needs to be discussed. The remaining response is that which is made by Horwich.

Horwich's Conclusion

Horwich argues that in cases of time travel where there is the possibility of their being a self defeating causal chain, "specific coincidences would ensue, in whose improbability we can have a great deal of confidence." (Horwich 1987). What he is saying is that because of the improbability of such thwarting coincidences occurring we can rule out the possibility of their being any time travel which could create self defeating causal chains. This point runs against Lewis's claim that thwarting coincidences would be strange but not impossible and thus could, indeed would, occur to prevent the paradoxes. I agree with Lewis that if the coincidences are possible then they could be used to remove the paradoxes. This is why the above arguments were aimed at establishing the impossibility of there being any thwarting coincidences and thus preserving the possibility of paradox. We may say that Horwich has excluded the

possibility of time travel due to the improbability of the thwarting coincidences whereas I have excluded it due the impossibility of the thwarting coincidences. I think my conclusion is far more persuasive simply because after reading Horwich's conclusion one can side with Lewis's position that the coincidences may be improbable but they are not impossible. The point is moot, but Horwich and I have at least reached the same conclusion. Horwich does not stop there however, the feature of his argument which is of interest to us is that he does not find that his conclusion prevents time travel absolutely. Rather he holds that time travel to the spatially local past is impossible, but this does not lead to the conclusion that time travel to the spatially distant past is impossible.

What this means is that our history is out of bounds to us, but that there are spatially distant points, in the past, which are possible destinations of time travel. For example, we could not travel to the Battle of Hastings but we could travel to the past of a distant star. For once at this star we could not initiate any self defeating causal chains. We can say that Horwich allows time travel to locations which are safe from their being any paradox. I will now argue that his conclusion fails and that time travel, even to the spatially distant past, is impossible.

The argument runs that although Horwich's conclusion allows for the possibility of time travel to the spatially distant past, he has not avoided the possibility of paradox. This is because he has overlooked the possibilities created by spatial travel. By "spatial travel" I mean travel in the standard "A to B over time" sense[4]. When Horwich's argument is supplemented with the possibility of standard spatial travel it becomes apparent that the possibility of paradox has not been removed.

Imagine that, in accordance with Horwich's conclusion, a time traveller leaves Earth and travels a million years into the past, to a star which is half a million light years away. By assuming that this is far enough away for there not to be the possibility of paradox, Horwich thinks that such time travel would be possible. However, from this star it would be possible, with a reliable space ship, enough fuel and

[4] As defined on Pg. 12

cryogenic suspension, to return to Earth. This would be achieved by travelling at just over half the speed of light thus allowing the time travellers to arrive before the initial departure to the past was made. The fact that the time travellers have gone on what is an aeonic diversion is irrelevant to the fact that they can arrive before they left. Once in this position, the time travellers would be able to initiate a self defeating causal chain.

Horwich's conclusion has therefore not removed the possibility of paradox from the possibility of time travel. As for counters to my argument; one may say that there are a number of contingent facts which remove the possibility of the time travellers "returning home." Facts such as extravagant fuel requirements, the unlikelihood of cryogenic suspension for such periods, or the improbability of being able to travel at half the speed of light. This rebuttal may be persuasive, save for the fact that the possibility of time travel itself rests upon the positing of facts like, or related to, those possible facts just stated. The theoretical possibility of time travel involves extravagant amounts of fuel and a very fast spaceship, so, this counter to my argument will not work.

It can be argued that I am mistaken in thinking that, in the above example, the time travellers have gone far enough away. Such an argument would claim that obviously the time travellers have not gone far enough away because the possibility of paradox remains. In order to formulate this counter the supporters of time travel might use the concept of "light cones." We saw in Part One that worldline diagrams depict the history of things in space and time. Light cones are an advancement on this notion. When we introduced the idea of worldline diagrams the relevant scales of the temporal and vertical axis were not stipulated. To construct a light cone we stipulate the scale of the diagram using the speed of light as unity. Hence, on the spatial (horizontal) axis one light year will be equivalent to one year on the temporal (vertical) axis. With the scale stipulated, it is clear that anything which travels at the speed of light will have a worldline which ascends at forty five degrees from the vertical. Nothing can travel faster than light, therefore, no possible worldline can tip at greater than forty five degrees from the vertical. Worldline diagrams simplify space time into the temporal and one spatial dimensions - it makes them easier to draw. Worldline diagrams that depict light cones use an additional spatial

dimension. We can draw the diagram with the second spatial axis coming "out of the page" at a right angle to the vertical axis. If on this diagram we drew the forty five degree "light speed" line, it would be circled around the vertical axis depicting a cone. This is a light cone.

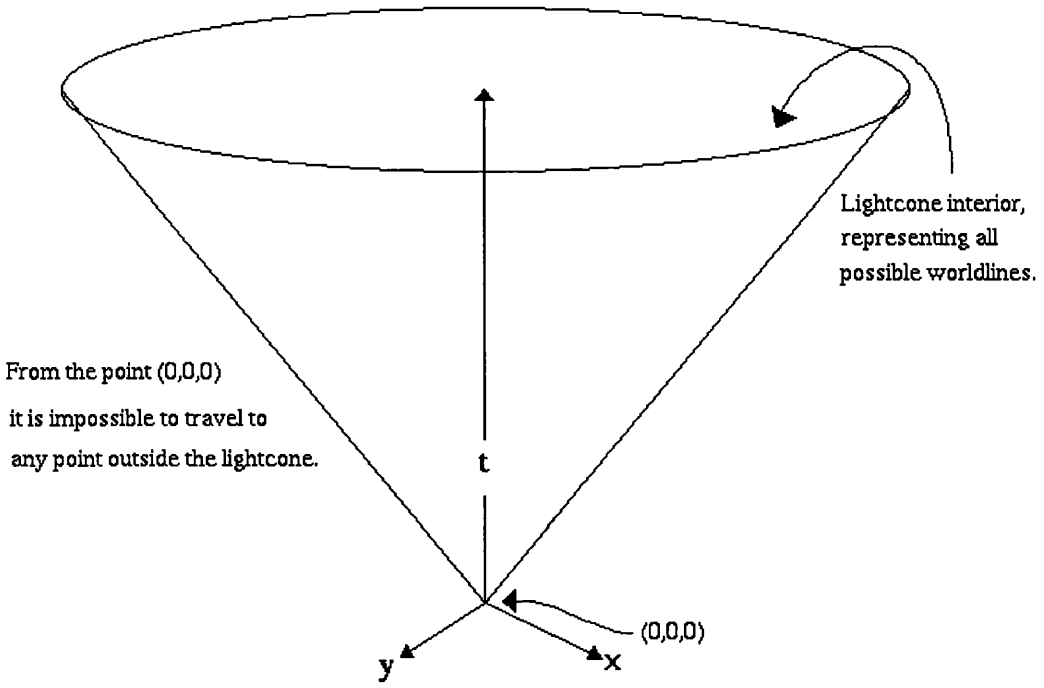


Fig. 4.1 - The Light Cone.

From the point (0,0,0), which can represent any place at any time, it is only possible, even at the speed of light, to travel to space time locations within the light cone. Anywhere outside the light cone cannot be reached. Every point in space-time has its own particular light cone. Now we can reformulate Horwich's argument as: time travel from point A to point B, where B is in the past of A, is possible if and only if A is not in the light cone B. If A is not in B's light cone then nor, ex hypothesi, will any point in A's past be in B's light cone. This demonstrates that if you travel from A to B there is no way to get back to A before you left for B (Fig 4.2). The light cone insulates the possibility of time travel from the possibility of paradox.

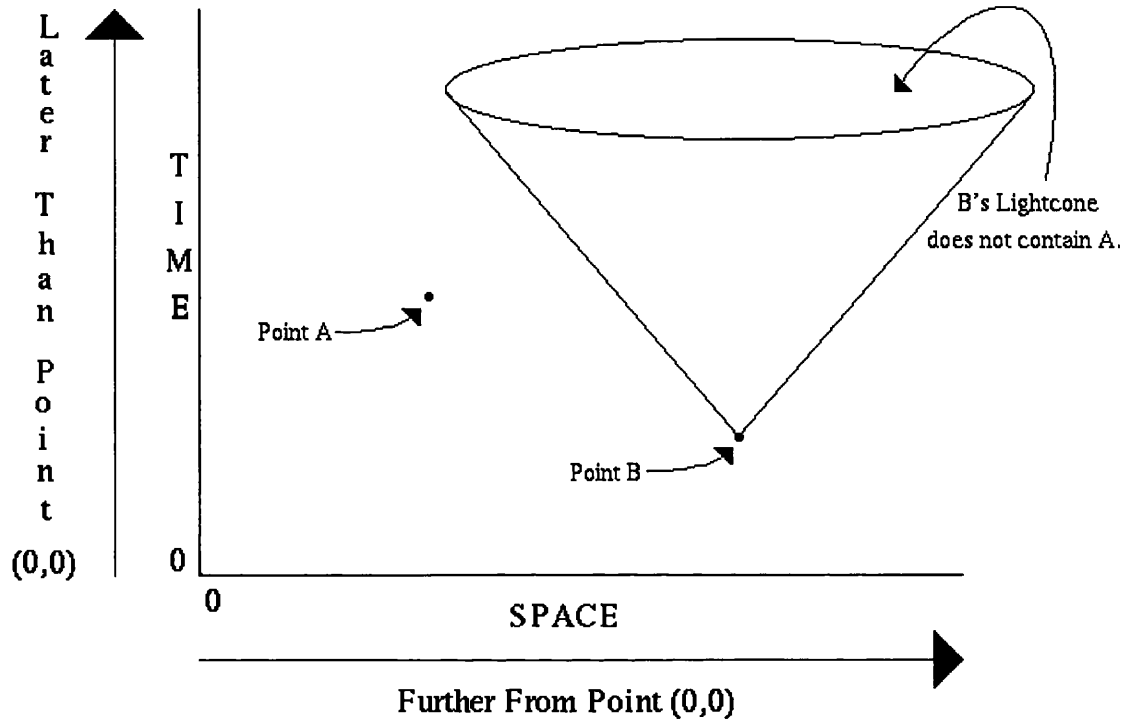


Fig. 4.2

A situation representing the above reasoning would consist of time travel to a point which is, say, a hundred years in the past and a two hundred light years away. Here the point of departure would not be in the light cone of your point of arrival, in which case you could not return in time to create a paradox. Is Horwich's conclusion now secure? No, because we can use the very method of time travel to the distant past to bring our travellers back into "paradox range." This can be done by one of two ways:

(1) The time travellers can go from A to B - as A is not in B's light cone. There can be another point, C, which has A in its light cone, but that does not have B in its light cone (Fig. 4.3). Thus they time travel to B and, using the same method, travel to C. From C it is possible to travel, by standard spatial travel, back to A; there they initiate a paradox.

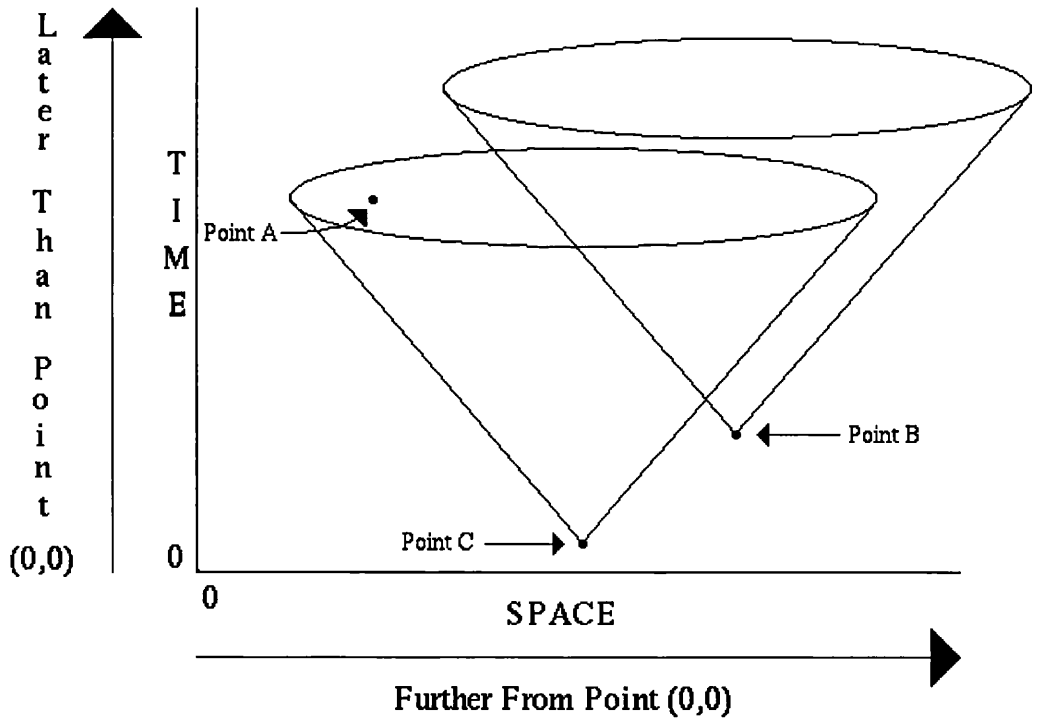


Fig. 4.3

(2) The time travellers can go from A to B, once at B they can wait for what may be a huge period of time until a point B1. B1 is a point which is in the future of A but which is not in A's light cone (Fig. 4.4). Thus they can time travel back, from B1 to A, and there, you guessed it, create a paradox.

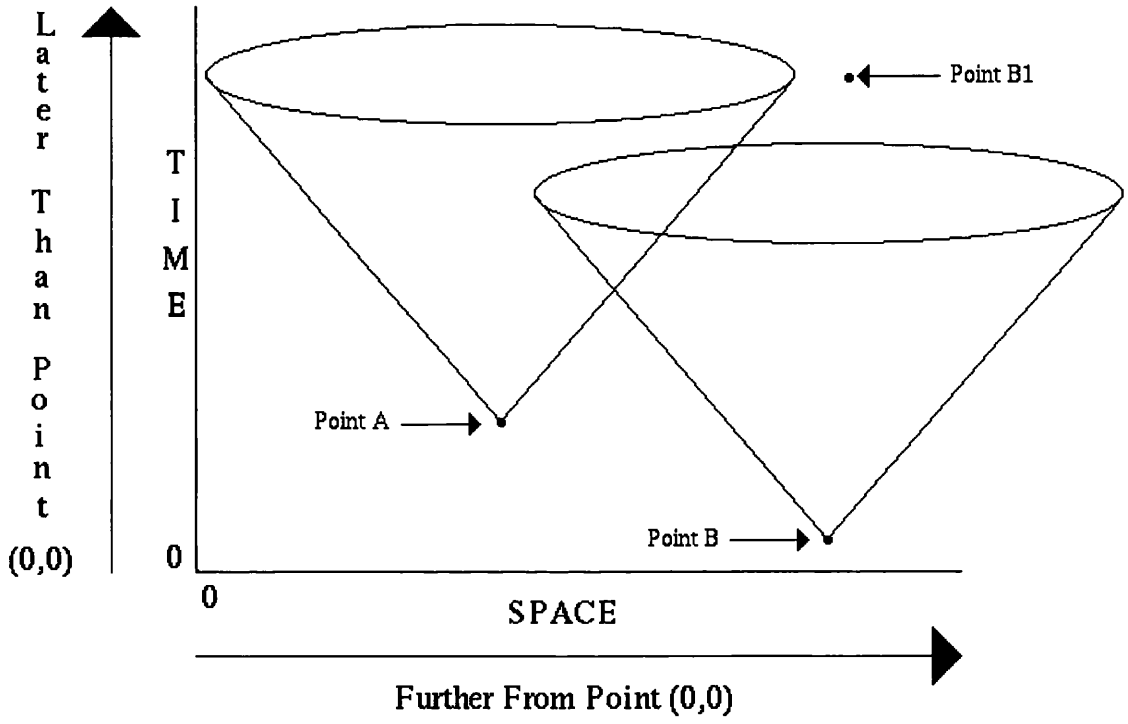


Fig. 4.4

Therefore if time travel is possible to the spatially distant past then it is possible to the local past. If time travel to the local past is possible then it is possible to create a paradox. No point in space-time is free from the possibility of paradox, therefore it is not possible to time travel.

Conclusion

Throughout this thesis the supporters of time travel have been given leeway to use arguments and concepts that have been shown to be mistaken. The severity of these mistakes have ranged from the "intolerably mystifying" external/personal time dualism, through to the implausibilities and contradictions revealed in the views of Meiland, Lewis, Harrison and Horwich. These mistakes were bracketed off so that we could continue to discuss time travel up to the point of the paradoxes of autofantiside. Here it was argued that the paradoxes could not be avoided and thus time travel is impossible.

The impossibility of time travel legitimises the removal of the "brackets" from the "bracketed off" mistakes that have been revealed, but put aside, throughout this thesis. I suggest we can now fully reject the change/influence distinction that attempts to remove the contradiction of changing the past. It can be rejected because the arguments made against it in Part Two showed it to lead into contradiction. We can also reject the claims to thwarting coincidences because it would be pointless to hold such a mistaken view when, even if the view were true, it does not achieve what it is intended to; the removal of the possibility of paradox. What of the external/personal time dualism? This could be discarded were it not for the supporting theoretical evidence that comes from the Special Theory of Relativity. Because of this I will not claim that it should be rejected although I will accept that the dualism can be thought to be "mystifying".

In Part One I stated Godfrey-Smith's objection against the "preposterous" block universe conception. Unfortunately, although time travel is impossible, we cannot use this impossibility to conclude that the block universe conception is indisputably mistaken. I suggest that more work is required in this area so that the conception, which is intuitively and empirically implausible, can be shown to be false. The most I can claim here is that the impossibility of time travel may help to, "knock a few more chips from its foundations."(Godfrey-Smith 1980).

The possibility of time travel is fundamentally mistaken. It can be given a spurious plausibility through the use of worldline diagrams, the block universe conception and, importantly, the linguistic conventions whereby we speak of time using spatial terminology. However, as this thesis has shown, when we get into the details and the implications of time travel, its impossibility becomes evident.

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