Riddles of Existence

A Guided Tour of Metaphysics

Earl Conee and Theodore Sider

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CHAPTER 3

Time

Theodore Sider

The Flow of Time

It is strange to question the nature of time, given how fundamental time is to our experience. As a child I wondered whether fish are conscious of water or whether they experience it unconsciously, as we experience the air we breathe. Time is even more ubiquitous than water or air: every thought and experience takes place in time. Questioning the nature of time can be dizzying.

Yet it is worth questioning. The ordinary conception of time, once you start to think about it, seems to make no sense! For we ordinarily conceive of time as being something that *moves*. 'Time flows like a river.' 'Time marches on.' 'Time flies.' 'As time goes by.' 'The past is gone.' 'Time waits for no one.' 'Time stood still.' These clichés capture how we tend to think about time. Time moves, and we are caught up in its inexorable flow. The problem with this way of thinking is that time is the standard by which motion is defined; how then could time itself move? This is metaphysics at its best. Look at the world hard enough, and even the most mundane things are revealed as mysterious and wonderful.

Let's examine this idea of time's motion, or flow, more carefully, by comparing it to the motion of ordinary objects. What does it mean to say that a *train* moves? Simply that the train is located at one place at one moment in time and at other places at later moments in time (see Figure 1). At time t_1, the train is in Boston. At later times t_2, t_3, and t_4, the train is located at places further south: New York, Philadelphia, and finally, Washington. The motion of the train is defined by reference to time: the train moves by being located at different places at different times. If at every moment the train stayed in the same place—Boston, say—then we would say that the train did not move.

Ordinary objects move with respect to time. So if time itself moves, it must move with respect to some other sort of time. But what would that other time be?

The way in which time seems to move is by the *present moment*'s moving. Initially the present moment is noon. Later the present is 3.00 p.m. Still later it is 6.00 p.m., and then 9.00 p.m.,

Fig. 1. The movement of a train defined by reference to time

and so on. Since motion is defined by reference to time, the present moment, if it is moving, must have these four different locations at four different times, t_1, t_2, t_3, and t_4 (Figure 2), just as the moving train had four different locations at four different times. But the diagram is confusing. It mentions the times noon, 3.00, 6.00, and 9.00, but it also mentions four other times, t_1, t_2, t_3, and t_4. These are the times with respect to which the present moment is moving. What are these other times? In what sort of time does time itself move?

One possibility is that t_1, t_2, t_3, and $t_{\pm 4}$ are part of a *different* sort of time, call it **hypertime**. Just as trains move with respect to something else (time), time itself moves with respect to something else (hypertime). Most motion takes place with respect to the familiar timeline, but time itself moves with respect to another timeline, hypertime.

Hypertime is a bad idea. You can't simply stop there; you need more, and More and MORE. Hypertime is supposed to be a sort of time. So if ordinary time moves, surely hypertime moves as well. So hypertime must move with respect to yet another sort of

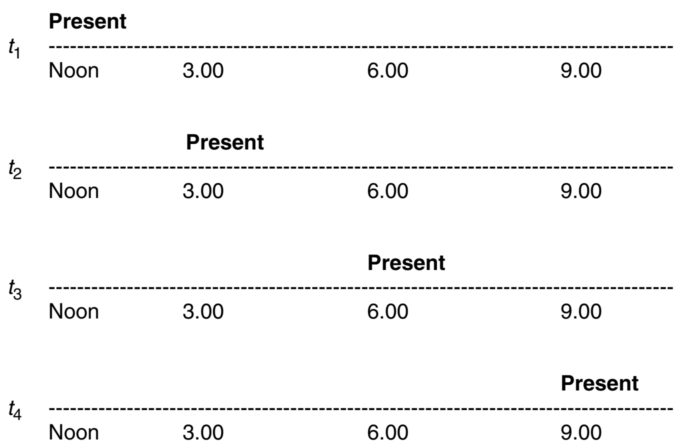


Fig. 2. The moving of the present moment

time, hyper-hyper time. That time must also move, which introduces hyper-hyper-hyper time. And so on. We are stuck with believing in an infinite series of different kinds of time. That's a little much. I can't *prove* that this infinite series does not exist, but surely there are better options. Let's see if we took a wrong turn somewhere.

Instead of being part of hypertime, perhaps t_1, t_2, t_3, and t_4 are just part of ordinary time. In particular, t_1, t_2, t_3, and t_4 could just be the times noon, 3.00, 6.00, and 9.00. According to this view, time moves with respect to itself. Is that plausible?

Although it's nice to be rid of hypertime, there is something strange about this picture. It's not that it isn't *true*. Noon is indeed present at noon, 3.00 is present at 3.00, and so on. But these facts seem *trivial*, and therefore insufficient to capture a genuine flow of time. This can be brought out by comparing time to space, and comparing *present* to *here*. Consider the spatial locations on the train track connecting Boston to Washington. Anyone in Boston can truthfully say 'Boston is *here*'. Likewise, anyone in New York can say 'New York is here'. The same goes for Philadelphia and Washington. So Boston is 'here in Boston', New York is 'here in New York', and so on, just as noon is present at noon, 3.00 is present at 3.00, and so on. But space doesn't move. The line in space connecting Boston with Washington is static. The mere fact that members of a series are located at themselves does not make that series move, whether that series consists of points of time or locations in space.

The Space-Time Theory

Time's motion has us all tangled up in knots. Maybe the problem is with that idea itself. According to some philosophers and scientists, our ordinary conception of time as a flowing river is hopelessly confused, and must be replaced with the **space-time theory**, according to which *time is like space*.

Graphs of motion from high-school physics represent time as just another dimension alongside the spatial dimensions. The graph pictured here (Figure 3) represents a particle that moves through time in one spatial dimension. This particle begins at place 2 in space at the initial time 1, then moves toward place 3, slows down and stops at time 2, and finally moves back to place 2 at time 3. Each point in this two-dimensional graph represents a time t (the horizontal coordinate of the point) and a location in space p (the vertical coordinate). The curve drawn represents the particle's motion. When the curve passes through a point (t, p), that means that the particle is located at place p at time t.

A more complicated graph (Figure 4) represents time alongside two spatial dimensions. (It would be nice to represent all three spatial dimensions, but that would require a four-dimensional graph and so a much more expensive book.) These more complicated graphs are called **space-time diagrams.** (Even the high-school physics graph is a simpler kind of diagram of space-time.) Space-time diagrams can be used to represent all of history; everything that has ever happened or ever will happen can be fit into a space-time diagram somewhere. This particular

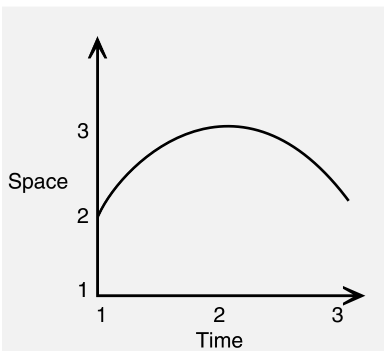


Fig. 3. High-school physics graph of a particle moving through time

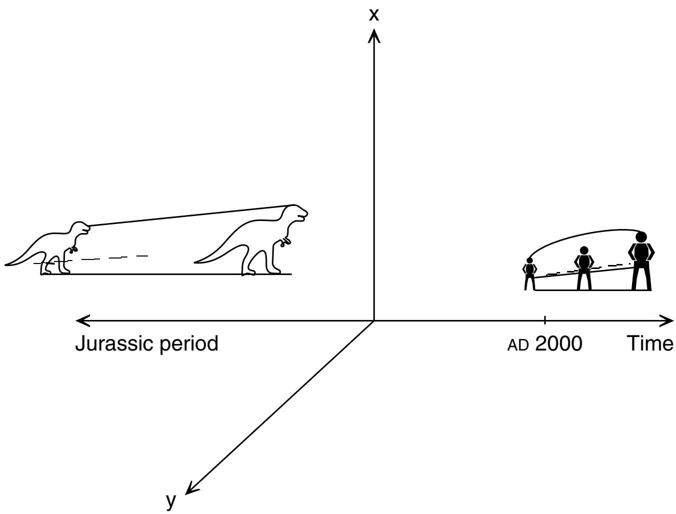
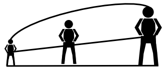


Fig. 4. Space-time diagram

diagram represents a dinosaur in the distant past and a person who is born in AD 2000. These objects stretch out horizontally in the graph because they last over time in reality, and time is the horizontal axis on the graph: the objects exist at different points along the horizontal time axis. They stretch out in the other two dimensions on the graph because dinosaurs and people take up space in reality: the objects exist at different points along the vertical, spatial, axes.

In addition to the dinosaur and the person themselves, some of their **temporal parts** are also represented in the diagram. A temporal part of an object at a time is a temporal cross-section of that object; it is that-object-at-that-time. Consider the temporal part of the person in 2000.  This object is the exact same *spatial size* as the person in 2000. But the temporal part is not the same *temporal size* as the person; the temporal part exists only in 2000 whereas the person exists at later times as well. The person herself is the sum total of all her temporal parts:

 Notice how the person is tapered: the earlier temporal parts (those on the left of the diagram) are smaller than the later ones. This represents the person's growth over time.[1]

In contrast to the ordinary conception of moving or flowing time, then, the space-time theory says that reality consists of a single unified space-time, which contains all of the past, present, and future. Time is just one of the dimensions of space-time, alongside the three spatial dimensions, just as it appears to be in the space-time diagrams. Time does not flow; time is like space.

Well, time isn't *completely* like space. For one thing, there are three spatial dimensions but only one temporal dimension. And time has a special *direction*: past to future. Space has no such direction. We do have words for certain spatial directions: up, down, north, south, east, west, left, right. But these are not directions built into space itself. Rather, these words pick out different directions depending on who says them. 'Up' means away from the earth's center on a line that passes through the speaker; 'North' means toward the Arctic pole from the speaker; 'Left' picks out different directions depending on which way the speaker is facing. In contrast, the past to future direction is the same for everyone, regardless of his or her location or orientation; it seems to be an intrinsic feature of time itself.

Still, according to the space-time theory, time and space are analogous in many ways. Here are three.

First, in terms of *reality*. Objects far away in space (other planets, stars, and so on) are obviously just as real as things here on Earth. We may not *know* as much about the far-away objects as we know about the things around here, but that doesn't make the far-away objects any less real. Likewise, objects far away in time are just as real as objects that exist now. Both past objects (e.g. dinosaurs) and future objects (human outposts on Mars, perhaps) exist, in addition to objects in the present.

[1] Temporal parts are discussed further at the end of Chapter 7.

Distant objects, whether temporally or spatially distant, all exist somewhere in space-time.

Second, in terms of *parts*. Material objects take up space by having different parts. My body occupies a certain region of space. Part of this region is occupied by my head, another by my torso; other parts of the region are occupied by my arms and legs. These parts may be called my spatial parts, since they are spatially smaller than I am. The corresponding fact about time is that an object lasts over a stretch of time by having different parts located at the different times within that stretch. These parts are the temporal parts mentioned above. These temporal parts are just as real objects as my spatial parts: my head, arms, and legs.

Third, in terms of *here* and *now*. If I say on the phone 'here it is raining' to a friend in California, and she replies 'here it is sunny' (Figure 5), which one of us is right? Where is the *real here*, California or New Jersey? The question is obviously misguided. There is no 'real here'. The word 'here' just refers to whatever place the person saying it happens to be. When *I* say 'here', it means New Jersey; when my friend says 'here', it means California. Neither place is *here* in any objective sense. California is here for my friend, New Jersey is here for me. The space-time theory

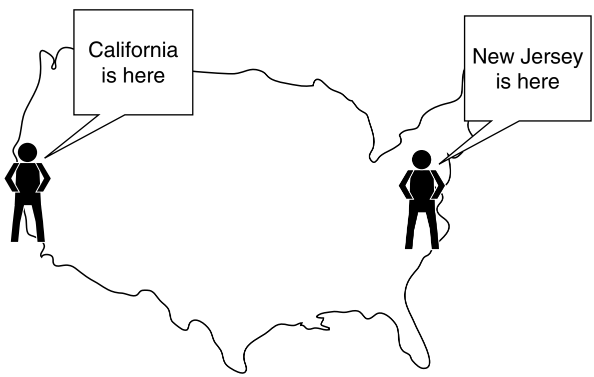


Fig. 5. Where is the 'real here'?

says an analogous thing about time: just as there is no objective here, so there is no objective *now*. If I say 'It is now 2005', and in 1606 Guy Fawkes said 'It is now 1606', each statement is correct (Figure 6). There is no single, real, objective 'now'. The word 'now' just refers to the time at which the speaker happens to be located.

Arguments Against the Space-Time Theory: Change, Motion, Causes

We have met two theories of time. Which is true? Does time flow? Or is time like space?

The space-time theory avoids the paradoxes of time's flow; that counts in its favor. But the believer in time's flow will retort that the space-time theory throws the baby out with the bath-

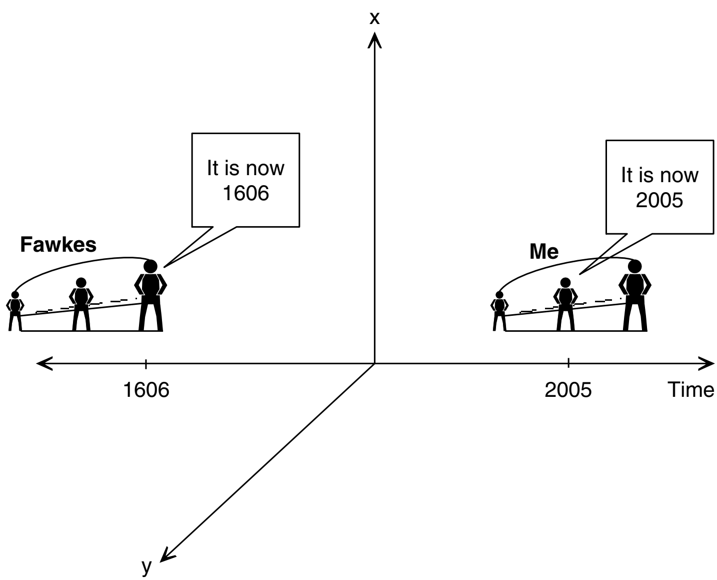


Fig. 6. 'Now' for me and for Guy Fawkes

water: it makes time *too much* like space. For starters, she may say that the alleged analogies between space and time suggested in the last section don't really hold:

> Past and future objects do *not* exist: the past is gone, and the future is yet to be. Things do *not* have temporal parts: at any time, the *whole* object is present, not just a temporal part of it; there are no past or future bits left out. And 'now' is *not* like 'here': the present moment is special, unlike the bit of space around here.

Each of these claims could take up a whole chapter of its own. But time is short, so let's consider three other ways the defender of time's flow might argue that time is not like space. First, regarding *change*:

> Compare change with what we might call 'spatial heterogeneity'. Change is having different properties at different times. A person who changes height starts out short and then becomes taller. Spatial heterogeneity, in contrast, is having different properties at different *places*. A highway is bumpy at some places, smooth at others; narrow at some places, wide at others. Now, if time is just like space, then having different properties at different times (change) is no different from having different properties at different places (spatial heterogeneity). Look back at the space-time diagram. Change is variation from left to right on the diagram, along the temporal axis. Spatial heterogeneity is variation along either of the two spatial dimensions. The two are analogous, according to the space-time theory. But that's not right! Spatial heterogeneity is wholly different from change. The spatially heterogeneous highway doesn't *change*. It just sits there.

Second, regarding *motion*:

> Things can move any which way in space; there's no particular direction in which they are constrained to travel. But the same is not true for time. Moving back and forth in time makes no sense. Things can only travel forward in time.

Third, regarding *causes*:

> Events at any place can cause events at any other place; we can affect what goes on in any region of space. But events can't cause events at just any other time: later events never cause earlier events. Although we can affect the future, we cannot affect the past. The past is fixed.

The first objection is right that the space-time theory makes change somewhat similar to spatial heterogeneity. But so what? They're not *exactly* the same: one is variation over time, the other is variation over space. And the claim that change and spatial heterogeneity are *somewhat* similar is perfectly reasonable. So the first objection may be flatly rejected.

The second objection is more complicated. 'Things move back and forth in space, but not back and forth in time'—is this really a disanalogy between time and space? Suppose we want to know, for a certain true statement about space, whether the analogous statement is true of time. The twentieth-century American philosopher Richard Taylor argued that we must be careful to construct a statement about time that really is analogous to the statement about space. In particular, we must *uniformly reverse ALL references to time and space* to get the analogous statement. And when we do, Taylor argued, we will see that time and space are more analogous than they initially seemed.

To illustrate. Our true statement about space is this:

> Some object moves back and forth in space.

Before we can reverse the references to time and space in this statement, we need to locate all those references, including any that are not completely explicit. For instance, the word 'moves' conceals a reference to time. When these references are made explicit, our statement becomes:

> *Moving back and forth in space*: Some object is at spatial point p_1 at time t_1, point p_2 at time t_2, and point p_1 at time t_3.

(See Figure 7.) Now we're in a position to construct the analogous statement about time—to reverse *all* references to time and space. To do so, we simply change each reference to a time into a reference to a point in space, and each reference to a point in space into a reference to a time. This is what we get:

> *Moving back and forth in time*: Some object is at time t_1 at spatial point p_1, time t_2 at point p_2, and at time t_1 at point p_3.

And we get the graph for this new statement (Figure 8) by swapping the 'Time' and 'Space' labels on the Figure 7.

Our question now is: is this second statement correct? Can an object 'move back and forth in time' in this sense? The answer is in fact *yes*, for a fairly humdrum reason. To make this easy to see, let's make the 'moving back and forth in time' graph look like our earlier diagrams by flipping it so that its temporal axis is horizontal (see Figure 9). It should be clear that the diagram represents an object that is first, at t_1, located at *two* places, p_1 and

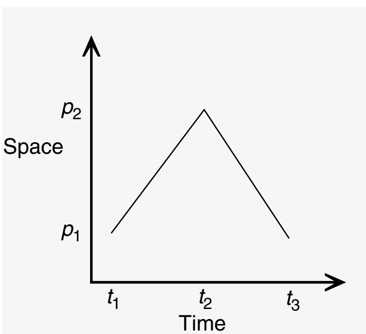


Fig. 7. Moving back and forth in space

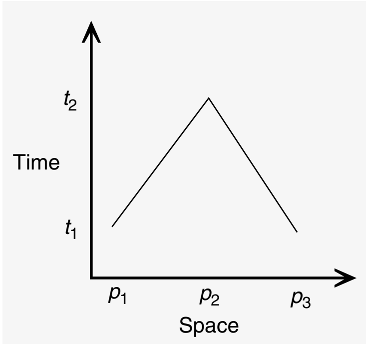


Fig. 8. Moving back and forth in time, temporal axis vertical

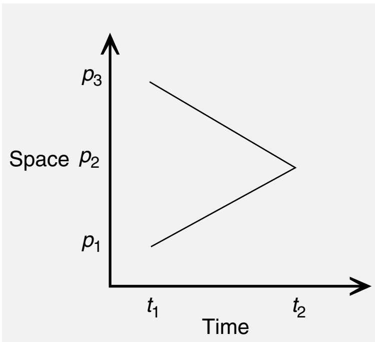


Fig. 9. Moving back and forth in time, temporal axis horizontal

p_3, and then, at t_2, is located at just one place, p_2. This sounds stranger than it really is. Think of a clapping pair of hands. At first the two hands are separated—one is located at place p_1, the other at p_3. Then the hands move toward each other and make contact. The pair of hands is now located at place p_2. Finally, suppose the pair of hands disappears at time t_2. This kind of scenario is what the diagram is representing.

So things *can* 'move back and forth in time', if that statement is understood as being truly analogous to 'moving back and forth in space'. We were deceived into thinking otherwise by neglecting to reverse *all* references to time and space. The statement ‘things move back and forth in space’ contains an implicit *reference dimension*, namely time, for it is with respect to time that things move in space. When we construct the statement ‘things move back and forth in time’, we must change the reference dimension from time to space. When we do, the resulting statement is something that can indeed be true.

The third objection is the most challenging and interesting. It is true that we do not actually observe ‘backwards causation’, that is, the causation of earlier events by later events. This represents a *de facto* asymmetry between space and time—an asymmetry in the world as it actually is. But a deeper question is whether this asymmetry is built into the nature of time itself, or whether it is just a function of the way the world happens to be. The question is: *could* there be backwards causation? *Could* our actions now causally affect the past?

If time is truly like space, then the answer must be *yes*. Just as events can cause events anywhere else in space, so too events can in principle cause other events anywhere in time, even at earlier times. But this has a very striking consequence. If backwards causation is possible, then *time travel*, as depicted in books and movies, ought to be possible as well, for it ought to be possible to cause ourselves to be present in the past.

Time travel may never *in fact* occur. Perhaps time travel will never be technologically feasible, or perhaps the laws of physics prevent time travel. Philosophy cannot settle questions about physics or technology; for speculation on such matters, a better guide is your friendly neighborhood physicist or engineer. But if time is like space, there should be no prohibition *coming from the concept of time itself*: time travel should at least be conceptually possible. But is it?

A familiar kind of time travel story begins as follows: ‘In 1985, Marty McFly enters a time machine, sets the controls for 1955, pushes the button, waits, and then arrives in 1955 . . . ’ Any time travel story must contain this much: the use of some sort of time travel device and subsequent arrival in the past. But even this much seems to conceal a contradiction. The troublesome bit is the end: 'and *then* arrives in 1955'. The suggestion is that McFly *first* pushes the button, and *second* arrives in 1955. But he pushes the button in 1985, which is *after* 1955.

This is an example of a so-called paradox of time travel. One attempts to tell a coherent story involving time travel, but ends up contradicting oneself. Saying that McFly arrives in 1955 both after and before he pushes the button is contradicting oneself. And if there is no way to tell a time travel story without self-contradiction, then time travel is conceptually impossible.

This first paradox can be avoided. Is the arrival after or before the pushing of the button? *Before*—1955 is before 1985. What about 'and *then*'? Well, all that means is that McFly *experiences* the arrival as being after the button-pressing. Normal people (i.e. non-time travelers) experience events as occurring in the order in which they truly occur, whereas time travelers experience things out of order. In the sequence of McFly's experiences, 1985 comes before 1955. That's a very strange thing, to be sure, but it does not seem conceptually incoherent. (What determines the order of McFly's experiences? Later members of the sequence of his experiences contain memories of, and are caused by, earlier members of the sequence. When McFly experiences 1955, he has memories of 1985, and his 1985 experiences directly causally affect his 1955 experiences.)

Yet a more potent paradox lurks. Let's continue the story from *Back to the Future*: 'Back in 1955, the dashing McFly inadvertently attracts his mother, overshadowing his nerdy father. As the union of his parents becomes less and less likely, McFly begins to fade away into nothingness.' The problem is that a time traveler could undermine his own existence. He could cause his parents never to meet; he could even kill them before he is ever born. But then where did he come from? Back to paradox!

That McFly begins to fade away into nothingness shows that the writers of *Back to the Future* were aware of the problem. But the fade-out solves nothing. Suppose McFly fades out completely after preventing his parents from meeting. He still existed before fading out (it was he, after all, who prevented his parents from meeting). Where then did he come from in the first place? Whatever its literary merits, as a work of philosophy *Back to the Future* fails miserably.

Let's not be too hard on careless screen-writers and authors. (We can't all be philosophers.) Though it's not easy, paradox-free time travel stories can be told. The movie *Terminator* is an excellent example (spoilers included):[2]

> In the future, machines take over the world and nearly destroy the human race. But the machines are eventually thwarted by the human leader John Connor. On the verge of defeat, the machines fight back by sending a machine, a 'Terminator', back to the past to kill John Connor's mother, Sarah Connor, before John is born. John Connor counters by sending one of his men, Kyle Reese, back to the past to protect Sarah Connor. The Terminator nearly succeeds, but in the end Reese stops him. (Reese dies, but not before impregnating Connor's mother, Sarah Connor. The baby, we later learn, grows up to be John Connor himself!)

This story never contradicts itself. It would if the Terminator killed Sarah Connor, since we are told in the beginning of the story that Sarah Connor lived and had a son, John Connor,

[2] *Terminator 1*, that is. *Terminator 2* appears to be incoherent. It says in the beginning that Cyberdyne systems learned the technology behind Skynet by studying the hand of the corpse of a T-800 Terminator from the future. Then at the end, after the T-800 is melted (Schwarzenegger's thumbs-up to Furlong), the movie suggests that Skynet is never created and Judgment Day is avoided. Where then did the time-traveling Terminators come from? *Terminator 3* does better: it never suggests that Judgment Day is avoided. Yet there are remaining questions, for instance about the true date of Judgment Day. *Terminator 1* is by far the best of the three, from a philosophical (as well as cinematic) point of view.

whose future exploits are the cause of the presence of the Terminator in the past. But since Sarah Connor survives, the story remains consistent.

The failure of *some* time travel stories (such as *Back to the Future*) to remain consistent shows nothing, since other consistent stories can be told. The similarity of time and space has survived: there is no conceptual impossibility with backwards causation and time travel.

There are numerous close calls in *Terminator*. Again and again, Sarah Connor narrowly escapes death. It would appear that on any of these occasions, she could easily have died. Yet we know that she must survive, because her son is John Connor. So it seems that she is not really in danger; she cannot die. But there is the Terminator in front of her. The danger seems very real. Back into paradox?

Not at all. What is strange about a time travel story is that we are told the end of the story first. We, the audience, learn early on that John Connor exists in the future. Later we find his mother endangered before he is ever born. We, the audience, know she will survive (if we trust the screen-writers to be consistent!), but that does not mean that *in the story* her danger is unreal.

A very peculiar thing arises when the time traveler himself knows how the story will end. Think of Reese. He knows that the Terminator will fail, since he knows that John Connor exists: it was Connor that sent him back to the past. Yet he fears for Sarah Connor's life, works hard to protect her, and in the end gives his life to save her. Why doesn't he just walk away and save himself? He *knows* that Sarah Connor is going to survive.

Or does he? He *thinks* he remembers serving a man called John Connor. He *thinks* he remembers Connor defeating the machines. He *thinks* Connor's mother was named Sarah. He *thinks* this woman he's defending is the same Sarah Connor. He *thinks* this woman has not yet had children. So he's got lots of evidence that this woman he's defending will survive. But then he sees the

Terminator advance. He sees it effortlessly killing everyone in its path, searching for someone named Sarah Connor. Now it advances on the woman he's defending. It raises its gun. Reese's confidence that this woman will survive now wavers. Perhaps she is not John Connor's mother after all. Or, if he's sure of that, perhaps she's already had a child. Or, if he's quite sure of that, perhaps he's made some other mistake. Perhaps all of his apparent memories from the future are delusions! Such self-doubt is ordinarily far-fetched, but it becomes increasingly reasonable with each step of the Terminator. As certain as he once was that Sarah Connor will survive, he has become equally certain about the danger presented by the Terminator: 'It can't be bargained with! It can't be reasoned with! It doesn't feel pity, or remorse, or fear. And it absolutely will not stop, ever, until you are dead!' He thinks 'I'd better be sure.' He raises his gun.

FURTHER READING

Peter van Inwagen and Dean Zimmerman (eds.), *Metaphysics: The Big Questions* (Blackwell, 1998): this anthology contains a number of readings on time (as well as readings on many other metaphysical topics.) Some highlights: 'Time', by J. M. E. McTaggart, makes the shocking claim that time is unreal! Two articles by A. N. Prior argue against the space-time theory. 'The Space-Time World', by J. J. C. Smart, defends the space-time theory. 'The Paradoxes of Time Travel', by David Lewis, argues that time travel is possible.

This article by Richard Taylor lays out a fascinating series of analogies between space and time: 'Spatial and Temporal Analogies and the Concept of Identity', *Journal of Philosophy*, 52 (1955), 599–612.

In addition to the conceptual issues about time travel discussed in this chapter, there are many interesting scientific issues as well. The following article is available online: Frank Arntzenius and Tim Maudlin, 'Time Travel and Modern Physics', http://plato.stanford.edu/entries/time-travel-phys/