

## CHAPTER 9

# *The Cinematic Universe*

... history is a pattern  
Of timeless moments.

T. S. Eliot, 'Little Gidding'

### **Muybridge's Horse and Zeno's Arrow**

Has photography changed the way we think about time? More particularly, has it affected our view of change and motion? Early photographic processes involved long exposure times, and so the first photographs tended to be still lifes, such as Fox Talbot's 'The Open Door', which depicted a broom leaning against a doorway at his home, Lacock Abbey in Wiltshire. But, as the technique developed, photographs gradually became 'snapshots'. By the 1870s, cameras were capable of taking photographs with exposure times of a thousandth of a second or less. This allowed the American photographer Eadweard Muybridge to undertake a series of studies of animal movement. (His original name was Edward Muggeridge, but he later adopted an 'Anglo-Saxon' spelling.) The most famous of

these, published in his *Human and Animal Locomotion* in 1878, was a series of stills of a galloping horse, Occident, who belonged to the one-time Governor of California, Leland Stanford. Muybridge succeeded in capturing on film the different positions of Occident's legs during the gallop, thus showing for the first time that the conventional representation in paintings of galloping horses, with all four legs off the ground, was mistaken. Similar studies of locomotion were undertaken around the same time by the French physiologist Etienne Marey, who described his technique as '*chronophotographie*'. Photography had reduced motion to a series of stills—images in which the object is frozen in the posture it adopts at an instant of time. Continuous motion is lost, although, as the inventors of cinematography discovered, the experience of such motion may be induced by projecting those stills in rapid succession onto a screen.

That 'real' motion is similarly an illusion is the conclusion of the third of Zeno's paradoxes, known as the *Arrow*. The Arrow is quite different from the other paradoxes of Zeno we have discussed. For one thing, it does not, at least very evidently, invoke the notion of infinite divisibility. In fact, there is, as we shall see, a closer connection with the topic of the previous chapter, on the notion of the present, than with infinity. The gist of the paradox is this: when we look carefully at what motion is, we find just a series of states in which the moving object simply occupies a position in space. None of these states individually counts as motion, and yet, when we have described each state, there is nothing left over to describe about the motion. Motion itself thus seems to have disappeared. Zeno's descriptive deconstruction of motion is like Muybridge's photographic deconstruction: both present us with an idea of motion that is quite unlike our ordinary experience of it, and we realize that the way the world appears to us may be no less a product of our minds than the motion of figures on the cinema screen. But before giving in to such an assault on our ordinary beliefs, however, we should look in detail at the structure of Zeno's paradox.

### No Motion at an Instant?

The Arrow can be presented in different ways, and we shall look at no less than three versions of it in this chapter. What was Zeno's original conception? Here, again, we have to rely on later commentators, perhaps the most helpful being Simplicius. This is his account of the paradox:

The flying missile occupies a space equal to itself at each instant, and so during the whole time of its flight; what occupies a space equal to itself at an instant is not in motion, since nothing is in motion at an instant; but what is not in motion is at rest, since everything is either in motion or at rest: therefore the flying missile, while it is in flight, is at rest during the whole time of its flight. (Lee 1936, 53)

For 'missile' we will substitute, as everyone does, an arrow. What is meant by 'occupies a space equal to itself at each instant'? Presumably, that the arrow fills a volume of space equal to its own volume. How, we wonder, could any object do otherwise, whether moving or not? Perhaps the idea is this. We could think of the arrow marking out a region of space as it moves, rather like the vapour trail behind an aeroplane. The region of space thus marked out will be greater than the volume of the arrow. But, in an instant, an object can only mark out a region of space equal to its own volume, and so cannot be moving in that instant. (But is it therefore not moving *at* an instant? We take a look at the distinction between 'in' and 'at' an instant in the next section.)

Let us set the argument out more explicitly. It looks somewhat like this:

#### *The Arrow: first version*

1. If the arrow moves throughout the period of its flight, then it moves at each instant of that period.
2. The arrow occupies a space equal to its own volume at each instant.

3. If the arrow occupies a space equal to its own volume at an instant, then it is not in motion at that instant.

*Therefore* (from 2 and 3):

4. The arrow is not in motion at any instant of the period.

*Therefore* (from 1 and 4):

5. The arrow does not move throughout the period of its flight.

Everything depends here on what we mean by ‘instant’. For premiss (2) to be at all plausible, we need to interpret this as an *indivisible* point of time, not further resolvable into smaller items. If there can be nothing smaller than an instant, then whatever takes place at an instant cannot be differentiated into distinct states obtaining in smaller moments. It is because the instant is indivisible that the arrow cannot move at an instant, for motion involves occupying different positions. So any time at which the arrow is moving is divisible into distinct parts: the part where the arrow occupies just *this* position, the part where it occupies just *that* position, and so on. But an instant is not so divisible.

As a way of making (4) seem more plausible, imagine some omnipotent deity who decides to bring a world into being—but only for a single instant. Can there be change in such a world? Surely not, for there would be no time in which change could occur.

Aristotle, who discusses the Arrow along with Zeno’s other paradoxes of motion in the *Physics*, has this, rather terse, objection: ‘[the conclusion] follows from the assumption that time is composed of moments: if this assumption is not granted, the conclusion will not follow’ (*Physics* 239<sup>b</sup>30–3). The premiss this observation is most relevant to is (1), since one could defend (1) on the basis that there is nothing to a period other than the instants within it, and what is true of the period must therefore be true of every instant within it. But this defence is suspect whether or not we suppose time to be composed of instants. For what is true of the whole may not be true of its parts. For example, this wardrobe is 7 foot tall, but none of the individual pieces of wood from which it is made is 7 foot tall. Or, to

take a temporal case, the concerto lasted 40 minutes, but none of the movements which comprise the concerto lasted that long. Perhaps, then, we should present (1) as an application of the following principle:

If an object has a certain property throughout a period of time then that object has that property at every instant of the period.

Now, clearly, for most properties, this principle is perfectly acceptable: green, cubic, composed of copper, at 10 °C, being someone's uncle, being 2 miles from Puddingdale, reflecting light, being thought about, etc. (1), then, will only be vulnerable if there is any good reason to doubt that the general principle above applies to the property of *being in motion*.

Why does Aristotle suppose the Arrow to depend on the premiss that time is composed of instants? As we have just seen, it is possible to defend (1) without recourse to such an assumption, and indeed explicit appeal to it would invite the charge of fallacy. Now it may be that Aristotle takes Zeno to be making a fairly obvious blunder, but there is a more interesting possibility.

One rather obvious assumption of the Arrow is that there are such things as instants, not simply as a useful idea, but as independently existing entities, for there to be truths about what is the case at those instants. But this assumption may have some rather surprising consequences. Let us imagine that the indivisible instants of time at which the Arrow occupies a space just its own size have a small, but non-zero duration. Then periods of time would be composed of such 'time atoms', an idea we first encountered in Chapter 7, and the number of such atoms in a period would determine its length (assuming that each atom has the same duration). Time atoms would be the fundamental unit from which periods were built up. Time atoms just are instants, so this picture of time raises no difficulties for the Arrow's assumption that there are instants. But now suppose instead that time is not discrete (composed of time atoms) but continuous, so that each period of time were indefinitely divisible. What implications would

this have for instants? Although time is continuous, we can attempt to avoid the consequence that would appear to flow from this, namely that each period contains an infinite number of instants, by the assumption of *finitism*. Nothing is *actually* infinite (there is no infinitely large object, for example), but only *potentially* infinite (see Chapters 6 and 7 for a discussion of this distinction). So a length is infinitely divisible only in the sense that, however many divisions you have made, you can always make more. The process of dividing has no limit. But the divisions do not exist independently of our making them, so the potentially infinite divisibility of a length does not imply the actual existence of an infinite number of divisions within that length. And as with length, so with time: a period of time is infinitely divisible, but only potentially so. Durationless instants do not exist independently of their being marked in some way. This view of the divisibility of space and time, as we saw in Chapter 7, provides Aristotle with an answer to two other Zenonian paradoxes of motion, the Dichotomy and the Achilles. Both paradoxes start from the assumption of the continuity of time and space, and derive the unpalatable conclusion that motion involves achieving the impossible: the traversal of an infinite number of subdistances in a finite length of time. Aristotle dissolves the paradoxes by denying that divisions have any independent existence. Admittedly, Aristotle only explicitly applies this to spatial divisions, but the same reasoning leads to a similar conclusion concerning temporal divisions.

This leads us to the following conjecture: Aristotle, quite correctly, takes the Arrow paradox to depend on an assumption about instants: that they really exist. But he takes this assumption to imply the existence of time atoms, i.e. tiny intervals of time that have non-zero duration but are nevertheless indivisible, which he expresses as the view that time is composed of instants. So attributing to Zeno the premiss that time is composed of instants is simply an expression of the fact that the Arrow depends on the real existence of instants. Given that time is continuous, however, instants do not have the independent existence required for the Arrow to work.

Whether or not this reconstruction of Aristotle's thinking holds water, it is certainly true that a number of commentators have attributed an atomistic premiss to Zeno. There is something attractive about the suggestion. For one thing, it presents a pleasingly symmetrical picture of the overall dialectic of Zeno's four famous paradoxes of motion. The Dichotomy and Achilles show that motion is impossible if space and time are continuous; the Arrow and Stadium show that motion is impossible if space and time are discrete. Since motion is impossible without time, and time must either have a discrete or continuous structure, motion is impossible.

Well that is just a suggestion. I do not press it too strongly, as it could be argued that Aristotle's conception of the potential-actual infinite distinction only conflicts with infinite numbers of spatial points, not infinite numbers of instants. Given Aristotle's conception of the actual infinite as that which exists *all at once*, a continuum of real spatial points would count as an actual infinite by this definition, whereas a continuum of temporal points would not, as the points are successive and not simultaneous. So perhaps Aristotle's finitism would allow the existence of instants even if time were infinitely divisible. What really matters is that an instant is indivisible, whether or not it is conceived as having duration (as in the picture of time as composed of time atoms) or durationless. It is because an instant is indivisible that there can be no motion within it.

There is another problem, however: why should we take the existence of indivisible instants seriously, when we can say everything we want to say about time by talking only of intervals (including, where necessary, infinitely small intervals)? Well, there is one instant at least whose existence is hard to impugn: the present moment. In the next section, we will see what happens to Zeno's Arrow when we build reference to the present into it.

Perhaps the most effective answer to the first version of the Arrow is to produce an account of motion that is both plausible and which undermines at least one of the premisses. So what is motion? The obvious answer defines motion as follows: motion consists just in an

object's occupying different places at different times. After all, is this not exactly what Muybridge's photographic study of animal locomotion revealed? This approach to motion we will call, following Bertrand Russell, the *static account of motion*. Now the Arrow seems to depend on this view of motion, implying as it does that an object can only occupy a position in space at any one instant. But, ironically, the static account of motion also appears to undermine the Arrow. There are two ways in which one might expand on this point. One is to say that the static account falsifies premiss (1). We could concede that there is no such thing as motion (or indeed change in general) at an instant, but merely the occupancy of a particular position (or state), and insist that motion is attributable to an object only over a period of time. By analogy, an extended object may be 10 foot wide without it being true that it is 10 foot wide at every indivisible spatial point (what would it mean to say that it is 10 foot wide *at a point*?). This is Russell's response to the Arrow (Russell 1903, 467–73). It is a rather surprising response, however, since there is a kind of motion that seemingly obliges us to talk of motion at an instant, namely *acceleration*. If an object accelerates continuously through a period, it surely has a different velocity at each successive instant. One could, perhaps, insist that this is merely a theoretical abstraction, but it would have to go hand in hand with the view that instants themselves are theoretical abstractions. A much more plausible approach takes our analysis of motion to undermine premiss (3). There is no need to deny that objects can move at an instant, but they do so only in a derivative sense. An object is in motion at an instant if (and only if) it occupies different positions at times immediately preceding and/or immediately succeeding that instant. What is true at an instant thus depends in part on what is true at *other* times. So from the indisputable fact that an object necessarily occupies a space just its own size at an instant it does not follow that an object cannot be in motion at an instant. By analogy, the shape of an object depends on its individual constituents, but they are not required to have the same shape as the whole object. The full account of motion, then, looks like this:

*The static account of motion.* An object is in motion throughout a period if and only if the object occupies different positions at every instant of that period; it is in motion at an instant if and only if it occupies a different position at instants immediately before and after that instant.

The game is not yet up for Zeno, however, for we can provide another reconstruction of the Arrow, one that brings out the limitations of the static account of motion.

### No Motion in the Present?

When Aristotle discusses the Arrow, he uses the phrase *εν τῷ νυν*. This can be translated either as ‘in an instant’ or ‘in the now’. The second translation opens up the interesting possibility that it is the *present* moment and not merely some arbitrary instant, that is the key idea in the Arrow. Now, assuming time to be infinitely divisible, the present can have no duration at all, for if it did, we could divide it into parts, and some parts would be earlier than others. But something that is present cannot be earlier than anything else that is also present! So the present cannot have earlier and later parts, which is to say that it can have no duration. So, using the slightly more idiomatic phrase ‘in the present’ for ‘in the now’, substituting this phrase in place of ‘at an instant’ in the first version of the Arrow, and simplifying the argument somewhat, we obtain the following:

#### *The Arrow: second version*

1. If the arrow moves throughout the period of its flight, then, when it moves, it moves in the present.
2. The arrow is not in motion in the present.

*Therefore:*

3. The arrow does not move throughout the period of its flight.

Recall one objection to the first reconstruction of the Arrow: that we could avoid talk of indivisible instants altogether in favour of

intervals, and in so doing make irrelevant the alleged fact that nothing moves at an instant. But turning the focus of the argument onto the present moment explains why the moment in question must be an indivisible instant and not a period. For if the present were divisible into different parts, some would be earlier than others, and so not present. But every part of the present must itself be present, which is to say, of course, that the present has no earlier and later parts.

Another feature of this version is that it talks, not of what is happening *at* the present, but *in* the present (this being the literal translation of  $\epsilon\nu$  to  $vuv$ ). This certainly makes the premisses somewhat more plausible, for we could happily concede that nothing moves *in* (i.e. within the space of) the present. It is not immediately obvious how this helps, however, because we could still insist that the crucial question is what is true of the arrow *at* an instant, and the static account of motion allows us to say of the arrow that it is moving *at* an instant of time. It moves *at* an instant by virtue of that instant being part of a period *in* which the arrow is continuously in motion.

Nevertheless, the second version does represent a significant advance on the first. The most powerful objection to the first reconstruction was provided by the static analysis of motion: something moves in an instant by virtue of its position both at that instant and at other times. So talk of motion at an instant is derivative: its truth depends on what is happening over a period of time. It is this move that is challenged by the second version of Zeno's paradox. For what is true in the present should not be *derivative*, but *fundamental*. It is the privileged status of the present that insulates present fact from past and future fact. The static analysis of motion makes expressions like 'moves in the present' temporally hybrid, turning what purports to be a simple statement about the present into a complex statement about past, present, and future. But, we may imagine the champions of the present arguing, 'the arrow moves in the present' is a simple statement about the present, and should not be taken as elliptical for something else.

But in what sense is the present special? And should its special status imply anything about the nature of change and motion? Before answering these questions, however, we should consider whether there is a plausible alternative to the static account of motion, one that does justice to the intuition that ‘the arrow moves in the present’ is a simple assertion about what is presently the case. The static account of motion, in a nutshell, goes as follows: An object moves at a time by virtue of its position at that time *and* its position(s) at other times. The contradictory of this should be something like the following:

*The dynamic account of motion:* an object’s motion at a time is independent of the object’s position at other times.

Perhaps so bald a statement does not merit the title of ‘account’. Something, certainly, needs to be said to make it intelligible how the motion of an object at a time can be independent of what is happening at other times. Here are two ways we could spell out what is going on (are there any others?):

- (i) It is an intrinsic property of an object that it is in motion at a particular time, the property in question being a disposition of the object to be elsewhere than the place it is. (An *intrinsic property* of an object being one that the object has independently of the existence or properties of other objects.)
- (ii) Events, including those involving motion, are primitive, not decomposable into series of states. Similarly, intervals are primitive, not decomposable into series of instants. So talk of ‘motion at a time’ must always be interpreted as motion in an interval, however small.

Account (i) falls victim to the following counterexample: a stationary object is struck by a rapidly moving one, after which it begins to move. Though the object is *disposed* to be elsewhere at the moment of impact, as a result of its being subjected to a force at that moment, we would count that moment as the last moment of rest,

rather than the first moment of motion. (i) would also conflict with the (more contentious) relationist assertion that constant motion is always relative to some other object or objects.

We are left, then, with (ii). It certainly undermines the first version of the Arrow, because it gives us a reason to reject the first premiss. Does it undermine the second? Let us reserve judgement for the time being, and return to the questions we raised earlier. What is it about the present that is special? And what effect does it have on our understanding of motion?

### Zeno and the Presentist

In the previous chapter, we introduced two different conceptions of time and the universe. One conceives of the universe as an *A-universe*, namely one in which time passes, and in which A-series facts (that, e.g. the party is going on now) are more fundamental than B-series facts (that the party OCCURS later than the Ascot races). The other conceives of the universe as a *B-universe*, namely one in which time does not pass, and in which there exist only B-series facts, these being the facts that make A-series statements ('Claudius ruled the Roman Empire two millennia ago') true. Now, clearly it is on the A-universe view that the present is special, indeed unique. The B-universe view simply relegates terms like 'now' and 'present' to the status of indexical terms like 'here' and 'I'. Unfortunately, the A-universe view, as we saw, is threatened by McTaggart's paradox, and the obvious (perhaps the only) way out for the A-universe proponent is to adopt presentism, the view that only what is present is real. One way of expressing presentism is to say that all facts are present facts. This strongly suggests that what *was* and *will be* the case obtains only by virtue of what is now the case. (Suggests, but perhaps does not entail. On the other hand, what other account could the presentist give of what makes true statements about past and future? At any rate, in what follows, I shall take 'presentism' to

refer to the theory that holds present fact to be the truth-makers of statements about past and future.)

Presentism, then, provides an account of what makes the present special, and indeed explains why motion, when it occurs, should occur in the present. For every aspect of reality is necessarily an aspect of *present* reality, so if motion is real, it must take place in the present. This now may help to explain what is suspect about the static account of motion, for if motion is pure and simply a present fact, it cannot depend on what is happening at *other* times. We have to be careful here, however. For presentism, although it rejects past and future fact, conceived of as parts of reality, allows for the truth of statements about past and future. (Assuming, of course, that the worries raised in the last chapter can be met, and the presentist can give a consistent account of the mechanism whereby statements about past and future can be made true by present fact.) The presentist, then, can allow that the arrow was in a different position from the one it now occupies, but has to insist that this is made true by present fact. So one set of present facts makes true ‘the arrow was at  $s_1$ ’, another set makes true ‘the arrow is at  $s_2$ ’, and yet another set ‘the arrow will be at  $s_3$ ’, where  $s_1$ ,  $s_2$ , and  $s_3$  name different locations in space. So it seems, after all, as if present fact can, in principle, make it true that the arrow is moving, even when we understand motion in terms of the static analysis.

But there is a remaining problem for any attempt to reconcile presentism with the static analysis of motion, and it has to do with the extent to which the present is capable of making determinate past states of affairs. As we saw in the last chapter, the presentist needs to assume that only one past is compatible with how things are at present. But even with this assumption, since presentism confines reality to a single, durationless point, it cannot build into the description of how things are now any reference to motion, for this (assuming the truth of the static analysis) imports states at times other than the present. All that is available to the presentist is the position of objects, their various states, and the forces acting upon those

objects. Is this enough to determine earlier and later positions? Consider the following two cases:

- (i) The absolutist conception of space as an entity existing independently of its contents is correct. Consequently, there is such a thing as absolute motion (this being simply motion relative to space itself). Now consider a universe of objects in absolute, but not relative, unidirectional and non-accelerating motion, and on which no forces are acting to disturb their uniform motion. Can the position of those objects at any one time determine earlier and later positions? No, for the position of the objects at any one time gives one no information about the *direction* of motion, and there are no forces that determine that direction.
- (ii) The relationist conception of space is correct, and all motion is relative to other contents of space. Now consider a (relatively simple) universe in which the forces on certain objects at a particular moment cancel each other out, so there is no resultant force on those objects in any one direction. Can the state of the objects at that moment determine their earlier and later positions? No, for the same reasons given under (i).

So, whether one is an absolutist or a relationist about space, there are situations in which present fact is simply not enough to determine whether objects *were* or *will be* in different positions from the ones they currently occupy. But on the static account of motion, whether something is now in motion depends precisely on what its past, present, and future locations are. So, in these situations, a combination of presentism and the static account of motion just leaves it indeterminate whether the objects in question are in motion or not. It seems, then, that it would be wise for the presentist to reject the static account of motion, and accept the dynamic account. And this, after all, is precisely what we would have expected.

Now, according to the version of the dynamic account which we were left with at the end of the last section, an object's being in motion is a primitive event, not further analysable in terms of

objects, properties, and times. Now for these primitive events to exist, on the presentist reading, they must be capable of existing in the present. But events, being changes, are not instantaneous items: they take up time. So, at best, what exists in the present are *parts* of events. The idea of events having parts that are not themselves events, however, conflicts with the primitive status of events. To the question, what are these parts? the obvious answer seems to be: instantaneous states of an object. Presentism is therefore incompatible with the suggestion that events are primitive, unanalysable entities. And this is very bad news for the presentist, for that means it conflicts with the dynamic account of motion, and we have just given reasons why presentism should reject the static account.

Making use of these insights, we can now present our third and final version of the Arrow, as follows:

*The Arrow. third version*

1. If motion is possible, then either the static or the dynamic account is the correct account of it.
2. If presentism is true, the static account of motion is false.
3. If presentism is true, the dynamic account of motion is false.  
*Therefore:*
4. If presentism is true, motion is impossible.

We suggested at the end of the last chapter that if the universe were a B-universe, this would raise certain difficulties concerning our understanding of change. It seems we can now draw a similar conclusion about the A-universe. For, although the Arrow is specifically about motion, it is an easy matter to adapt it so that it concerns change in general. And if presentism is the only way for the A-theorist to avoid McTaggart's paradox, then, since the presentist has difficulty in accounting for change, it is not clear how we can accommodate change in an A-universe.

The problem is further compounded for that view of time, discussed in Chapter 2, which regards time as a series of changes. For if

only the present can be real, time just is change, and change cannot occur in the present, does it not follow that time itself is unreal?

#### Questions

What is the smallest period of time possible? How far could something move in that period?

Does a moving object move *in the present*?

If only the present exists, and change must take time in order to happen, is change real?

## CHAPTER IO

# *Interfering with History*

Do not be afraid of the past. If people tell you that it is irrevocable, do not believe them.

Oscar Wilde, *De Profundis*

### **The Lost Days**

In the September 1752 issue of *The Gentleman's Magazine*, a monthly periodical offering a diverting mixture of news, book reviews, recipes, advice, and poetry, there appeared a rather unusual letter. The correspondent reported an unsettling experience he had just had:

I went to bed last night, it was Wednesday Sept. 2, and the first thing I cast my eye upon this morning at the top of your paper, was Thursday, Sept. 14.

As the author explained, having until recently been in the West Indies, he had been unaware, until the fact had caught him out, that Parliament had at last consented to move from the Julian ('Old Style') to the Gregorian ('New Style') calendar. The correction

required the removal of 11 days, so 3 September to 13 September, 1752 had been ruled out of existence. This had some amusing consequences, as the correspondent went on to explain:

I used to laugh at a man of my acquaintance for having a birth day but once in three years, because it fell on the *29th of February*: he laid me a considerable wager one of these nights, that I should lose a birth day some year or other as a punishment for my mockery. He was drunk when he made the proposal, but I little thought I should live to see it demanded. Sir, I am born the *13th day of September*.

And now the tone becomes rather aggrieved (though no doubt with tongue-in-cheek):

But must I confess the fatal truth to you. Sir, I have solicited the most amiable of her sex these five weeks: she seemed for a long time only to laugh at me, though my fortune is equal to her own: at last, Sir, she fixed the day, for the tenth of *September*, and gave me a bond of ten thousand pounds for the performance. I have consulted my lawyer; he is now at breakfast with me: and he says it will not do for next year, because the date 1752 is fixed to it: and so my ten thousand pounds are not worth ten pence. A fine affair, Sir, that a man must be cheated out of his wife by a parcel of *Mackmaticians* (sic) and *almanack makers*, before he has her: a new sort of divorce, truly.

Another correspondent, this time to Samuel Johnson's periodical *The Rambler* (for 26 March 1751) saw interesting possibilities in the change:

I think the new stile is a delightful thing; for my mamma says I shall go to court when I am sixteen, and if they can but contrive often to leap over eleven days toget'ier, the months of restraint will soon be at an end. It is strange, that with all the plots that have been laid against time, they could never kill it by act of parliament before. Dear Sir, if you have any vote or interest, get them but for once to destroy eleven months, and then I shall be as old as some married ladies . . . nothing surely could please me like a year of confusion, when I shall no longer fix this hour to my pen, and the next to my needle, or wait at home for the dancing-master one day, and the next for the musick-master; but run from ball to ball, and from drum to drum; and spend all my time without tasks, and without account, and go without

telling whither, and come home without regard to prescribed hours, or family-rules.

I am, Sir  
Your humble Servant,  
PROPERANTIA

Not everyone took the change in such a light spirit. In many other European countries, the change had been made some 170 years earlier, on the recommendation of Pope Gregory, from whom the new calendar took its name. It would have been made in England at the same time, as Queen Elizabeth was in favour of it, had it not been opposed by the Archbishop of Canterbury, who was at pains to resist all papist influence. When the New Style was finally adopted, there was rioting in London and Bristol, just as there had been in Frankfurt in 1582, and there were less violent demonstrations elsewhere. Some people actually lost their lives in these upheavals. There seems to have been a general feeling amongst the demonstrators that some fundamental and unwelcome change had taken place. It was not just that a certain day was to be given the name of 14th, rather than 3rd, September, but that eleven days had really been cancelled. Would Saints' days now be celebrated *at the wrong time*? Had people been cheated out of wages rightly theirs? Had their lives been shortened? There was undoubtedly widespread confusion as to what the change really amounted to, whether it was no more than a correction to a convention system of dates, or genuine interference with history, indeed with time itself. If we are inclined to regard these incidents as confined to a less sophisticated age, we should remember that as recently as the second half of the twentieth century, a group of farmers in Midwest America, when faced with the introduction of Daylight Savings Time, objected that an extra hour of sunlight would burn the grass.

Well, we certainly cannot affect time by changing our calendar, or our clocks, but can we interfere with it by any other method?

### **The Alterability of the Past**

There is a simple objection to the idea that we could have any effect on what has happened, namely that to affect the past would be to change it, and changing the past would involve a logical contradiction. Take some event, such as my gambling a preposterous amount of money in a game of roulette last night, and (of course) losing. Naturally, I regret my actions, and would like nothing more than to cancel that event, make it the case that it never happened. Unhinged by remorse, I persuade myself that I can indeed undo last night's disaster, and set about muttering the relevant incantations. Have I any hope of success? Suppose that I do indeed make it the case that I did not gamble last night. Since the fact that I did gamble and lose was the cause of my undoing that event, it appears to follow that it is both the case that I *did* and that I *did not* lose a large amount of money in roulette last night. This plainly being a contradiction, it follows that I cannot alter the past. But then if I cannot alter the past, I cannot affect it, for what is it to affect something if it is not to alter it? I affect the cushion I am sitting on by depressing it; the tea-pot affects the atmosphere of the kitchen by making it slightly more humid; the leaves falling outside are affecting the state of the house by blocking the gutters, causing them to overflow when it rains, and so making the walls damp. To affect, it seems, is to change. I cannot, on pain of contradiction, change the past, so I cannot affect it.

There is something worrying about this argument. If we apply it to the case of the future, and on the face of it we can, the result is a much less congenial conclusion. For can we change the future? To change it suggests that there is already a way in which the future is going to be, otherwise it is not there to change, so to speak. So let us say that it is now true that I shall step on the 10.05 train from Skipton to Carlisle tomorrow. I decide, at the last moment, not to go. Have I changed the future? If so, then it is the case now both that I will step on that train, and that I will not. I cannot avoid the contradiction by saying 'It is true now that I shall step onto the train, but, tomorrow

morning, it will not be true that I step on the train,' for if there are truths about the future, then it is true now that I shall decide at the last moment not to step onto the train. I cannot, on pain of contradiction, change the future. But if to affect something is to change it, then I cannot affect the future either. That means that what will happen has nothing to do with my current decisions, and that I am therefore a helpless pawn in the hands of fate.

Some people have found that line of reasoning attractive, but it seems only prudent to look for ways of resisting it. One way is to reject the suggestion that there are truths about the future in the way that there are truths about the past. So, although it is now true that there was a thunderstorm over the Aire valley *last week*, it is neither true nor false on this view that there will be a thunderstorm over the Aire valley *next week*. There are no future facts, as there are past facts, and so nothing to make true, or false, assertions about the future. The future can be conceived of as a range of possibilities which are only resolved into one actuality when the moving present arrives there, rather like a zip fastener. That is one kind of A-universe, considered in Chapter 8, and it captures what many people think of as the asymmetry between the past and the future. On this view, the future is alterable in just one sense: it can be made determinate by our actions. It is not that there is already a truth about the future that we are at liberty to falsify: that would plainly be absurd. Rather, there is no truth as to how the future will turn out, but when it becomes present, what states of affairs are actualized will depend, in part, on our actions.

This is the view that we saw run into difficulties in Chapter 8. If the past is real, and this explains why we cannot affect it as we can affect the future, then there are past facts. But these past facts are not compatible with present facts. That was the gist of McTaggart's paradox. Now we suggested that there were two ways out of McTaggart's contradiction (perhaps there is a third, but what is it?): the B-theory and presentism. So let us see what consequences each of these views has for the alterability, of affectability, of the past and future.

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In the B-universe, there is no passage of time, and no time that is uniquely and mind-independently present. All times, in consequence, are equally real. So if I make a statement about the past ('The bus was delayed this morning'), that statement has a determinate truth-value, because reality contains the earlier facts that make it true or false. The past (i.e. what OCCURS—see Chapter 8—earlier than your reading this) therefore cannot be altered, on pain of contradiction. But, equally, if I make a statement about the *future* ('The electrician will be here this afternoon') that statement already has a definite truth or falsity, because reality contains the later facts that make it true or false. The future (i.e. what OCCURS later than your reading this) therefore cannot be altered either, on pain of contradiction. This now leads us back to the problem we encountered earlier. If it is the unalterability of the past that explains why we cannot affect it, then, if the future is similarly unalterable, we cannot affect it either. The worry, then, is that the B-universe deprives us of our role as agents. However, we need not jump to this conclusion. It is important to distinguish, the B-universe proponent will insist, between two kinds of alteration. One is an alteration in *things*, as when a building is demolished. The other is an alteration in *facts*, where we take a fact to be of the kind expressed by 'The Public Library BE demolished at 11.30 a.m. on Wednesday, 21 November 2001'. We can alter things, but not facts. I can be responsible for the demolition of the Public Library, and so change the state of the building, but I cannot change the fact that the Library BE demolished at 11.30, etc. Now it is plausible to say that affecting the world means changing it only if the kind of change we are speaking of is the first kind, that is, change in things, not in facts. (It is worth pointing out that some kinds of affecting might involve *prevention* of change. So, for example, I affect the vase that has just been knocked accidentally from the mantelpiece by catching it before it smashes itself to pieces on the floor.)

So, following this line of thought, I can affect something if I bring it about that it has one property at one time and another property at

another time, and this variation over time in properties is what constitutes change in the object. But this does not imply that I have the power to change the *fact* that the object has this property at this time and that property at that time. We can, then, affect future facts without altering them. Now although this is good news, does it not commit us to the view, which some may find contrary to both reason and experience, that we can affect the *past*? For if we can affect the future without altering it, the unalterability of the past is then no obstacle to our affecting it. Well, in distinguishing between affecting and altering, we may have left the door open to the idea of affecting the past, but we are certainly not committed to it. For affecting is a causal notion, and causation is one-way, or *logically asymmetric* (see Chapter 5), so that *a*'s being a cause of *b* is not compatible with *b*'s being a cause of *a*. It is also, arguably, *temporally asymmetric* (to be discussed in the next chapter), so that a cause always precedes its effect. Now the B-theorist can exploit the temporal asymmetry of causation as follows: to affect something is to be a cause of one of its features. But, causes being earlier than their effects, I can only affect how something is later, not how it is earlier. Therefore, although I may affect the future, I cannot affect the past.

So much for the B-theorist's view of affecting the past. What of presentism, the view that only what is present is real? Here it seems that the door has been left open, not only to the idea of the affectability of the past, but also to its *alterability*. Consider the question we raised in Chapter 8: what, if only the present is real, makes statements about the past and future true? It is hard to resist the conclusion that, assuming that concrete facts are needed to make such statements true, they are made true by present fact. Now, given that what is present is certainly within the range of what we can alter, does it not follow that, according to presentism, we can alter the past—by altering what makes true our statements about it? This idea is well captured in the following passage from George Orwell's *Nineteen Eighty-Four*, where the hero, Winston Smith, is being interrogated by the sinister O'Brien:

An oblong slip of newspaper had appeared between O'Brien's fingers. For perhaps five seconds it was within the angle of Winston's vision. It was a photograph, and there was no question of its identity. It was *the* photograph. It was another copy of the photograph of Jones, Aaronson, and Rutherford at the Party function in New York, which he had chanced upon eleven years ago and promptly destroyed. For only an instant it was before his eyes, then it was out of sight again. But he had seen it, unquestionably he had seen it! He made a desperate, agonizing effort to wrench the top half of his body free. It was impossible to move so much as a centimetre in any direction. For the moment he had even forgotten the dial. All he wanted was to hold the photograph *in* his fingers again, or at least to see it.

'It exists!' he cried.

'No', said O'Brien.

He stepped across the room. There was a memory hole in the opposite wall. O'Brien lifted the grating. Unseen, the frail slip of paper was whirling away on the current of warm air; it was vanishing in a flash of flame. O'Brien turned away from the wall.

'Ashes', he said, 'Not even identifiable ashes. Dust. It does not exist. It never existed.'

'But it did exist! It does exist! It exists in memory. I remember it. You remember it.'

'I do not remember it,' said O'Brien.

How can O'Brien say that the photograph *never existed*? The answer lies in his view of the past. The interrogation continues:

'There is a Party slogan dealing with the control of the past,' he said. 'Repeat it, if you please.'

' "Who controls the past controls the future: who controls the present controls the past," ' repeated Winston obediently.

' "Who controls the present controls the past," ' said O'Brien, nodding his head with slow approval. 'Is it your opinion, Winston, that the past has real existence?'

Again the feeling of helplessness descended upon Winston. His eyes flitted towards the dial. He not only did not know whether 'yes' or 'no' was the answer that would save him from pain; he did not even know which answer he believed to be the true one.

O'Brien smiled faintly. 'You are no metaphysician, Winston,' he said. 'Until this moment you had never considered what is meant by existence. I

will put it more precisely. Does the past exist concretely, in space? Is there somewhere or other a place, a world of solid objects, where the past is still happening?’

‘No.’

‘Then where does the past exist, if at all?’

‘In records. It is written down.’

‘In records. And—?’

‘In the mind. In human memories.’

‘In memory. Very well, then. We, the Party, control all records, and we control all memories. Then we control the past, do we not?’

To put O’Brien’s disturbing vision in terms of the two views of time we are considering: treating the past as having a reality that puts it on a par with the present, as the B-theory does, leads to the absurd conclusion that the past is somehow *still going on* somewhere, which implies that it is after all not past but *present*. Since this is plainly false, we are led to presentism, which denies all reality to the past except its existence in present causal traces, such as records and memories. That is, statements about the past are true only in virtue of facts about present evidence. Since evidence can be destroyed, replaced or otherwise tampered with, it follows that what it is now true to say of what happened in the past can similarly be altered. That is, history itself (that is, the events, not merely the records) can be interfered with. On O’Brien’s version of presentism, the past is alterable.

But O’Brien’s presentism is a very extreme and implausible kind of presentism. For one thing, it limits the range of present facts that determine the truth or otherwise of statements about the past to present *evidence*, i.e. traces that we would readily recognize as establishing, or suggesting, what happened in the past. So, because the burned newspaper photograph could not be recognized for what it is, it no longer counts as evidence, and so is no longer capable of making true any statement about the photograph’s past existence. And the absence of such evidence, for O’Brien, means that it is now true that the photograph *never* existed. Finally, O’Brien supposes that evidence can be altered to suggest a quite different set of truths

about the past. That is, the past can not only be obliterated: it can be created. But presentism is not committed to any of these disturbing consequences. First, the present facts that make true statements about the past do not have to be limited to what we would recognize as evidence. Why should our powers of observation or deduction be relevant? What matters is that the past leaves its traces, whether discoverable or not. And if statements about the past can be made true by facts we are not necessarily in a position to discover, then it may not be true that we can obliterate all traces of the past. If, for example, it turns out that only one past history is compatible with the present state of the universe, then nothing we can do will make any difference to what it is now true to say about the past. Secondly, even if past traces are obliterated, that does not necessarily falsify a once-true statement about the past. Suppose O'Brien has destroyed all traces of the photograph. It does not follow that there is sufficient evidence to establish that it did *not* exist. That is, the presentist can say that it is neither true *nor* false that the photograph existed. Thirdly, falsified evidence may bear the traces of its manufacture, and so may not be sufficient to establish different truths about the past.

A final comment on O'Brien: it is quite unfair to depict a view of the past as real as implying that the past is *still going on*. Treating the past as real is not the same thing as treating the past as another region of space (although it may be analogous in certain respects to a region of space). By definition, the past is *not* still going on, for it happened before the present. Only an implicit assumption that only what is present is real will yield the conclusion that the past can only be real if it is going on now, but such an assumption is quite illegitimate when considering the implications of, for example, the B-theory.

We conclude, then, that although some versions of presentism may represent the past as alterable, this is not an essential implication of all versions of the theory. There are reasons, whatever view of time one takes, to resist the view that the past can indeed be

altered. But there is one hypothesis that seems to imply the alterability of the past, namely the hypothesis of time travel, so to that we now turn.

### Dilemmas of the Time-Traveller

What is time travel? Anyone who has read a time-travel story has an intuitive conception of what it is, but when it comes to defining it, we face certain difficulties. Consider ordinary, spatial, travel: we travel about in space in virtue of occupying different places at different times. (Strictly, what makes this travel as opposed to mere motion is that it is, to a certain extent, under our control. But let us ignore that for the moment.) Now if we simply substitute time for space in this definition to give us a characterization of time travel, we end up with something that is either trivial or nonsensical: to travel in time is to occupy different times at different times. If this just means that, e.g. we occupy 8.15 a.m. at 8.15 a.m. and 4.30 p.m. at 4.30 p.m., then we are travelling in time constantly. But this is certainly not what we mean by time travel, which implies doing something different from what everyone else is doing. It makes no sense, however, to say that we can occupy 4.30 p.m. at 8.15 a.m. (within the same time zone), for this suggests that those two times are simultaneous, which by definition they are not.

It seems, to overcome the difficulty, that we need to distinguish between the time of the time-traveller and the time of the world through which he is travelling. So, following a suggestion of David Lewis's, let us talk of the *personal time* of the time-traveller, where this is understood as the set of changes going on in the time-traveller and in his immediate vicinity (whose bounds are defined by the sides of the time machine itself). Thus, the time-traveller's personal time just *is* the advance of the hands on his wristwatch, the beating of his heart, the imperceptible lengthening of his hair and nails, his changing thoughts, the burning of a nearby candle (supposing there to be

such an anachronistic timepiece aboard the time machine), etc., etc. *External time*, by contrast, is time itself, registered by changes outside the time machine. So, despite the names, external and personal time are not two different times, or two different dimensions, for the changes that constitute personal time also take place in external time. Applying this distinction, let us imagine a journey taken by the time-traveller to 2101. The journey has taken 100 years in external time, but in terms of personal time, only 5 minutes (say) have elapsed. That is, the changes within the time machine occurring during the journey are those that normally register 5 minutes of external time. As far as the time-traveller is concerned, then, only 5 minutes have passed: that is what his wristwatch tells him, and how it appeared to him subjectively, and he himself has aged physiologically only by that amount. But, stepping outside his machine, he discovers that 100 years have passed away.

It is tempting, then, to define time travel as a discrepancy between personal and external time. But this is not really adequate. For, whether we are time-travellers or not, we all have our personal time, that is we all change by varying amounts in a way that registers time itself. Indeed, not only us sentient creatures, but all objects have a personal time. The clock on the mantelpiece has a personal time, the soufflé baking in the oven has a personal time, as does the aspidistra on the window sill, the fading photograph on the wall, the dripping tap in the kitchen. By varying the rates of these changes, I may perhaps be said to induce a discrepancy between the personal time of these objects and external time. To take a particularly dramatic illustration of the point, imagine that you volunteer to take part in an experiment in cryogenic preservation. You permit yourself to be frozen for 100 years, during which time your metabolic rate and heartbeat will be slowed down to almost zero. You will age, in effect, only a few days during that long period. At the end of it, you emerge not very much older, physiologically speaking, than you were at the beginning of the experiment. You have no memories of the freeze, since you were deeply unconscious for the whole of it. For you it will

have passed in an instant. A short period of personal time has taken 100 years of external time—a significant discrepancy, and you will certainly have the sense of having travelled forward in time. And, according to the definition of time travel we are considering, you have indeed travelled forward in time. But have you? If there is some doubt in your mind, consider this rather simpler and more familiar case. My watch stopped 5 months ago and I still have not got around to taking it to the jeweller's to be repaired. It simply has not registered, in the way that it normally does, the passing of time. Has my watch become a time machine, then? Surely not.

To avoid this difficulty, it would be better to consider the history of the time-traveller and time machine to be a discontinuous one in external time. Thus, when the time machine leaves for 2101, it simply does not exist in the intervening times. If it did, then we would still be able to see the time machine standing exactly where it was when the time-traveller activated the controls, absolutely motionless and apparently unchanging within. But, as everybody knows, when a time machine leaves for another time it *disappears*. We can still make good use of the personal–external time distinction, however, as follows: the journey, although discontinuous in external time, is nevertheless continuous in personal time. That is, a clock aboard the machine does not suddenly take a great leap forward (or backwards) when the machine arrives at its destination: processes within the machine continue as normal.

We still have not dispelled the air of paradox, however. Think of the events taking place aboard the time machine: the traveller consulting time charts, the whirring machinery, the digits on the chronoscope (the instrument that tells one what year one would be in if one landed now) whizzing past. Where in time are these events? They cannot be *nowhere*, and yet we suggested just now that the journey itself has no location in external time. Perhaps the answer is that the journey takes place in another time-series altogether. We may imagine this time-series ‘branching off’ from our own and rejoining it at a later (or earlier) date (Figure 22).

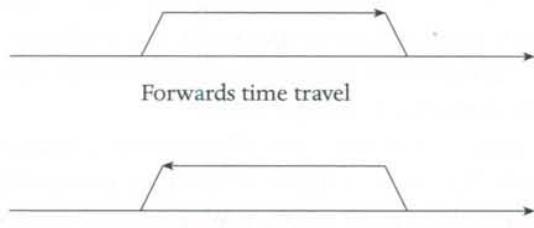


Fig. 22. Time travel and branching series

Whether or not the idea of two different time-series is coherent is a question we will leave until the next chapter.

Now we have a definition of time travel on the table, we can begin to explore the consequences of such travel. Let us say that backwards time travel, i.e. travel into the past, is possible. Does it not follow that the past is alterable? Or, to put the matter somewhat differently, if it is self-contradictory to assert that the past can be altered, does it not follow that time travel must be impossible? Let us pursue this line of thought.

The first point to make is that, for time travel to be possible, presentism cannot be the correct account of time. If neither the past nor the future is real, then it is impossible to travel to them. We could no more travel to 1789 or 2340 than to Samuel Butler's Erewhon. Travel into the past requires the reality of the past—and of the future. For, once one has arrived in the past, the present left behind becomes the future, and it would make no sense at all to suppose that the point of departure was not real (or no longer real). One might say: 'Ah, that future (or past) time might not be real *now*, but it will be real enough when you get to it.' But it would be very odd if reality depended on where one happened to be. If something is real, it is surely real *absolutely*, not merely real in relation to a particular location. (Consider the absurdity of 'Big Ben is real *in London*, but not real *in Paris*.' Is the temporal counterpart any less absurd?) Admittedly, the presentist does think that reality changes over time,

time. What is real is still, for the presentist, real absolutely. What is now present is real without qualification, not real relative to the date at which you happen to read these words.

We will assume, then, the reality of both past and future, which in turn requires that we regard statements about past and future as having a determinate truth or falsity. We cannot, then, explain the alterability of the past in terms of the alterability of the present, on which the truth of such statements depend. But if statements about the past and future have a determinate truth or falsity, then we cannot change that truth or falsity, for to do so would result in contradiction, as we have already seen. It appears, then, that time travel requires for its possibility the absolute unalterability of the past (and future). And this conflicts with our intuitive understanding of what time travel makes possible. Suppose, for example, I discover that I left my umbrella on the train that is now a hundred miles away. Instead of feverishly jumping into a car and racing to the station at the end of the line, I calmly step into my time machine, set it for the time just before I alighted from the train, and this time make sure that I do not leave without my umbrella. What, after all, could possibly prevent me?

That this is not possible can be shown quite simply. The cause of my travelling back in time is a fact we will designate *f* (the discovery that I left my umbrella in the train, for example). The effect of my doing so is the negation of that fact, Not-*f*. But *f* and Not-*f* cannot both obtain. If this seems unconvincing, let us illustrate the problem by a more striking and appalling example. Disappointed in love, I wish myself dead. More than that, I wish that I had never lived. ‘Let the day perish wherein I was born,’ I say, along with the stricken Job. Given that I have a time machine, I am in a position to bring this about. So I travel back to some suitably distant moment before my conception, find a relevant relative (a grandparent will do if neither of my parents has yet been conceived) and, with malice aforethought, strike them dead. I thus bring it about that I was never conceived. But

now this unsettling narrative must be exposed for the nonsense it is. If my action is successful, *who is it who prevents my conception?* It cannot be me, for it is now apparently true that I was never conceived, and so never grew up to step into a time machine to prevent my conception. I cannot, then, prevent my conception.

Take another example. Appalled by the disastrous and senseless loss of life during the First World War, I decide to travel back to 1914 and prevent the assassination of Archduke Ferdinand at Sarajevo. I spot the assassin in the crowd. I approach closer and closer and then . . . I trip over, and the shot is fired. I fail, and indeed I must fail, for if the assassination had not taken place then (let us suppose, perhaps not very plausibly) the First World War would not have happened, and so I would have had no reason to go back in time to prevent it. Dramatic though these two cases are, they are but two illustrations of the unassailable truth that I cannot change *any* past fact, however trivial.

This itself may seem to have further worrying implications. For if I cannot prevent my own conception, and cannot prevent the First World War, despite being present at the right time, does this not suggest that I am not, as a traveller into the past, a free agent? If this is an implication, then it extends to our ordinary, non-time-travelling situation. For I am not free to change the future, either. However, we can again appeal to our earlier distinction between *affecting* facts (i.e. being their causes) and *changing* facts. Although by travelling back in time I cannot change the past, I may yet affect it. Thus, my actions may—indeed, cannot fail to—have causal effects, effects which in part determine the character of the past. Suppose, as I approach the Sarajevo assassin, my tripping over causes me to fall against him, thus moving his arm just as the gun goes off. But, whereas (being a poor shot) he had been set to miss the Archduke, now, thanks to my interference, the bullet finds its mark, and history is set on its course of mass destruction. Of course, this is hardly a good example of a free action, but it does illustrate how I may affect the past without changing it. Time travel, then, does put the past

within our causal reach, and so gives us control over it in just the same sense as we have control over the future.

But other paradoxes haunt the would-be time-traveller. We will end this section by considering two cases, each apparently allowed by time travel, but each containing an anomaly or contradiction. Here is the first case:

Tim is spending the summer holiday at his grandfather's house in rural Sussex. Bored one day, he wanders into his grandfather's library. On one of the more remote shelves, Tim discovers a dusty book with no title on its spine. Opening it, he sees it is a diary, written in a familiar hand. With a growing sense of wonder he realizes that one of the entries provides detailed instructions on how to build a time machine. Over the next few years, following the instructions to the last detail, Tim builds such a machine. It is finally completed, and he steps on board, and throws the switch. Instantly, he is transported back fifty years. Unfortunately, both the machine and book are destroyed in the process. Tim writes down everything he can remember in a diary. He cannot rebuild the machine, however, because it requires technology that is not yet available. Reconciled to getting back to the twenty-first century by the traditional method of doing nothing and letting time carry one back, he marries and has a daughter. The family move to a rambling mansion in rural Sussex. The diary is left to gather dust in the library. Years later, Tim's grandson, spending his summer holidays with his grandfather, discovers the diary.

The identity of Tim will be obvious, and this in itself is rather strange. But the question we are concerned with is this: where did the information on how to build a time machine come from? From the diary, of course, which itself was written by Tim. But where did he get the information from? From the very same diary! So the information has appeared from nowhere. At no stage has someone worked out for themselves how to build a time machine and passed on the information. The existence of this information is therefore utterly mysterious.

Here is the second case:

Peter and Jane, both 20 years old, are out for a walk one day in 1999 when suddenly a time machine appears in front of them. Out steps a strangely

familiar character who tells Jane that he has an important mission for her. She must step into the machine and travel forward to the year 2019, taking with her a diary that the stranger hands to her. In that diary she must make a record of her trip. Obligingly, she does as she is asked and, on arrival, meets Peter, now aged 40. She tells Peter to travel back to 1999, taking with him the diary she now hands him, and recording his trip in it. On arrival in 1999, he meets two 20-year-olds called Peter and Jane, out for a walk, and he tells Jane that he has an important mission for her.

This raises several questions: How many trips are made in total? What happens to Peter and Jane? When they have finished travelling, what are their ages? But the really tricky question is: how many entries are there in the diary when Jane first steps into the machine? We imagine it blank. But this is the very same diary as the one Jane hands to the 40-year-old Peter, which by then contains her entry. And by the time Peter arrives back in 1999, it will contain his entry too. But then, if the diary already contained two entries when Jane was handed the diary, then it would contain three entries when she handed it to Peter, who would then add another one, so the diary would have contained four entries when it was first handed to Jane, and so on. If the problem is not immediately apparent, this is because we imagine an indefinite number of trips, but in fact there are just two: Jane's trip to 2019 and Peter's trip to 1999. So there ought to be a consistent answer to the question, how many entries are there in the diary when it is handed to Jane? Yet, as we have seen, there does not appear to be a consistent answer.

### Causation in Reverse

Given that the time-traveller into the past cannot avoid interacting with a past time, a necessary implication of the possibility of time travel is the possibility of backwards causation. Let us say that the traveller lights a candle aboard the time machine just before departure. The candle is still burning on arrival, say, four centuries earlier. The cause of the candle burning in the seventeenth century therefore

lies in the future: its being lit in the twenty-first century. ‘Backwards causation’ is the name given to the phenomenon, whether purely imaginary or not, where causes occur after their effects. Is backwards causation an incoherent notion? If so, then time travel is too. But, even if we reject time travel on other grounds, we can still ask about the intelligibility of backwards causation. Could something I do now affect the past?

One argument against the possibility of backwards causation has already been undermined: backwards causation is impossible, because it would involve affecting the past, and the past is unalterable. This objection is not a compelling one given our earlier distinction between affecting and altering. We can affect the past without altering it. But there is a related objection that is harder to dismiss, and it goes as follows. We can affect the future because it is not yet fixed, that is, there is as yet no fact of the matter as to what will happen. Our actions, in affecting the future, help to make it determinate. But the past is not like this. Unlike the future, it is entirely determinate. There is a fact of the matter as to what happened in the past. So, because our present actions cannot make the past any more determinate than it is already, they cannot affect the past. Causation cannot be understood without supposing this fundamental asymmetry between past and future. That is why causes are always earlier than their effects. Of course, this objection is not available to someone who thought of the universe as a B-universe. Nor is it available to the presentist. It is only available to one who thinks of the past as real but the future unreal—precisely the position that, we suggested, was vulnerable to McTaggart’s paradox.

A rather different approach is to consider the circumstances in which we would actually be justified in thinking that we had witnessed a case of backwards causation. Let us say that I habitually wake up 5 minutes before my alarm clock goes off. Reflecting on this, I start to entertain the idea that it is the *later* going off of my alarm clock that causes my *earlier* waking up. How do we test this hypothesis? If there is just the one occasion where I wake up before

the alarm goes off, we cannot test it, but then we would have no reason to entertain the hypothesis. In the case we are considering, the alarm clock going off is in general preceded by my waking up. So the hypothesis under consideration is that the alarm clock going off is *in general* the cause of my waking up 5 minutes earlier. I can try to falsify this hypothesis by waiting until I wake up in the morning, and then trying to *prevent* the alarm from going off. If I succeed, then I show that my waking up was not caused by the alarm, at least on this occasion. And if I accumulate enough such instances, I falsify the backwards causation hypothesis. But let us say I fail, and indeed fail on every single occasion that I prevent the alarm from going off. Perhaps I knock it off the table, or do not reach out in time, or the off switch is broken, etc., etc. Then there is a rival hypothesis to the hypothesis of backwards causation that also explains our failure: my waking up is (somehow) the cause of the alarm going off. This is, of course, a rather foolish example, but the general principle here can be applied to any case. We cannot have evidence which confirms a backwards causation hypothesis but which does not also confirm a rival forwards causation hypothesis. The two are incompatible if we assume that causation is *asymmetric*, i.e. is such that necessarily, if A caused B then B did not cause A. In these circumstances, we would never prefer the backwards causation hypothesis to the rival forwards causation hypothesis.

A final thought: if there were a large number of instances of events caused by later, rather than earlier, events, would the world not be rather more surprising than it is? That is, would we not expect to witness sudden happenings that would be completely unpredictable on the basis of the antecedent conditions and whose real explanation lay in the future?