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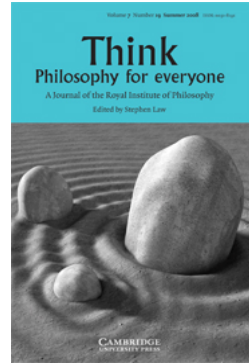
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**TOM BAKER: HIS PART IN MY DOWNFALL.
(A PHILOSOPHER'S GUIDE TO TIME-TRAVEL.)**

Alasdair Richmond

Alasdair Richmond introduces some famous paradoxes about time travel.

Many philosophers have tried to prove that something we ordinarily think happens all the time in fact can't possibly happen at all. The ancient philosopher, Zeno of Elea, notoriously argued that all motion is utterly impossible and that nothing therefore can ever possibly move. However, there is another tradition, equally lively, which argues that something long-held to be impossible is actually more feasible than you might think. For many reasons, several philosophers and scientists take the prospect of time-travel seriously and this paper aims to tell you how and why philosophers think about travelling in time.

This philosophy lecturer ultimately owes his livelihood to a train of thought sparked off by long-running BBC TV series, *Dr. Who*. The first philosophical issue I ever encountered was a moral dilemma/time paradox in the 1975 *Who* story 'Genesis of the Daleks'. As you may know, the titular Doctor is an alien Time Lord (native to the planet Gallifrey), who travels freely through space and time fighting injustice. The Doctor has devoted much effort to thwarting a race of sociopathic cyborgs called the Daleks (from the war-ravaged planet Skaro). The Daleks are ruthless totalitarians, who combine advanced space- and time-travel technology with a hatred of all other life and a belief in their own racial supremacy. They're deeply unpleasant, in short. (Sometimes the BBC tried depressing attempts at making Daleks funny. To me, Daleks aren't markedly more comical than Nazis or H-bombs.)

What sparked my five-year-old imagination was this: fore-seeing a time when Daleks might destroy all other life, his

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fellow Time Lords despatch the Doctor to Skaro at a time just before the Daleks evolved. The Doctor is ordered to intervene in already-established events so Daleks either never evolve at all or evolve into something less genocidally self-righteous. As it transpires, the Doctor is presented with an opportunity to trigger a bomb that will destroy the embryonic Dalek mutants and thereby (paradoxically) alter future events so the Daleks (and all the misery they go on to cause) *will never have been*. Just when the viewer thinks all is in place for a thoroughly satisfying explosive finale, the Doctor suddenly finds cause for pause.

Readers of a certain age may recall holding their breaths as the then-occupant of the Doctor's role (the irrepressible Tom Baker) hesitated over taking the step that would forever erase his greatest foes from time and space. What makes the Doctor hesitate is a moral scruple: if he erases an entire species from history, he will have effectively stooped to genocide himself. If his objection to Dalek methodology is a principled objection to genocide (full stop) then he cannot fulfil his mission while respecting the intentions behind it. The Daleks aren't the enemy because they look and sound weird; rather, they're the enemy because they want to wield the power of life and death (principally death) over all that is not Dalek. While agreeing that Daleks are uniquely and criminally dangerous, the Doctor nonetheless assumes that genocide is still a crime even if practised against the genocidal. (A moral point that seems to have escaped his fellow Time Lords . . .) As a lad, I'd never seen a moral problem framed so starkly and so powerfully and, to this day, I still defend at least the Doctor's dilemma and consequent hesitancy. (Thank you, Tom – *my hero*.)

It's a measure of how enthralling I found this dramatic crux that it was ages before I wondered if moral scruples about changing history aren't misplaced. Surely, the reason you can't change history is not that you might violate a moral imperative in so doing but that you would create contradictions thereby. If the Doctor did wipe the Daleks out of history, where would the events have come from that he

sought to change? If history is altered, the Daleks must both survive (creating the history that the Doctor comes from and that he wants altered) and not survive (i.e. they cease to exist once their embryonic forms are destroyed). Thus, paradox.

The Doctor's dilemma involves a particularly dramatic example of the time-travel 'Grandfather paradox'. Such paradoxes would arise whenever a time-traveller goes into the past and prevents an event that is a pre-condition of the traveller making the backward time-journey in the first place. Imagine a time-traveller goes back in time and assassinates her/his grandfather before Grandfather has fathered children. If Grandfather dies at this point, then one of our traveller's parents never exists. Hence the traveller can't be born and travel back to kill Grandfather ... and so on. Surely such things can't happen because they would violate the law of non-contradiction – Grandfather would somehow both survive to become a parent and not survive. If contradictory situations are impossible, and if time-travellers could create contradictory situations, then surely time-travel is impossible. Actually, killing Grandfather is a bit excessive – all you need for a stark paradox is a traveller going back in time and interfering with any of the conditions needed for the journey. Equally paradoxical is this: build a time-machine, travel back twenty-four hours and cut the power-supply to your own laboratory so you can't finish the experiment that lets you go back in time to cut the power. . .

Almost as puzzling as self-undermining 'Grandfather' cases are self-fulfilling 'Casual loops'. In such cases, rather than prevent their own occurrence, backward time-journeys create some of their own pre-conditions. Imagine you pick up the telephone one night and hear an oddly familiar voice giving you instructions for building a time-machine. You write the instructions down. The call tells you how to set the machine so its first trip takes you back into the recent past. On so doing, you dial your own phone number and tell your earlier self how to make and operate a time-machine. Nothing has been destroyed in this transaction – this is not

a case where one past mysteriously disappears and another just as mysteriously springs into existence in its place. But still something feels wrong – where did the information come from that let you build the machine? SF writers have had a field day with such loops (e.g. Shakespeare copies all his plays from a time-displaced edition of his own *Collected Works*). In Robert Heinlein's unsurpassed causal-loop story “_All You Zombies_”, a hermaphrodite time-traveller contrives (unwittingly) to self-fertilise and so becomes both her/his own parents. (The information this quasi-cloning loop creates is the time-traveller's DNA.)

Faced with such perplexities, philosophers concluded that time-travel may be pleasant enough in stories but it's deeply suspect logically and not to be taken seriously. Meanwhile, general relativity and quantum mechanics began to offer a plethora of ways in which physically-realistic mechanisms might be created (or even exist in nature) that might allow time-travel. In 1949, Kurt Gödel published a remarkable paper which described a world governed by general relativity, wherein travellers can voyage (as many times as they like) between any two points in space and time. (See ‘An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation’, *Reviews of Modern Physics*, 21, 1949.) Such ‘Gödel universes’ are still hotly debated to this day. Gödel's original model is very *unlike* the world we think live in – for a start, his model-universe is infinite and rotating where our universe is apparently finite and non-rotating – but other, more realistic scenarios have since been uncovered. (Often using exotic objects like cosmic strings, wormholes or very rapidly rotating black holes or other ultra-dense masses.) So, have physicists cheerfully turned a blind eye to the law of non-contradiction and learned to live with paradoxes? Perhaps not – maybe we can preserve the law of non-contradiction and still leave room for time-travel.

The classic defence of the logical possibility of time-travel is David Lewis' paper, ‘The Paradoxes of Time-travel’, (*American Philosophical Quarterly*, 13, 1976). Lewis had no

particular drum to beat on behalf of Gödel-universes or any other particular physical theory of time-travel – his concern was simply to show that time-travel needn't (always and invariably) promise logical contradictions. How might this be done?

First of all, Lewis distinguishes the personal time of travellers from the global time of their surroundings. A backward time-traveller has later moments in personal time which correspond to earlier moments in global time. For non-time travellers, personal and global time march in step. External time is like the shortest route between two events (a line 'as the crow flies'), whereas personal time can be a more winding path between two points. Like that of everyone else, personal time for time-travellers increases as their memory-traces accumulate. Future-bound time-travellers complete fewer hours measured in their frame of reference than in an external frame of reference. Backward time-travellers have a personal arrow of time pointing in a reverse direction to that of global time.

If time-travellers visit areas of their own lifetimes and meet other temporal stages of themselves, there arise cases of 'double occupancy' – places where two stages of the same person exist at the same time. Surely, a person must necessarily be in only one place at any given time. Lewis replies: the two stages of the traveller have only similar *global* spatio-temporal locations; in terms of the traveller's personal time, the two can be arbitrarily far apart. Lewis likens the personal time of such self-meeting time-travellers to a railway line with a trestle in its course. The line doubles back on itself so the line which passes under the trestle is also the line which goes over it.

Lewis takes a short way with causal loops. Any causal chain can do one of only three things: a) extend infinitely, b) loop back on itself or c) appear from nowhere. Lewis thinks causal loops *appear* strange but are really no worse from the explanatory point of view than infinite causal sequences or such brute happenings as alpha-particle emissions or the Big Bang. We have no *complete*

explanation for any causal sequence (whether closed, infinite or linear) and we may just have to accept spontaneous creation of information in other cases. Explaining the existence of the whole loop may be a very different matter from explaining the existence of any loop-component.

Lewis spends most effort tackling 'Grandfather' objections. These say: if time-travel is possible, then contradictions are possible; contradictions aren't possible so time-travel isn't possible. Lewis partly accepts this argument – he believes contradictions can't occur in actuality. (To put it another way, no real thing can be *truly* contradictory.) What Lewis *rejects* is thinking that the possibility of time-travel must entail the possibility of contradictions. Lewis says: the appearance of paradox arises because we don't keep clearly in mind what it means to say that something is possible – something can appear possible measured against one set of facts but impossible measured against another.

Let's consider a case. I've no bone to pick with either of my (sadly late) grandfathers, so let's imagine I travel back in time (say from 2010) with a view to assassinating someone I really do have a problem with. Specifically, let's assume my target is Adolf Hitler in Vienna c. 1910, (i.e. long before his rise to power in 1933 or his suicide in Berlin in 1945). Suppose I've done my homework and I arrive in 1910-Vienna suitably equipped to pass myself off as a local but also concealing about my person a powerful modern sniper's rifle and telescopic sight. Furthermore, let's assume my eyesight is good (perhaps the most far-fetched bit of the whole scenario), my gun is loaded and my hand is steady. So, in some sense, I do have what seems necessary to take out Hitler. (Furthermore, Hitler isn't bullet-proof or equipped with an anachronistic Kevlar vest or bullet-deflecting force-field.)

I lie in wait for my target, and eventually he duly appears. Suppose further that I get Hitler in my sights. What can happen next? Seemingly, my mission must be doomed to fail – any one of a host of perfectly natural causes might intervene. Maybe I sneeze, someone jogs

my arm, Hitler ducks to tie up his shoelaces, I'm struck down by a horse-and-cart, or whatever. If I am not able to create either a contradiction or a mysterious branching of history (more about branching histories later), the one thing we seemingly *cannot* have is my successfully assassinating in 1910 a man who doesn't die until 1945. (Assuming death is a one-off operation.) But provided my mission fails, no paradox occurs. My killing Hitler is only possible relative to one set of facts (e.g. those about my gun, my training and Hitler's lack of a Kevlar vest, say). However, relative to a more inclusive set of facts, my killing Hitler in 1910 isn't possible, (e.g. the fact that the very same man doesn't die until 1945). The *appearance* of paradox arises, says Lewis, because we don't keep these different sets of facts clearly distinguished when we imagine such cases.

To adapt another example of Lewis's: in some sense, it ought to be possible for me to speak (Scots) Gaelic – my tongue and larynx are in fair working order, there are plenty of Gaelic speakers not so very far from where I live and there are plenty of good introductory books on the language. Relative to these sorts of facts, my speaking Gaelic is a distinct possibility. However, don't ask me to recite any of Scotland's rich heritage of Gaelic poetry in the original, because I never learned how to speak Gaelic. There's another set of facts (e.g. about my schooling and linguistic aptitudes) which is inconsistent with my being able to speak Gaelic. But there's no paradox here. What is possible relative to one set of factors may not be possible relative to another set.

At this point, you might be thinking: this is all very well but hasn't history changed just in virtue of your trawling round Vienna looking for future criminal dictators to off? Well, not necessarily. Provided the history I leave behind me when I get in my time-machine c. 2010 is consistent with the history I arrive in when I actually get to 1910, it's not clear that my mere presence has changed anything. Suppose there is in existence at this very moment a hitherto-unknown diary of Hitler's that covers his Vienna years. In this diary are entries

like the following: “Vienna, February 23rd, 1910. Weather fair. Persistently shot-at by inexplicable Scots marksman. Has fine rifle but can’t shoot for toffee. February 24th. Same again. February 25th. And again. How many times can one man’s elbow be jogged? February 26th. Lobbed apple at Scots marksman and put him off his aim. Scots marksman rushed towards me with a dagger but was fatally crushed between two trams. Rifle squashed beyond repair.” In other words, provided the consequences of what I do when I get to Vienna in 1910 are already in place in the history I depart from in 2010, no paradoxical overhaul of history has occurred. When I travel back to 1910, I don’t *remake* history into something it wasn’t – rather, I simply *fulfil* the events described in Hitler’s diary.

Well, suppose we grant the Lewis analysis thus far. Aren’t time-travelling assassins going to be pretty peculiar and thick-skinned people? Suppose it’s 2010 and I’m about to set off on my mission to 1910. A colleague comes to me, says “I think you’d better read this”, and hands me a translation of a hand-written diary newly-unearthed from a Vienna cellar. I read the document and realise that it refers (in all probability) to what I have not yet done but am about to do. Now here the problem of time-travel touches that of free will: why should I choose to undertake a journey that seems fore-doomed to end in my failure and horrible death? Well, there are still possibilities: maybe the diary is a fake, maybe the unnamed Scotsman isn’t me, or maybe Hitler made a mistake and the marksman survived.

Now we reach another problem: even if time-travel is logically possible, isn’t the above string of failures rather suspicious? Surely, if time-travelling assassins walk among us, we could identify them by the string of unlikely coincidences they trail behind them. (This objection appears in Paul Horwich’s *Asymmetries in Time*, 1987.) Suppose I travel back to Vienna as one of a team of fifteen, all expert marksmen and all laden with grenades to boot. Surely Hitler successfully dodging such a shooting-gallery is too weird to be countenanced. Thus, Horwich’s objection runs:

even if time-travel is logically possible we can still be confident that it's phenomenally unlikely in a world that functions like we think ours does. However, Nicholas J. J. Smith ingeniously replies, (in 'Bananas Enough for Time Travel?', *British Journal for the Philosophy of Science*, 48, 1997). One might ask: how likely is it that time-travelling assassins would a) believe that the past can be altered and b) would persist in this belief in the face of repeated failures? Such assassins seem rather obtuse. (And in sore need of a healthy dose of David Lewis.)

But time-travel still seems rather pointless if you can't really *change* anything. Well, Lewis also tries to clarify what we mean by change. 'Change' can mean two related, but subtly different, things. In one sense of 'change', we change something by replacing one state with another. If I take a hitherto-intact cup and smash it, then I've clearly changed it – what was an intact cup has been replaced with a broken one. In this replacement sense, changing the past is impossible. (I cannot take a version of history where Hitler dies in 1945 and replace it with one where he dies in 1910.) However, there is another sense of 'change': one where you can change something by making it different from *what it would have been* had you not intervened. (This is what one might call a 'counterfactual' sense of change.)

Consider a pivotal moment of history: say Blücher's Prussian forces arriving at Waterloo. (Generally held – not least by Wellington – to have been decisive in sealing Napoleon's fate.) Clearly, Blücher's arrival changed things from what they would have been had he not arrived. We can assert (counterfactually): "If Blücher had got lost, Napoleon would have won". Now, in this *counterfactual* sense, we can talk of time-travellers changing the past. In our original example, Hitler's life in 1910 Vienna is clearly different from what it would have been had I not gone there. (For a start, his diary would have been robbed of several striking incidents.)

Maybe time-travelling assassins can console themselves thus: okay, I can't get Hitler whenever I want but maybe my

efforts slowed him down or prevented some of the mischief he might otherwise have made. Maybe the effort of dodging my rifle-shots in 1910 contributed something to the general infirmity that prevented Hitler fleeing the bunker in 1945. Of course, it may be that your intervention makes things *worse* than they would otherwise (counterfactually) have been. Suppose I slowed Hitler down on February 26th 1910 such that the tram that gets me would otherwise have killed him. In this scenario, it's (partly) my presence that makes his later career possible at all.

So far we've assumed that time-travel takes place within one version of history, or one world. But what if it doesn't? After all, many quantum physicists think the world (and everything in it) is continually branching into all the physically-possible states there are. Maybe time-travellers can have their cake and eat it too, i.e. travel in time but still preserve uncertainty about their own futures and the law of non-contradiction. On this view, the actions of a traveller in the past would create alternative chains of history. So, you leave World A in 2010 (where Hitler dies in 1945) and arrive in Vienna in 1910, wherein you create a new history (World B) by shooting Hitler dead. (This 'new' world runs henceforth alongside the 'old' one you came from.) Sounds ideal – no paradoxes here, because the Hitler who dies in 1945 and the one who dies in 1910 are different individuals in different worlds who just happen to have the same name and (presumably identical) biographies up to 1910. However, one might ask: in what sense is this *time*-travel, as opposed to inter-world travel? Obviously, there's no paradox in killing another world's Hitler in 1910 but that's not what I want; I want to remove *the* Hitler and save *my* world from the Holocaust and World War Two. Inter-world travel sounds more like running away to somewhere nicer than it does like actually changing history. To put it slightly more technically: Lewis is concerned to defend the logical possibility of time-travel within a single causal chain; invoking travel across other causal chains and calling *that* time-travel is changing the subject without changing the name.

In any case, if Lewis's analysis succeeds, we don't need parallel worlds to allow for time-travel – one (internally consistent) world is enough.

However, let's suppose for now that you could *change* (in the replacement sense) history within a single world. Leaving the paradoxes aside for one moment, what would you actually achieve? Suppose I gun down *the* Hitler (i.e. our Hitler – not some alternative-world counterpart) in 1910 and the local constabulary catch me red-handed over the body. What plea could I make in my defence? "This man here is a mass-murderer"? Perhaps not – this man here is a mediocre landscape artist full of bullet-holes and in no position to do anything else ever again. "This man here would otherwise have gone on to be a mass-murderer, and furthermore I have seen the consequences"? The problem is: if your native history is really replaced, you can't show your accusers what you've achieved. However, if you wait until Hitler has done something really actionable then you may be too late to arrest the movement he started. Indeed, you might even create a martyr and make conditions still riper for Nazism. However, the imagination balks rather at killing the innocent infant Adolf-to-be, his parents or even his grandfather. The risk of making things worse applies even if somehow you could alter history in the 'replacement' sense. (There's a strong note of this in 'Genesis of the Daleks', when the Doctor is forced to reveal his knowledge of the future and risks completely foiling his own mission by forewarning the Daleks against what would otherwise be millennia-worth of coming defeats.)

Another worry is the 'If at first you don't succeed' problem. So, somehow you kill Hitler in 1910, and then another pro-Nazi time-traveller goes back and shoots you in your cradle. Your friends are briefed for these eventualities and try derailing the whole shooting-match by packing Bismarck off in a crate in 1840 to Bolivia so that Germany is never unified. Meanwhile, in 1805, Nazi time-travellers are sabotaging British ships at Trafalgar. And on it pointlessly goes ... To what end? Once you allow that history

might be altered, there seems no stable resting-point thereafter. Science fiction stories usually let the good time-traveller win, and destroy the totalitarian enemy before he dies, but this is just wish-fulfilment. In the face of these possibilities, I devoutly hope that any time-travel Nature allows is Lewisian.

To close with a final thought on the Doctor's dilemma: 'Genesis of the Daleks' ends with the Doctor having delayed Dalek evolution by perhaps as much as a thousand years. Clearly, he hasn't replaced a Dalek-creating history with a Dalek-free one, but this doesn't necessarily mean his efforts were in vain. Even if the delay he created was there all the time, part of the original history he came from, history might have been worse still if he hadn't intervened. Maybe that's as much consolation as exists for anyone who contemplates history's woes.

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