

Rememberances, Mementos, and Time-Capsules

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Time Capsules and Presentism

I want to consider some features of the position put forward by Julian Barbour in *The End of Time*¹ that seem to me of particular philosophical interest. At the level of generality at which I'll be concerned with it, the view is relatively easy to describe. It can be arrived at by thinking of time as decomposing in some natural way linearly ordered atomic parts, 'moments', and combining an observation about the internal structure of moments with an epistemological doctrine about our access to the past. The epistemological doctrine, which I'll call 'Presentism', following Butterfield, is the view that our access to the past is mediated by records, or local representations, of it. The observation is that the state of the world at any moment has the structure of what Barbour calls a 'time capsule', which is to say that it constitutes a partial record of its past, it is pregnant with interrelated mutually consistent representations of its own history.

When he speaks of time capsules, Barbour has in mind things like tracks formed in a cloud chamber when a decaying nucleus emits an α -particle,² footsteps in the sand made by a passerby, or fossil records of prehistoric animals. But to get a grip on what time capsules look like in cases that approach realistic complexity, you should think of something like Proust's *Remembrance of Things Past* conceived not as an historical novel, but as a description of the intrinsic structure of a single moment. For the book is not really about the past, but about the traces that it has left on the present, and what it gets exactly right is the way in which each temporal part of one's conscious life is a kind of Barbourian time capsule. Each living moment has written into it, into its *intrinsic* structure, a representation of times that preceded, replete with *their* internal representations of those that preceded *them*, and theirs of those that preceded them, and so on, potentially *ad infinitum*.³

¹ London: Weidenfeld and Nicholson, 1999.

² The Mott-Heisenberg analysis of α -decay is his explicit model.

³ My present experience is coloured by memories, including memories of myself remembering, and the way those memories coloured experience under them.

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Barbour, as I said, isn't so literary about it, but part of the appeal of his position is that it gets something right about the structure of a life, and something right about our *experience* of time. Each moment is at least as richly structured as Proust's novel; every moment contains within it its very own *Remembrances of Things Past*. The way to picture McTaggart's B-series⁴ is not as a sequence of structureless points, but a stack of novels, each as thick as Proust's, and each containing a kind of Proustian representation of those that precede it.

Combine this insight into the internal structure of the parts of time, with Presentism, and a gap opens up between the records and what they are supposed to be records of (i.e., between the past and the present representations of it)⁵ that Barbour exploits (and that Bell first recommended to followers of Everett to do so) to reconcile the appearance of historical continuity (i.e., the *appearance* that the present state of the world arose as the product of continuous evolution from earlier states) with its non-actuality.⁶ From an epistemological perspective, the gap was always there—it was always possible to call into question the accuracy of our historical records—(Russell made the point with his remark that for all we know, the world was created three seconds ago, replete with fossils, and history books, memories, and all the rest of it)—but it is exacerbated in the context of quantum mechanics for reasons I'll say below.

Now, go back to the stack of Proust volumes. The time capsule structure of each means that it contains a representation of the volumes that precede it, but there is nothing in the picture—and nothing in particular, in the *internal* consistency of the various volumes in the stack—that keeps us from stacking volumes that are inconsistent *with one another*, i.e., that *misrepresent* earlier representations of historical events, and misrepresent them precisely as

⁴ 'The Unreality of Time', *Mind*, New Series, 68, Oct. 1908. McTaggart distinguished two series in which events were ordered, an A-series, which ordered them in terms of their relations to the present moment, and a B-series, which ordered in terms of their unchanging, eternal, temporal relations to one another.

⁵ No restriction on the form such records take is presumed; photographs, recordings, footprints in sand, traces in memory...

'But what is the past? Strictly, it is never anything more than we can infer from present records. The word "record" prejudices the issue... we might replace "records" by some more neutral expression like "structures that seem to tell a consistent story".' (Barbour, op. cit., p. 33)

⁶ 'Quantum Mechanics for Cosmologists', in *Speakable and Unsayable* in *Quantum Mechanics*, Cambridge University Press, Cambridge (1987), p. 117–38.

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being consistent with their own depiction thereof. What we've really got, so far as constraints on the consistency of the picture go, is a set of novels horizontally stacked, potentially disagreeing about historical events, but representing themselves *as* in accord. And the discrepancy is undiscoverable so long as we are epistemically trapped within the pages of a particular novel, forever creating new records of old records, and of relations between old records and what they are records of, but never in a position to compare any record directly with the event it purports to record. We have no way of establishing the reliability of the mechanisms that generate records of past events that doesn't itself make use of those mechanisms. The circle of justification is inescapable, and it is vicious.

The insight in Bell's recommendation to Many Worlds theorists that they relinquish continuous trajectories, is that this kind of structure, internal to the parts of time, places virtually no restrictions on the external relations *between* them. We can give a completely consistent description of a universe constituted by a set of time capsules, arranged in a McTaggartian B-series, containing internally consistent representations of their own histories but inconsistent *with one another*, and inconsistent, moreover, with the actual history, jointly constituted by the lot of them. But Barbour takes things one step further, and, in a bold Leibnizian move, kicks away even the external relations between the time capsules, so that there is not, in actuality, any history at all. In Barbour's picture, time capsules bear one another internal relations of similarity and accord, but there is no external dimension in which they are collectively ordered.⁷ There are not really any genuinely external relations between time capsules, none that don't supervene on their internal properties.

Moments, in this picture, are elements in a grand configuration space, like the worlds in Lewis' modal universe; there *is* no time-like dimension constituted by them collectively and misrepresented by them individually. An order can be reconstructed *within* each moment by stacking together internal *representations* of others, using a procedure that works by comparing their intrinsic structures.⁸ But that, according to Barbour, is only an internal surrogate,

⁷ Just as, in a Leibnizian universe, there is not any genuinely external dimension in which the monads are ordered; spatial relations, such as they are, arise from relations among the intrinsic properties of monads. This is why I call the move Leibnizian.

⁸ The procedure identifies places across time in a way that minimizes resulting overall motion of bodies, and it turns out that both Newtonian time, and time in General Relativity are explicitly definable in this way from the dynamical evolution of the universe.

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compatible with the non-existence of any real, external time. All that there is, on this view, are the various instantaneous configurations of the universe,⁹ replete with their interior ‘records’ of other instantaneous states, arranged in a relative configuration space by a similarity relation expressed by Barbour’s best-matching procedure.¹⁰

There are a huge number of details, and they matter, but that, if I understand it, is the broad vision. What our physics, properly understood, gives us, according to Barbour, is a ψ -function sitting timelessly in a relative configuration space, defining a probability distribution that clusters on time capsules¹¹, with the *appearance* of temporality arising from structure internal to the capsules. The view is a temporal analogue of Leibnizian monadism. Whereas, for Leibniz, space arose from purely internal relations among monads, each of which contains an internal representation of itself *as* located in a real space (i.e., in a network of external relations among spatially extended systems), for Barbour, time arises from purely internal relations among monads, each of which contains a representation of itself *as* located in real time.

What puzzles one about the picture is the question of why, having gone so far, Barbour stops where he does? What reason could he have, by his own lights, for supposing the universe contains anything more than a single time capsule? It’s the same puzzlement one feels, in a Many Worlds universe, about what the other worlds are *there* for, or in a Leibnizian universe about why one should suppose that there are *multiple* monads. The problem, in each case, is that once you have written all worldly structure into one part of the universe, you are left with nothing for the other parts to *do* (except, perhaps, if this is a proper sort of occupation—*get represented*, and the thing about the other time capsules in a Barbourian universe is that they don’t even do *that* very well). It’s as though Barbour replaced windows with paintings of external landscapes, and then insisted on keeping the landscapes, denying even, that they were faithfully depicted.¹²

⁹ All those ascribed a non-zero amplitude by the quantum state.

¹⁰ E.g.: is time atomic? How big is the smallest time-capsule? Endless technical details, and questions of motivation.

¹¹ Barbour is up-front about the conjectural nature of the assumption that the ψ -function will end up clustering on time-capsules; the position could fall on this purely technical consideration.

¹² At least in the case of monads, their internal structure really *does* reflect the actual network of relations, though it turns out that they are internal.

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Suppose we parted ways with Barbour on this question and held that the universe consists of a solitary Barbourian time capsule: a single temporal monad. It would be hard to say, in that case, what remains of Barbour's denial of the reality of time. It is an essential part of the view, crucial to its empirical plausibility, that time capsules have an internal surrogate for time (i.e., parts that represent parts of time, and that can be ordered by a best-matching procedure into a representation of history), and the question is, what is missing in a universe that consists of a single capsule, to make one want to describe it as a time-less one? What distinguishes it from an ordinary McTaggartian B-series? And if nothing, why would one describe a view that holds that the universe consists in a whole big bunch of these as one that denies the existence of time? Isn't it rather a temporally **rich** universe? What this puts pressure on is the very difficult analytic question, raised by any view that denies the reality of time, of what it is, exactly, for time to exist.

I can think of a couple of things that might make one resist describing the single capsule universe as an ordinary temporal reality. One is that while a time capsule has an internal time, it is not itself extended in time. It is like a book with parts that represent parts of time, but that are not themselves arranged *in* it. The second is that the gappiness of historical records in a time capsule universe has to be given an ontological interpretation. The history of such a universe has to be as spotty as our records of it; if there is nothing in its occurrent state to determine the precise moment between two times, t and t^* , that an α -particle is emitted from a radioactive atom, then there *was* no such moment (although it will still be correct to say that the particle was emitted, and indeed emitted between t and t^*).¹³

Both considerations seem too esoteric to underwrite the denial of the existence of something that plays such a central role in so much of our thinking about the physical world. And Barbour, in any case, holds firmly to the existence of all time capsules assigned a non-zero probability by the ψ -function. His reason is this:

'I believe all of Platonia is "there", not just a single time capsule, because there is then at least some chance of explaining why I experience this instant (because it is one of many to which the wave function of the universe gives a high probability). So the mere fact that I experience this instant with properties that (in

¹³ Suppose that t is the time at which we prepared the particle, that t^* is the instant, 5 seconds later, at which it is first detected outside the nucleus, and that there is nothing to place the emission event at any moment between t and t^* .

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principle if my scheme is correct) theory predicts allows me to conclude that the others must be experienced too.’¹⁴

I’m not sure what to make of this, but I’ll let Barbour have the last word, and turn to a couple of features of the general metaphysical picture that make it interesting from a philosophical perspective.

Temporal Leibnizianism

The first is something I have already noted: the Leibnizian structure of the Barbourian universe. Leibniz’ and Barbour’s pictures both make something of the fact, which is both a consequence of our physical theories, and a salient feature of our experience of the world, that every part of space and time has written into its material contents—i.e., into the structure of the concrete bodies, and the waves it contains, into the memories of the people that occupy it, and the books and sounds they produce—variously complete and variously faithful representations of other parts.

Our physical theories provide us with increasingly detailed accounts of natural mechanisms that give rise to this kind of structure (theories of wave-propagation that tell us how waves carry structure from one part of space to another; neurophysiological theories that tell us how world-representing structure gets built into the wet stuff between our ears, theories we can add to our practical understanding of how to build the structure in our heads into our material surroundings). It is something that Bohm calls attention to repeatedly, and that plays a central role in his own philosophy;

‘consider ... how on looking at the night sky, we are able to discern structures covering immense stretches of space and time, which are in some sense contained in the movements of light in the tiny space encompassed by the eye (and also how instruments, such as optical and radio telescopes, can discern more and more of this totality, contained in each region of space).’¹⁵

And rather than reify the global structure in each of the parts, Barbour and Leibniz both deny the existence of anything over and above the parts, and think of temporality and spatiality, respectively,¹⁶ as emerging from internal relations among, or structure internal to,

¹⁴ Personal communication.

¹⁵ ‘Quantum Theory as an Indication of a New Order’ in *Wholeness and the Implicate Order*, Routledge, New York (1980), p. 149.

¹⁶ Or, in Barbour’s case, the appearance of it.

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the parts. Barbour does with time essentially what Leibniz does with space, and what Bohm does with space-time. There are differences, to be sure: Barbour takes time as the basic structure, denies the existence of genuine temporal relations between time-capsules, and doesn't place restrictions on the internal relations among them. Leibniz takes space as the basic structure, and denies the existence of spatial relations (conceived non-reductively as genuinely *external* relations between monads), but places strong consistency constraints on internal relations among them.^{17,18} Bohm takes space-time as the basic structure, conceives of spatio-temporal relations as full-fledged, external relations between point-like events, and has much that is new, and very interesting, to say about the particular way in which global structure is locally represented. But all of them have in common the basic construction of a whole constituted by parts that contain (variously complete and variously accurate) representations of it.

Memories and mementos

The second thing I want to consider is the relationship between Barbour's metaphysical view and quantum mechanics. The insight Barbour took from Bell was that one can deny that the actual history of the world is continuous, while explaining the *appearance* of continuity by pointing to quantum mechanisms for the creation of consistent records. The idea was that once you've got all this past-representing structure written into the present, acknowledged that knowledge of the past is mediated by knowledge of present past-representing structures, and accepted a quantum-mechanical account of how such structures (i.e., records) are produced, you realize that the appearance of consistency (which is to say, a positive result for measurements to check the accuracy of our records of the past) places virtually no constraints on the actual relations between those records and the past, or even, indeed, among those records themselves. The history of the world may jump around as discontinuously as you please from one moment to the next, without any threat to the appearance of continuity, and without any way of dis-

¹⁷ The internal structures of monads have to be unfolding in sync with one another in a way that gives rise to the impression of a common external cause.

¹⁸ The other difference, of course, is that Barbour describes his view as a denial of the reality of time, where Leibniz describes his as a view about the true nature of space.

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covering that the physical mechanisms that produce records are anything but what they purport to be: more or less reliable ways of generating faithful representations of past events. Barbour did Bell one better by denying that there *are* trajectories, continuous or otherwise. All that exists, according to him, is the collection of time capsules, and the ψ -function giving their relative probabilities.

Butterfield, in a review of Barbour's book,¹⁹ points out that Presentism, as a philosophical doctrine, isn't inevitable. And that is correct. But it does express the epistemological position in which our *physical* theories (both classical and quantum) cast us, and that gives it something more than the status of an optional, and not especially attractive, philosophical view. We simply *cannot* accept a broadly naturalistic picture of ourselves and deny that our knowledge of distant places and times is mediated by local representations. He also remarks that Barbour's position makes as much sense in classical contexts as in quantum mechanics, and that too is correct, but it leaves out Bell's central insight.²⁰ It is true in the classical world, as surely as the quantum one, that we are trapped in the present, forever planning new measurements to check results of old ones, but no more able to check whether the new are consistent with the old than whether the old are consistent with what they measure, i.e., forever creating records of past events, and records of the relations between those records and the events they record, with no independent way of ascertaining whether the mechanisms for creating records really *do* that, no way of telling for sure, that is, whether they actually reveal pre-existing consistency.²¹

The twist added by quantum mechanics is that it elevates what was in the classical case a mere epistemic possibility (*viz.*, that

¹⁹ Butterfield, *BjPS*, forthcoming. The article surveys the whole of Barbour's work and situates it with respect to the contemporary philosophical literature about time.

²⁰ Bell himself dismisses the view on the grounds that it gives rise to scepticism:

"Everett's replacement of the past by memories is a radical solipsism – extending to the temporal dimension the replacement of everything outside my head by my impressions, of ordinary solipsism or positivism. Solipsism cannot be refuted. But if such a theory were taken seriously it would hardly be possible to take anything else seriously." (Bell, *op.cit.*, p. 136).

²¹ There are two ways to think of the relationship between records and measurements; you can think of measurements as interactions that create accessible records of not otherwise accessible facts, or you can think of records as the presently accessible results of measurements on the past.

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measurements don't simply create records of preexisting facts) to a nomological necessity. The theory actually entails non-canonical relations between measurement results and the events they are supposed to record.²² Whereas in classical mechanics, the physical laws entail that a photograph, a footprint in the sand, or in general, the position of a pointer observable after measurement can only have arisen by a deterministic process from the preceding events of which they constitute records, in quantum mechanics, the physical laws themselves block any direct backward inference from the result of a measurement to the state of the world beforehand. Whereas in classical mechanics, one cannot deny the faithfulness of records and the reliability of the processes that generate them without denying the physical laws, the laws of quantum mechanics themselves *entail* that records aren't generally reliable. For recording is just a kind of measuring, one that takes the present observable state of the world as a pointer observable in a measurement of its state in the past. And we know that we cannot in general interpret the results of individual quantum mechanical measurements as simple, faithful representations of the state of the measured system.

There is a film in theatres now called *Memento* in which the hero doesn't have a short term memory, and has to rely for his information about the recent past, on various kinds of material artifacts: snapshots, written notes, tattoos, what other people tell him. We think that the fact that we have memories puts us in a better position, but if memories are just tattoos in the brain—i.e. present representations of the past events—the difference is shallow. They are only as reliable as the processes that produce them.

Conceived naturalistically, memory has the same status as perception; both are physical processes that generate local (respectively, present/internal) representations of distant (past/external) states of affairs.²³ Doubt is appropriate if there are occasional, contextual reasons for thinking that the mechanisms aren't functioning normally (things are broken, conditions are non-standard, or some

²² The only thing we can conclude from the result of an individual measurement is that the measured system is not (or, is with measure zero probability) in an eigenstate of the measured observable with eigenvalue orthogonal to the one observed.

²³ There are philosophical positions (sometimes called 'direct realist') that hold that both perception and memory, are representationally unmediated ways of apprehending external things and the past. So long, however, as we are spatially localized things picking up information about our environments from local causal interactions, Presentism is the epistemology built into our physical theories.

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such), but global scepticism is possible only by denying that the mechanisms operate as they are supposed to, i.e., by holding a special, non-standard *theory* about their operation. That is what traditional sceptical possibilities offer; whatever else it is, Descartes' evil daemon is an alternative hypothesis about the mechanisms that give rise to our perceptual states.

The lesson that Barbour took from Bell, and that we can learn from him, is that quantum mechanics provides just the kind of non-classical account of the generation of records that undermines their general reliability as sources of information about the past. The insight is that in a quantum context, the mechanisms that generate future representations of moments past leave us with something that bears as loose a relation to their source as the post-measurement position of a pointer observable to the pre-measurement value of the measured observable. The hero of *Memento* gets into all sorts of difficulties because his records are generated by unreliable mechanisms (they are produced by people [himself included] and hence dependent for their reliability on the trustworthiness of their producers). If we call records like that 'mementos', we can put the lesson by saying that, where classical physics gave us memories, quantum mechanics gives us only mementos.²⁴

Queries

A couple of final questions. There is an irony in the fact that at just the point that Barbour thinks physics has divested itself of all vestiges of temporality, if what I have been suggesting is correct, it actually does a fair job of capturing central features of the *experience* of time. One of the most surprising things about Barbour's view is just how much of our temporal experience can be recovered from structure *internal* to his time capsules.²⁵ This raises again the question of why Barbour describes his view as a denial of the *reality* of time, rather than an idiosyncratic theory about what time *is*. The question is not inconsequential. It is, of course, in its general form ('What does the world have to be like for time to be real?', or, more

²⁴ Or, a formulation I prefer, the classical world remembers its earlier states, where the present state of the quantum universe is merely a memento of its past.

²⁵ I have argued, independently that we can even find in the relations among temporally situated representations of time—of which time capsules are instances—something that satisfies McTaggart's desiderata for passage ('The Reality of Time', *ms.*).

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pointedly, ‘What properties must a physical parameter have to deserve to be called “time”?’) the question that confronts the quantum gravity theorist.

Another question that it would be good to hear more from Barbour about has to do with records. Time capsules are records of a certain kind, specifically, structures that encode an appearance of history. But he doesn’t give any explicit, intrinsic characterization of what this means. In the classical contexts, we could think of them as structures generated by mechanisms that lend them a kind of natural intentionality; we could say that A is a record of B *iff* B was caused in the right way by A, or, perhaps, if B was typically a reliable sign of a preceding A-occurrence, or if A gave rise to B by a structure-preserving process, or some such thing.²⁶ The problem is that in a quantum context, reliable covariation is out of the picture, and Barbour forswears external connections, so causal relations, at least as usually conceived, aren’t available to him. In virtue of what, by Barbour’s lights, does an instantaneous configuration (e.g., a footprint in the sand, a track in a cloud chamber) constitute a record of this or that sort of preceding event.

Questions about what it is for a structure to have representational purport, and to have the particular purport that it does, are notoriously hard; the reason it is fair to demand something more from Barbour in the way of an explicit account is that his central notion is ill-defined without one, and none of the approaches in the literature would seem to serve his purpose.²⁷ There are some indications in his discussion of the Mott-Heisenberg analysis of α -decay of how it might go, but one would like to see it worked out.

There is a very great deal more to say about the view; I have focused on features that are especially suggestive from a philosophical perspective: in particular, the surprising degree to which our experience of time can be recovered from structure *internal* to its parts, and the insight about the looseness, in a quantum context, of the relationship between the past and our present representations of it. There are other aspects of the position, also of philosophical interest, and a number of deeply perplexing issues, that I haven’t

²⁶ There are a variety of accounts in the literature, all presupposing some form of causal determination or nomological covariation.

²⁷ The derived intentionality of artifacts like linguistic structures, designed with representational **intent** isn’t obviously applicable (unless the intent is God’s, and Barbour wants to convict him of malice). One might surmise, however, from some of his remarks about consciousness, that Barbour inclines towards some sort of irreducible intentionality derived from their relations to human minds.

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touched on (not to mention endless questions, of both a technical and conceptual nature, concerning the physics and the relationship to quantum gravity).²⁸ It is bound to take some time before the view is fully absorbed, and I am not sure I have understood it entirely, but it seems to me a genuinely *new* position, with deep and acknowledged affinities to Leibnizian monadism, that is bound to repay philosophical attention.

²⁸ There are a whole set of questions, for instance, about what Barbour means when he talks about selves; he speaks sometimes as though he is a self-aware time-capsule, and sometimes as though he thinks he is temporally extended, 'present', somehow, in different time capsules.

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