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Fabrice Correia
Andrea Iacona *Editors*

Around the Tree

Semantic and Metaphysical Issues Concerning Branching and the Open Future

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Preface

In 1958 Arthur Prior received a letter from Saul Kripke in which the latter expounded an idea Prior found congenial, as it suggested one way to give substance to some of his reflections on time and modality. The idea was that in order to capture the idea of indeterminism, one should represent the courses of events which are possible from a given moment on as branches of a tree (see Ploug and Øhrstrøm 2011). Prior (1967, p. 126) sketched a model for tense logic along these lines:

> […] a line without beginning or end which may break up into branches as it moves from left to right (i.e. from past to future), though not the other way; so that from any point on it there is only one route to the left (into the past) but possibly a number of alternative routes to the right.

Shortly after, the tree model was formulated in a more rigorous way by Richmond Thomason (1970), and since then it has constantly aroused the interest of people working in philosophy and logic, as well as other areas such as computer science and physics.[1]

This volume discusses the philosophical implications of the tree model. Over the past few years, the model has been widely employed to deal with issues concerning the semantics of temporal discourse. The thought which has motivated its adoption is the Kripke-Prior thought that the most plausible way to make sense of indeterminism is to conceive of future possibilities as branches that depart from a common trunk, constituted by the past and the present. However, the thought still needs to be further articulated and defended, and several important questions, both semantic and metaphysical, remain unanswered. The volume is intended to be a 360° reflection on the tree model. The contributions it gathers concern the model and its alternatives, both from a semantic and from a metaphysical point of view.

[1] The references in all these areas are numerous. The papers in this volume contain references to the main philosophical works. For computer science, see, e.g., Huth and Ryan (2004) and for physics, Belnap (1992), McCall (1994), and Saunders et al. (2010). For logic, one may consult Hodkinson and Reynolds (2006) and Zanardo (2006).

One of the questions that are still open is how actuality can be understood and formally represented in a branching framework. This question, which concerns the conceivability of the actual future as a *Thin Red Line* (to borrow a term coined in Belnap and Green 1994), is addressed primarily by Andrea Borghini and Giuliano Torrengo, Manuel García-Carpintero, and Andrea Iacona. Another question is whether the tree model is really the best way, or even a coherent way, to make sense of indeterminism. This question is addressed particularly by E. J. Lowe and Sven Rosenkranz. Further questions may be raised about the relation between the idea of branching and other notions or views: Craig Bourne and Emily Caddick Bourne focus on fictional representation, Fabrice Correia on presentist reductions of eternalist discourse, Ned Markosian on presentism and the truth-maker problem, and Storrs McCall on rational agency.

The idea of a volume with this title comes from a meeting on *Language and Temporality* held in L'Aquila, Italy, in September 2009. On that occasion, some of the contributors had the opportunity to discuss, among other things, the materials of their papers. The remaining contributors joined the project at a later stage. A shared feeling that emerged at the meeting, and that grew stronger as other works were added to the initial papers, is that an extensive discussion on the tree model as such would be welcome in many respects. We hope that this volume can help to raise the level of the debate on branching and the open future. Its main purpose is to show that there is still plenty of room for discussion on these issues.

Fabrice Correia and Andrea Iacona

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Contents

Relativism, the Open Future, and Propositional Truth

Manuel García-Carpintero

Abstract In his paper "Future Contingents and Relative Truth," John MacFarlane argues for truth relativism on the basis of the possibility of the open future. He defends the relativization of a truth predicate of linguistic items: utterances of sentences produced in concrete contexts. In more recent work, however, he contends that this was wrong, because when propositions are taken as truth bearers, the truth absolutists he was objecting to have an escape, and offers a new argument for relativism based on the semantics of "actually." Here, I will critically examine these points. In the first place, I will suggest that the new argument concerning "actually" is not convincing. More importantly, I argue that truth absolutists should not accept MacFarlane's "gift," that is, his proposal for them to resist his previous arguments once they take truth to be a predicate of propositions: *if* there was a good argument in "Future Contingents and Relative Truth" for truth relativism taking truth as a property of linguistic items, there is still one when taking it as a property of propositions; these issues do not depend on the nature of truth bearers. I conclude by outlining what I take to be the best line for truth absolutists to take regarding the open future.

Keywords Future contingents • Open future • Indeterminism • Truth

Preamble

In his paper "Future Contingents and Relative Truth," John MacFarlane (2003) argues for truth relativism on the basis of the *a priori* possibility of the open future. He defends the relativization of a truth predicate of linguistic items: utterances of

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sentences produced in concrete contexts. In more recent work (2008, 94), however, he contends that this was wrong, while, on the one hand, taking linguistic entities such as sentences or utterances as truth bearers goes against ordinary usage,[1] on the other, his arguments depend at crucial points on intuitions about ordinary truth predications.[2] Moreover, he contends that, once his arguments are evaluated with respect to a reconstruction of the ordinary truth predicate applied to propositions, truth absolutists – in particular, truth absolutists defending supervaluationist accounts of truth vis-à-vis the open future – are in a position to resist them. Fortunately for him, he has a new argument for truth relativism, this one based on the semantics of the "actually" operator.

In this chapter, I will critically examine these points. In the first place, I will suggest that the new argument concerning "actually" is not convincing. More importantly, I want to argue that truth absolutists should not accept MacFarlane's "gift," that is, his proposal for them to resist his previous arguments once they take truth to be a predicate of propositions: *if* there was a good argument in "Future Contingents and Relative Truth" for truth relativism taking truth as a property of linguistic items, there is still one when taking it as a property of propositions; these issues do not depend on the nature of truth bearers.

The latter point turns on the nature of truth relativism, and so my main aim is to contribute to clarifying this issue. Several people, MacFarlane himself among them, have distinguished two varieties among recent truth-relativist proposals: a "moderate" one (which MacFarlane, with a descriptively accurate label, calls "non-indexical contextualism" – the proposal advanced by Kölbel (2004), for instance) and a more "radical" one, which is the one that he himself endorses (under the simpler label "relativism"). According to my own (2008) previous suggestions for characterizing the debate, which in their turn follow Evans' (1985), the two varieties correspond to *content-truth* relativism, which is not worrying and is, I think, an adequate semantic proposal for some applications, and *assertion-truth* relativism, which may well be incoherent and which in any case we should resist, for reasons already outlined by Evans. I will argue that by accepting MacFarlane's proposals the purportedly truth absolutist ends up embracing the latter – which would make his views doubly incoherent, if assertion-relativism is so already. Thus, truth absolutists have every reason to reject MacFarlane's poisoned gift.

This leaves us with the original argument for relativism based on the open future, which, if my main point in this chapter is correct, still stands when we take

[1] As he (2005, 322) puts it, "there is something a bit odd about calling utterances or assertions, in the 'act' sense, true or false at all. We characterize actions as correct or incorrect, but not as true or false"; assertions in the object sense – "what is asserted" – are according to him (2008, 93) just propositions.

[2] Austin (1950, 119) – who had as good an ear for common usage as anybody – pointed out that it is also far away from common usage to predicate truth of propositions, in the philosophers' sense. Ordinary language predicates truth of *things said*, which in my own view are not just propositions, but propositions taken with a generic constative force.

propositions to be our primary truth bearers. Although this will not be my main concern here, I will rely on recent work by Greenough (ms) and Barnes and Cameron (2009), as well as a previous proposal by Tweedale (2004), to suggest that, at least if we take for granted the atemporal metaphysical foundations that MacFarlane himself assumes, the truth absolutist has no need for worry.

This chapter is structured in four sections. In the first, I present MacFarlane's (2003) original argument for truth relativism based on the open future and then his (2008) recent worries about the original argument and his suggestion for how the supervaluationist can resist it. In the second, I present his new argument concerning "actually" and show why it is unconvincing. The third section discusses the core issues just summarized concerning the irrelevancy of the nature of truth bearers for disputes concerning truth relativism. The final concluding section outlines the view I favor to resist truth relativism based on the open future.

MacFarlane's Original Argument and the Truth Absolutist's Alleged Escape Through Propositional Truth

There are *dynamic* (presentist, growing-block-theoretical, etc.) and *static* ways of thinking of the metaphysics of the open future. MacFarlane assumes a static, atemporalist way of presenting the issues, and it will be convenient for me to follow suit – although, at the end of the day, this might betray the most fundamental problems at stake. The assumption is that the basic particular facts until a given moment in time m_0 (today) – which we will think of as specified in tenseless language – plus the laws of nature leave open several possibilities: on a history h_1 open at m_0, there is a sea battle at m_0 plus one day (tomorrow), m_1 in h_1; on another h_2, there is peace at that time in that history, m_2.[3] At m_0, Jake assertorically utters (1):

(1) There will be a sea battle tomorrow.

"Is his utterance true or false?" MacFarlane (2003, 323) asks and goes on to argue as follows: "The utterance takes place at m_0, which belongs to both h_1 and h_2. In h_1 there is a sea battle the day after m_0 while in h_2 there is not. We may assume that nothing about Jake's intentions picks out a particular history (h_1 or h_2). Jake may

[3] I follow MacFarlane (2003, 323) in presupposing "the metaphysical picture of objective indeterminism articulated in N. Belnap *et al.*, *Facing the Future* (Oxford University Press, 2001), pp. 29–32, 139–41. Moments are idealized time-slices of the universe, partially ordered by a causal–historical precedence relation (<) with no backward branching, and histories are maximal chains of moments." Cf. also Thomason (1970). In speaking of "basic particular facts," I am gesturing in the direction of any adequate way of putting aside "facts about the future" such as the fact that it is true in 1492 that the Olympic Games were going to be held in Barcelona 500 years later.

take himself to be making a claim about 'the actual future history', but if this means 'the future history that includes this utterance', then it is an improper definite description. There is no such unique history. Given that nothing about the context of utterance singles out one of the histories of which it is a part, symmetry considerations seem to rule out saying either that the utterance is true or that it is false. Thus, it seems, we must count it neither true nor false. This is the indeterminacy intuition."

MacFarlane then argues that a supervaluationist account of the truth conditions of utterances (modeled here as sentences in contexts) provides the best way of capturing this alleged *indeterminacy intuition*. For familiar reasons into which we do not need to go here, we need double indexing of the *points of evaluation* posited by our semantic machinery (distinguishing *contexts* and *indexes*), in order to discriminate the relativization of the semantic values of context-dependent expressions such as indexicals (which depend on nonshiftable features of context) from that of expressions whose values depend on indexes shiftable by operators.[4] For present purposes, we only need to care about the relativization of truth values to the times of contexts and histories passing through them.[5] Thus, to illustrate, we define as follows the semantics of a "settled at *m*" operator:

(Sett$_m$) ⌜Sett$_m$: ϕ⌝ is true at a point of evaluation $<C, h>$ if and only if, for every *h'* overlapping with *h* at *m*, ϕ is true at $<C, h'>$

When we consider the evaluation of an utterance of a sentence at a context, we fix the relevant parameters in these relativizations, thus obtaining an absolute truth value; this is how the supervaluationist account, to be discussed here, proposes to do it, with $H(C)$ designating the class of histories overlapping at C:

(SVT) ϕ is true [false] at a context of utterance C if and only if ϕ is true [false] at every point $<C, h>$ such that $h \in H(C)$.

(SVT) assigns an absolute truth value to Jake's utterance of (1), which agrees with the indeterminacy intuition: on this proposal, the utterance is neither true nor false at m_0, the time of Jake's utterance.

The problem with this, MacFarlane (2003, 324–5) argues, is that given the absoluteness of utterance truth on this proposal, it cannot capture a *determinacy intuition* we also allegedly have when it comes to *retrospective* assessments of utterances such as Jake's: "But now what about someone who is assessing Jake's utterance from some point in the future? Sally is hanging onto the mast, deafened by the roar

[4] See Kaplan (1989) and Lewis (1980) for clear expositions of those familiar reasons and different versions of the ensuing framework.

[5] I am presenting the arguments in MacFarlane's (2003) using the terminology in his (2008), for ease of exposition. As far as I can tell, nothing hinges on these decisions.

of the cannon. She turns to Jake and says 'Your assertion yesterday turned out to be true'." Sally's reasoning appears to be unimpeachable:

(2) Yesterday, Jake asserted the sentence "There will be a sea battle tomorrow."
There is a sea battle taking place today.
∴ The assertion that Jake made was true.

Sally's reasoning is additionally supported by Dummett's (1969/1978, 363) *Truth-Value Links* – the principles that articulate necessary connections of truth value between variously tensed sentences conceived as uttered at different times, such as this:

(TVL) "There will be a sea battle tomorrow" was true if uttered at d iff "There is a sea battle today" is true if uttered at $d+1$.

MacFarlane argues that the best account of the case is given by relativizing the truth of utterances to *contexts of assessments*, which ontologically are the same kind of thing as context of use, "a concrete situation in which a use of a sentence is being assessed" (2005, 309):

(RT) ϕ is true [false] at a context of utterance C_U and a context of assessment C_A iff ϕ is true [false] at every point $< C_U, C_A, h >$ such that $h \in H(C_U) \cap H(C_A)$.[6]

If we evaluate Jake's assertion with (RT) simultaneously when it is made, so that $C_A = C_U$, it is neither true nor false exactly as it was using (SVT), because both h_1 and $h_2 \in H(C_U) \cap H(C_A)$, but now, if we evaluate it with Sally's as context of assessment, it turns out to be true, because non-sea-battle-at-that-time histories are ruled out from then on. We thus capture the determinacy intuition, while sticking to the supervaluationist's diagnosis of the indeterminacy intuition. Later on, we will be in a better position to appreciate the cost we have incurred in obtaining this result. Let us now move on to MacFarlane's (2008) recent qualms about this argument for truth relativism.

The problem he sees, as announced above, is that the argument is based *on intuitions we are supposed to have* as regards the evaluation of claims or assertions in the face of the open future, but we do not have any intuitions when it comes to evaluating linguistic items such as utterances, because this is not a practice that we follow in ordinary parlance. In fact, as MacFarlane notes, Sally's argument (2) was not presented in his original paper, as it is above, but thus:

(3) Yesterday, Jake asserted that there would be a sea battle tomorrow.
There is a sea battle today.
∴ Jake's assertion was true.

[6] Or just to *H(CU)*, if no history overlaps with both *CU* and *CA*. I will disregard this possibility in what follows.

MacFarlane (2008, 94) comments on this as follows: "I think there is a reason I slipped into proposition talk in giving the retrospective assessment argument, despite my efforts to avoid it elsewhere. I was trying to elicit the intuition that the retrospective assessment of Jake's prediction as true was a natural one – something no ordinary person would reject. And in ordinary speech, truth and falsity are almost invariably predicated of *propositions*." The problem this poses is as follows:

> [S]upervaluationism gives the "wrong" retrospective assessments of truth for past utterances of future contingents. But if I am right that utterance truth is a technical notion that plays no important role in our ordinary thought and talk, then the supervaluationist can accept these consequences without being revisionist about our ordinary future-directed talk. What really matters is whether supervaluationism can vindicate our retrospective assessments of the truth of *propositions*.

MacFarlane contends that, indeed, it can. In order to see this, we need to model the ordinary language monadic truth predicate of propositions; MacFarlane proposes this definition:

(True) "True" applies to x at a point of evaluation $<C, h>$ iff (i) x is a proposition, and (ii) x is true at h.

MacFarlane (2008, 25) highlights what he takes to be two virtues of this definition. In the first place, it does not have an argument place for a time, so it is never true to say that a proposition is True at a time and not True at another time; MacFarlane suggests that tense indications in ordinary talk about the truth or falsity of propositions (as in "what you said yesterday *was* true") result from merely grammatical, nonsemantic requirements. Secondly, on the assumption (EXP), it implies every instance of a disquotational principle, (DIS):

(EXP) If S at C expresses x, then x is True at h iff S is true at $<C, h>$.
(DIS) $\forall x\ ((x = \text{the proposition that } S) \rightarrow (True(x) \equiv S))$.

But now, MacFarlane claims, the supervaluationist truth absolutist that invokes (SVT) as the proper account for the metalinguistic truth predicate *can* capture Sally's *propositional* retrospective assessment in (3), that is, the determinacy intuition properly stated. Let us consider how (SVT) leads us to evaluate Sally's assertion of (4),

(4) Jake's assertion is True.

Given (SVT), (4) is true at Sally's context C_1 including m_1 iff "True" applies to the referent of "Jake's assertion" at every point $<C_1, h>$ such that $h \in H(C_1)$. Now, according to MacFarlane (2008, 93), "'Jake's assertion' denotes what Jake asserted, not Jake's act of asserting it. Although the word 'assertion' can be used to refer either to an *act* of asserting or to the content of such an act, it is doubtful that we ever predicate truth of *acts* at all, even if they are speech acts." Thus, given (True), (4) is true at C_1 iff what Jake asserted is true at every such $h \in H(C_1)$. What Jake asserted is the proposition that there would be a sea battle the day after m_0, but the way we have described C_1 (with Sally "hanging onto the mast, deafened by the roar of the cannon") guarantees that proposition is true at

every $h \in H(C_1)$, because, as we put it before, non-sea-battle-at-m_1 histories are ruled out from then on.[7]

Can the supervaluationist also capture the indeterminacy intuition now? What would be the result of a supervaluationist evaluation of an assertion of (4) concurrent with Jake's assertion of (1) or just after it? There is a problem here, as MacFarlane admits; if the supervaluationist said that (5) is true, that would commit him to (6), given the disquotational principle (DIS):

(5) What Jake just asserted – that there would be a sea battle tomorrow – is not True.
(6) There will not be a sea battle tomorrow.

Given that, on the supervaluationist account, the utterance of (6) in Jake's context is untrue as much as (1) is, he should also deny that (5) is true; in fact, this appears to be the diagnosis provided by (SVT) and (True). It thus seems that now the supervaluationist is unable to capture the indeterminacy intuition; as MacFarlane (2008, 97) puts it: "the semantic fact recorded in the metalanguage by the observation that neither [(6)] nor its negation is true at such a context is *ineffable* from the 'internal' point of view. To express it, one must deploy the semanticist's technical notions of utterance truth or sentence truth relative to a context." To deal with the difficulty this poses, MacFarlane makes a proposal to the supervaluationist. The proposal is to introduce a "determinate truth" predicate:

(Det) "DetTrue" applies to x at a point of evaluation $<C, h>$ iff (i) x is a proposition, and (ii) x is true at every history $h \in H(C)$.

Thus, as MacFarlane (2008, 97) says, using this predicate "our speakers can correctly characterize propositions whose truth is still unsettled as 'not Determinately True'."

[7] On behalf of what she describes as "traditional semantics" – which she characterizes by its not countenancing relativizations to context of assessments, nor therefore MacFarlane's "very radical view" rejecting "the assumption of standard semantics that sentence truth is relative only to a context of use," Brogaard (2008, 329) accepts MacFarlane's suggestion for traditionalists to account for the determinacy and indeterminacy intuitions, in contrast to what I will later suggest they should do. She rejects instead MacFarlane's contention that traditional, supervaluationist semantics cannot capture those intuitions when it comes to the evaluation of linguistic items. She argues that even on the traditional assumptions, the following counts as true, uttered by Sally to Jake: "The sentence 'There will be a sea battle tomorrow,' as uttered by you yesterday, was true at the time of utterance." To show that she contends that the mentioned sentence is not merely mentioned but also used and resorts to Recanati's proposal concerning such *mixed* or *open quotation* cases. The essential feature of the idea is that, while indexicals such as tense or "tomorrow" in the mentioned sentence obtain their value from the implied context (Jake's) in which it was uttered, in order to obtain the ascribed proposition, the worlds/histories at which it is supposed to be evaluated are rather provided by the context of the ascription (Sally's). In this way, we obtain the same effect as with MacFarlane's proposal concerning evaluations of propositions as True or otherwise. Thus, Brogaard and I argue for the same claim, that the issues concerning relativism do not depend on whether sentences or propositions are truth bearers. Of course, for the reasons I will provide in the third section, I think that the way Brogaard's proposal manages to show this gives the game away to the relativist, much as MacFarlane's does.

I'd like to consign here, for later use, what I take to be a small oversight in MacFarlane's description of the status of this suggestion. He motivates the proposal as one useful "for those supervaluationists who *do* think that a proof of unsettledness should compel withdrawal of an assertion about the future" (as we have seen, they cannot demand this by using "True"). I find this way of motivating the proposal slightly inadequate, in the context of the present dialectics. The reason is this. The problem with the (2003) argument was held to be that the open future argument for relativism is based on intuitions we have, which any proper account should capture; our intuitions concern the evaluation of the truth of propositions, but when we consider an acceptable account of such intuitions, it turns out that the supervaluationist can capture one of them, the determinacy intuition. Now, if all of this is right, any proper account should *also* capture the indeterminacy intuition; hence, the supervaluationist who allegedly can capture the determinacy intuition must be shown to be equally able to capture it as well. Unfortunately, this, as we have seen, cannot be done *in the very same terms* invoked to account for the determinacy intuition. So I take it that MacFarlane's suggestion of introducing a "determinate truth predicate" is not merely intended, in the context of this dialectics, to help those who demand withdrawal of unsettled claims in the object-language but motivated first and foremost by the need to allow the supervaluationist to capture also the indeterminacy intuition *somehow*.

In fact, this is what MacFarlane's (2008, 98) concluding remark on the matter roughly acknowledges: "It now appears that […] the supervaluationist *can* account for the asymmetry between contemporary and retrospective assessments of contingent claims about the future. She can acknowledge that I can now truly assert 'What I said was true', even though I couldn't truly assert this yesterday. And she can acknowledge that I can now truly assert 'What I said was determinately true', even though yesterday I could have truly asserted 'What I just said is not determinately true'." The slight inaccuracy I am complaining about here consists in not making sufficiently explicit that, in fact, the proposal for the supervaluationist to capture the intuitions is not entirely convincing. To capture the determinacy intuition, he appeals to an object-language disquotational truth predicate of propositions, modeled by "True." But this cannot capture as well the indeterminacy intuition; to the extent that we ordinary speakers have it, the supervaluationist must say, it is either because we are deploying a unique ordinary truth predicate modeled by "True," and then we are confused, or it is because we have it with respect to a different truth predicate (a nondisquotational one), and then we are also confused, this time by our not realizing that we are deploying two different (even if related) truth notions, one disquotational, the other not.

I will come back to this point later when we are in a better position to evaluate the full package of pros and cons concerning the proposals at stake, including the one that MacFarlane makes on behalf of the supervaluationist. But before we come to that, I want to present and critically examine the new argument he thinks he has for relativism against the allegedly enlightened supervaluationist whose views we have just characterized.

MacFarlane's New Argument for Truth Relativism

In the framework we are using, the usual semantics for "actually" goes as follows:

(Act) ⌜ Actually: ϕ ⌝ is true at a point of evaluation $<C, h>$ iff ϕ is true at $<C, h_C>$, where h_C is the world/history including the context C.

As MacFarlane (2008, 98) notes on this definition, the operator satisfies an intuitively mandatory requirement of *initial redundancy*, which he proposes to state as (IR):

(IR) An operator * is initially redundant just in case for all S and C, S is true at C iff ⌜$*S$⌝ is true at C.

Now, in a branching framework, there is not just one world/history overlapping the context. Given this, MacFarlane suggests that in order to respect (IR), the supervaluationist should define "actually" as follows:

(Act_s) ⌜Actually: ϕ ⌝ is true at a point of evaluation $<C, h>$ iff ϕ is true at $<C, h'>$ for every $h' \in H(C)$.

In contrast, the relativist would offer the following definition:

(Act_R) ⌜Actually: ϕ ⌝ is true at a point of evaluation $<C_U, C_A, h>$ iff ϕ is true at $<C_U, C_A, h'>$ for every $h' \in H(C_U) \cap H(C_A)$.

We have seen in the previous section how the supervaluationist can somehow mimic the relativist account of the indeterminacy and determinacy intuitions when it comes to claims such as (1), once he turns to truth evaluations of propositions in the object-language. Compare now what supervaluationism has to say about an alternative utterance of (7) in the context of (1):

(7) There will actually be a sea battle tomorrow.

On the one hand, it appears that we have exactly the same indeterminacy and determinacy intuitions with respect to, respectively, contemporary and retrospective evaluations of the two assertions. And on the other, in the presence of (Act_s), the combination of (SVT) and (True) will not now allow the supervaluationist to capture the determinacy intuition regarding the retrospective evaluation today of the assertion of (7) yesterday: when evaluated today, in the middle of the sea battle, the claim made with (7) is as much unTrue as it was when evaluated yesterday, after it was made; because in both cases, given (Act_s), we are supposed to consider all histories overlapping the context at m_0, when the claim was made.

Before moving on to compare this result with the relativist proposal, I would like to highlight at this point one more small oversight in MacFarlane's presentation of the supervaluationist he characterizes, which adds to the one pointed out at the end

of the previous section. It is not just that such supervaluationism counts an assertion of (7) as unTrue, both in contemporary and retrospective evaluations; in fact, it counts it as False, and as DetFalse as well. For the semantics for "Actually" in (Act_S) makes it a settledness operator, an operator of historical necessity; hence, it is not just that the supervaluationist that MacFarlane envisages treats assertions of (7) and (1) asymmetrically, in that it cannot capture the retrospective determinacy intuition regarding the former while it allegedly can, regarding the latter. The view is totally unable to capture the indeterminacy intuition regarding contemporary evaluations of (7), not even in the peculiar way allowed to capture it regarding (1) discussed in the previous section.

This leads us to appreciate the second small oversight in MacFarlane's presentation. We can now see that, even though – as MacFarlane (personal communication) pointed out to me – "Actually" as defined by (Act_S) does meet (IR) (for that only requires that *S* and **S* are each *true* in a context if the other is), it does not meet what I take to be the intuitive idea of *initial redundancy*, which, in the present non-bivalent framework, should rather be that *S* and **S* must have *the same semantic value* in every context: true, false, or neither true nor false. To justify the intuitiveness of (IR), MacFarlane (2008, 98) says:

> This is not because "actually" has no effect on truth conditions, but because of a delicate relation between the semantics for "actually" and the definition of sentence truth at a context. The effect of adding an actuality operator to the *front* of a sentence is to shift the world of evaluation to the world of *C*. This has an effect on the sentence's truth-at-points profile, but not on its truth-at-contexts profile, because (in standard, nonbranching frameworks) a sentence is true at a context *C* just in case it is true at the point <*C*, *wC*>, where *wC* = the world of *C*.

Should these considerations not be extended to all truth values? If not, why not? In stating (IR) the way he does, and in not mentioning the fact that the supervaluationism he is describing counts as neither true nor false utterances of (1) but false those of (7) (and unTrue what (1) says, while False what (7) says, when contemporarily evaluated), MacFarlane (2008) overlooks a second, important peculiarity of the position he has construed as his target in that work[8].

Let us go back now to the exposition of MacFarlane's new argument. No discrepancy between our theoretical account of the intuitions concerning (1) and (7) is obtained when we use the relativist definition (Act_R), which makes the semantic value of "Actually" dependent not only on the context of utterance but also on the context of assessment. MacFarlane (2008, 101) concludes, "I think the relativist's view accords better with common sense." Is this so? Although, as I announced above and will explain in detail in the next section, this is a purely theoretical exercise,[9] it is still useful to see that MacFarlane's "Actuality" argument is not very compelling. Even if purely theoretical, the exercise of running through the reasons why this is so is, I think, convenient, for it will help us appreciate how subtle and complex

[8] Dietz & Murzi (forthcoming) make related points, cf. fn. 20 and surrounding text.

[9] For, to reiterate, I do not think any serious truth absolutist who adopts supervaluationism as a means for capturing his preferred option (among the two that the facts of the open future leave to truth absolutist, to wit: capturing the contemporary indeterminacy intuition, or rather the retrospective determinacy intuition) should accept MacFarlane's offer.

the issues are and the extent to which appeals to intuitions on these matters pose delicate problems.

As Lewis (1983, 19, see also postscript B) points out, "actual" is ambiguous between the *rigid* sense captured by (Act) and a *shifty* sense, which (8) and (9) illustrate:[10]

(8) If Max ate less, he would actually enjoy himself more.
(9) The following is contingent: in the actual world, Cæsar is murdered.

The shifty sense is captured by the following definition:

(Act_{sh}) ⌜Actually: ϕ⌝ is true at a point of evaluation $<C, h>$ iff ϕ is true at $<C, h>$.

In the shifty sense, "actual" also satisfies (IR), of course, because it is in fact an operator redundant *everywhere*, not just initially: it is just a particle used perhaps for rhetorical emphasis and such things. Concerning it, MacFarlane (2008, 99) concedes: "It may be that there is a use of 'actually' in English that behaves this way […] but we're after an operator that makes a difference in embedded contexts." We may be after it, but the presence of the shifty sense in natural language allows MacFarlane's contender an easy reply: to the extent that we do have indeterminacy and determinacy intuitions regarding (7), they can be explained in that we are assuming the shifty sense of the operator.[11]

MacFarlane does consider more complex examples, such as (10), for which this explanation would not work[12]:

(10) Today it is still possible that the weather tomorrow will be different than it actually will be.

Here "actually" occurs embedded inside an operator of historical possibility; these are the kinds of occurrence that evince the difference between the shifty, everywhere redundant, sense, and the rigid sense. If we consider that the shifty sense (10) is obviously false, no matter when we evaluate it, this is because it just comes to asserting the possibility of a contradiction: today, it is still possible that the weather tomorrow will be different from what it will be. With respect to the rigid sense, if the weather today was indeterminate yesterday – when (10) was asserted – both the supervaluationist and the relativist would count what it says as unTrue, in fact as False, if assessed concurrently with the utterance. However, when it comes to retrospective assessments today, while the supervaluationist has to stick to that verdict, the relativist can count what is said as True. This, then, would have to be the ultimate

[10] Hunter & Asher (2005, 121) provide additional nice examples: 'If someone other than George Bush had won the election, the actual winner would have been happy'.

[11] Brogaard (2008, 332–4) also provides this reply to the new argument. For her, having a reply is not merely theoretical exercise, given that (as a previous footnote explains) she gladly adopts the line that MacFarlane offers to the supervaluationist. The same applies to Dietz & Murzi (forthcoming), who also provide this reply, and similarly appear to embrace MacFarlane's "gift" to supervaluationists.

[12] Isidora Stojanovic pointed this out to me.

piece of intuitive evidence that according to MacFarlane (2008, 101) supports the relativist proposal.

What should we make of this? I think someone who is happy to adopt the line that MacFarlane is suggesting that the supervaluationist should take can safely disregard the putative strength of this evidence.[13] To start with, I am not sure how reliable we should take to be our intuitions regarding truth evaluations of assertions of simpler sentences such as (1) and (7) on the assumption of the open future. MacFarlane should, to a certain extent, agree with this, because as we saw, he allows for a certain shakiness when it comes to both the supervaluationist and the relativist account of the indeterminacy intuition concerning (7), in contrast with (1) – what is said by the former is counted as False, what is said by the latter, as neither True nor False. We should not assign too much importance to whatever intuitions we find ourselves having with respect to retrospective evaluations of such utterances in the presence of the open future, because it might well be that the possibility of objective indeterminism is too remote from ordinary assumptions for such intuitions to count as data in our theorizing. When it comes to (10), this skepticism is even more justified. We should not worry about being considered very irrational if we refuse to adopt MacFarlane's variety of relativism on this most tenuous basis.

In any case, as I said above, this exercise was purely theoretical. We have already found compelling reasons for not taking very seriously the supervaluationist contender that MacFarlane (2008) has construed for him to oppose. We saw in the previous section how poor that supervaluationist account of the indeterminacy intuition was, and we have seen in this one how even more unsatisfactory the account of the same intuition is when it comes to utterances including "actually." In the next section, I will argue that the situation is even worse: the account surrenders too much to a form of relativism that we have good reasons not to embrace.

The Relativism of MacFarlane's Supervaluationist

In this section, I would like to show why, in addition to being exposed to the difficulties we have already highlighted, the supervaluationism capturing the determinacy intuition in retrospective assessments that MacFarlane's (2008) characterizes has

[13] It would be interesting to know what Brogaard (2008) thinks, but she does not discuss the more complex examples such as (10). Dietz and Murzi (forthcoming), who also appear to accept MacFarlane's proposal for the supervaluationist to capture the determinacy intuition, do discuss (10) – cf. their section 5. Surprisingly in my view, they just contemplate the shifty sense, and hence contend that it is false. However, they are happy to accept the non-shifty, true reading of 'yesterday it was still possible that the weather today would be different than it actually would be'. A truth-value links principle corresponding to TVL above would validate the intuition that, to the extent that this sentence has a true reading, (10) must equally have one. Dietz & Murzi appear to accept only the true, non-shifty reading of the quoted sentence for the ad hoc reason that it does not create the problem that accepting such a reading for (10) poses, given the package of views they accept: to wit, that MacFarlane's argument at least works for a reading of (10).

given up too much of its main philosophical motivation for the view to be appealing to anybody. One might wonder why this is a point worth making; after all, MacFarlane should be only too happy with this result, for in articulating the proposal, he was just making things more difficult for his ultimate goals. In reply, I note first that it could be useful in order to disabuse misguided truth absolutists who might be taken in by MacFarlane's proposal.[14] Secondly and more significantly, the discussion of these issues is philosophically important in itself, because it helps us clarify what is at stake in debates between truth absolutists and truth relativists. A different reason for doubting that the task on which I am about to embark is worth pursuing lies in that MacFarlane himself (2008, 97, footnote.) candidly admits that "True" is *assessment-sensitive* (in contrast with "DetTrue," which, he says, is merely *use-sensitive*). This appears to concede that it is a radical-relativist notion – which is exactly the point I want to make. However, he (p.c.; cf. also his ms, § 9.7.2, 271) now thinks that this concession was misleading. So, let us try to disentangle these issues.

Traditionally, the contents of speech acts such as assertions and mental states such as judgments and beliefs are taken to determine (or just *be*) properties of possible worlds, modeled by functions from worlds to truth values that thus supervene on them. Two different sorts of reasons are traditionally given for this. Firstly, the *operator motivation*: it allows for a natural compositional semantics for modal operators, "necessarily," "possibly," "actually," and so on. Secondly, the *content-commonalities* motivation: in this way, we capture intuitive commonalities between different acts or states, discernible in the facts that contents are intended to account for. Thus, it is natural to think that the content that speakers assert in uttering "snow is white" and that their audiences grasp is not dependent on the actual facts about the color of snow; one would be asserting or grasping the same content both if the facts were as they actually are – snow being white – or if the facts differ and snow were blue; for this is why one can sensibly purport to provide information with an utterance of "snow is white," or – on the other side of the communicative exchange – obtain information from it. But this should not mean that contents are fully unrelated to how the actual facts are, because the point of making an assertion or a judgment is to classify them as being a certain way. As Wittgenstein's *Tractatus* suggested, we validate both intuitions by taking contents to be, or at least determine, properties of possible ways for the world to be, ascribed to them in the act of asserting.[15]

Some proponents of relativism make life easy for themselves by taking it to be just the claim that contents have further parameters in addition to worlds, that is, that they are not just properties of worlds, modeled by functions from worlds to truth values, but properties of worlds and some additional truth determinants. One of MacFarlane's outstanding contributions to this debate is to make it clear that

[14] The already discussed Brogaard (2008) and Dietz & Murzi (forthcoming) show that this is no mere theoretical possibility.

[15] I present these considerations in counterfactual terms in order to make manifest something I would have thought is obvious, but I have found sometimes contested in presentations of this material, to wit, that nothing in them requires by itself a commitment to modal realism.

the "additional parameters in contents" suggestion will not do, if the goal is to articulate a clear formulation of something that corresponds sufficiently to the truth relativist claims throughout the history of philosophy. The temporalism espoused by Kaplan (1989) and the *centered worlds* account of *de se* contents propounded by Le wis (1979) jointly establish that adding parameters to contents is not sufficient for (genuine) truth relativism. The first is motivated by operator considerations about the semantics of tense; it can also be motivated on the basis of content-commonalities considerations motivating the second. However, as MacFarlane has repeatedly pointed out, such nonstandard views on content do not appear to have anything to do with traditional intimations for truth relativism, nor can the resulting views be assimilated to the truth-relativist proposals that we would like to understand better. Adding parameters is not necessary either, as the sort of relativism contemplated in this paper shows: nothing other than (classes of) traditional parameters such as world/histories is at stake, but the assessment sensitivity that MacFarlane advances does appear to be close to traditional truth-relativist suggestions.[16]

So, what is the difference between the nonindexical contextualism (in MacFarlane's terminology, which as I said, for reasons that will presently become clear, I find descriptively accurate, and I am adopting here) that, for instance, Kölbel (2004) adopts with respect to evaluative notions and a true form of relativism? Here, one could think, the answer is easy. Nonindexical relativism follows the pattern of Kaplan's temporalism. Temporalists relativize the truth of sentences/propositions to points of evaluation consisting of worlds and times; sentences are uttered and propositions are used in *contexts of utterance/use*,[17] and then their truth value is settled, absolutely, by fixing the parameters with values given by such contexts: the world and time of the context of utterance/use. The same applies, *mutatis mutandis*, when-following nonindexical contextualist proposals-we include standards of value, judges, or moral codes as further parameters in the characterization of contents. True relativists, by contrast, posit in addition a *context of assessment* and take the value for some parameters as fixed by it – as we have seen MacFarlane suggesting earlier, with the relevant parameter in the open future case being the class of histories overlapping a given context.

However, I do not think this is enough to fully appraise what is going on, for "parameters fixed by the context of utterance/assessment" is a theoretical notion. Let me invoke an analogy at this point. I assume that, in order to properly understand and appraise the differences between Newtonian and relativistic dynamics, it is not enough to grasp their theoretical apparatus; one must also have a grasp of (1) the facts those theories purport to account for (the behavior of heavenly bodies, tides, harmonic oscillators, or what have you) *described independently* of the theoretical apparatus and (2) how exactly both theories explain them by deploying their distinctive

[16] A clear presentation of these points can be found in Chapter 3 of MacFarlane (ms). See also MacFarlane (2005), 307–9.

[17] Concerning the notion of *use of a proposition*, which will play a crucial role in what follows, MacFarlane (ms., 4.3, 97) says: "It may seem strange to talk of a proposition being true at a context of use, because a proposition is not 'used' in the way that a sentence is. But […] in an extended sense, we can think of assertions or beliefs as 'uses' of the propositions asserted or believed."

theoretical notions. Similarly, in our case, it is not enough to have a conception of the theoretical metalinguistic relative notions of truth that each theory invokes; we must have an independent grasp of the facts that they purport to account for and fully grasp how the theories deploy their theoretical notions in accounting for them. For it might well be that, at the end of the day, the proposals are only notational variants of each other. Or the other way around, it may be that one can state a truly relativist proposal in the theoretical terminology of nonindexical contextualism. This is no mere abstract possibility, as we will see later with an actual example provided by Egan (2010).

So, to pose again the question, what does the difference between relativism and nonindexical contextualism come to, in terms of their respective accounts of pretheoretical data? The difference must lie at the point where the semantics interacts with the uses to which language is put, which is what we have sufficiently clear intuitions about that can be taken to antedate theoretical proposals like the ones we are canvassing. In particular, we use propositions/utter sentences with given semantic contents to make assertions, and we invoke *truth* in what we might call its *normative role* to evaluate such acts.[18] An ascertainable difference concerning this intuitive normative role that we give to the truth predicate results from the fact that nonindexical contextualism relativizes its theoretical truth predicate merely to contexts of *utterance* – as of course, the truth absolutist (indexical) contextualist does – while true relativism does this with respect to contexts of *assessment* as well.

In general, *there is* in fact a clear pretheoretical difference between the nonindexical contextualist's and truth absolutist's "parameters set by the context of utterance" and the corresponding relativist's "parameters set by the context of assessment," which MacFarlane has come to emphasize of late. As we saw, he takes contexts of assessment to be, ontologically, the same kind of thing as contexts of use, the difference between calling them "of use" or "of assessment" having to do with the two different uses to which they can be put in semantic explanations that we are trying to be clear about. Now, in recent work, MacFarlane (ms., 3.2.3, 78) has pointed out a pretheoretical distinguishing mark, to wit, that "the context of assessment is not fixed in any way by facts about the context of use, including the speaker's intentions; there is no 'correct' context from which to assess a particular speech act." This is helpful. As is well known, for many indexicals, we cannot appeal to *objective* features of the context in which they are used to determine their value, even on traditional assumptions.[19] Thus, "here" usually refers to the physical place where the use occurs, but it also has "demonstrative" uses, in which it refers, say, to a place indicated by pointing to a map, and even in the more usual case in which it refers to the location of use, the extent of that location is only determined by the demonstrative intentions of the

[18] The truth of sentences/propositions also plays a nonnormative role in evaluating the contents of sentences also when they occur embedded and thus nonasserted, for instance, in order to account for the semantics of truth-functional operators such as "or" and "if … then."

[19] In part, because of this, I prefer Stalnaker's (1978) notion of context as a "presupposition set," but for present purposes, we can go along with MacFarlane's choice.

speaker.[20] Hence, there are no easy objective pretheoretical features that allow us to distinguish semantic accounts that allow parameters to be fixed only by contexts of use, from others that allow context of assessments to play this role. What fixes the referent of "here," in general, is not the physical place at which the utterance/use occurs but the directing intentions of the speaker; thus, what counts as *the place of the context of utterance* for that purpose might well be as far away in space and time as "contexts of assessment" typically are.

If, however, parameters that are clearly *not intended* by the speaker can play a "context of assessment" role vis-à-vis the normative role of the concept of truth, then this does produce a pretheoretical difference that can help show that nonindexical contextualism and relativism are not just notational variants. Unfortunately, however, it is not clear at all that we can apply this criterion in the open future case. For there is a time manifestly relevant for the evaluation of a statement about the future to minimally reflective speakers, namely, the time – referentially or generically indicated in the content of the utterance, depending on the correct semantics of tense – at which matters are settled one way or the other. Thus, it might well be that speakers do *intend* (when aware of the possibility of the open future) the histories open at that time to be the only ones relevant to evaluate their claims; in fact, something like this "thin red line" proposal will be the best option I will suggest in the final section in order to deal with the open future.[21]

Now, MacFarlane would no doubt point out that, if we did so, we would not have the indeterminacy intuition, only the determinacy intuition. Still, the nonindexical contextualist could take the situation to be analogous to that involving the sort of data (about answering machines, billboards, and so on) discussed in Egan (2009) – say, "Jesus loves *you*," said by the televangelist to his audience, intending different singular claims, not a collective one, or the undercover cop infiltrating the bank heist ring uttering, both for the benefit of the gangsters in the room and his fellow officers in the surveillance van, "Everything is going just as *we* planned." These cases are in my view accurately described by saying that the speaker intends in fact different *claims* or *assertions* by uttering a single sentence. In the open future case, one would be an assertion *concerning* – using Perry's (1986) terminology –[22] classes of histories open at the time of the assertion (which would account for the indeterminacy intuition) and another one concerning classes open after the relevant time in the future (which would account for the determinacy intuition). We cannot thus distinguish nonindexical contextualism from relativism in these terms, because it cannot be ruled out that reflective speakers with the open future in mind might

[20] In my own view, this applies to all indexicals, including also "I"; think of Neo in *Matrix* using "I" to refer not to his real scruffy self but to his glossy virtual avatar in the matrix. When the global behavior of indexicals and demonstratives is taken into consideration, I do not see any good reason to consider these cases as any more "pragmatic" than the demonstrative or anaphoric uses of "here" and "now."

[21] For the concept of the *Thin Red Line*, cf. Belnap et al. (2001), 135 ss.

[22] In Perry's terminology, the assertion is not *about* it – otherwise, it would be a purely *indexical contextualist* view, as opposed to a nonindexical contextualist proposal.

intend the different relevant classes of histories, and for reasons we pointed out at the end of the previous section, the intuitions of unreflective speakers are of doubtful relevance.

MacFarlane has been concerned with this problem since his (2003) paper. Aside from the point that contexts of assessment need not be intended, which cannot be of use when the predicament concerns the present case, his approach to it has been to consider the consequences of the different semantic proposals for theories of assertion.[23] In previous work (2003, 332–6; 2005, 318–22), he considered consequences relative to a conception of assertion in terms of different commitments that asserters incur. In more recent work (ms., Ch. 5), he has extended the range covered by considering alternative accounts of assertion. Here, I will follow the proposals in the latter work concerning accounts of assertion in terms of constitutive rules. This is in part because I think that these approaches are more on the right track (asserters do incur commitments, but only, I think, as a result of subjecting their acts to the rules constitutive of assertion), and also because it helps to make the essential points clearer.

On the constitutive rules approach, what I called the normative role that we give to our truth evaluations is predicated on the constitutively normative nature of the act of assertion.[24] Williamson (1996/2000) claims that the following norm (the *knowledge rule*) is constitutive of assertion and individuates it:

(KR) One must ((assert p) only if one knows p).

In the course of the debate that Williamson's proposal has generated, other writers have accepted the view that assertion is defined by constitutive rules but have proposed alternative norms; thus, Weiner (2005) proposes a *truth* rule, (TR):

(TR) One must ((assert p) only if p).

MacFarlane (ms, 5.2) takes (TR) to be a more plausible candidate than (KR) and assumes it in his discussion; I will follow suit for, again, I do not think anything of substance for the present purposes hinges on it.

To recap, we have on the table two contenders with allegedly different views. Firstly, the relativist proposal presented in previous sections for utterances of "There is a sea battle tomorrow," or the corresponding proposition, which relativizes their truth to classes of histories overlapping contexts of assessment; secondly, nonindexical contextualist analogues of Kaplanian temporalism applied to the open

[23] Presumably, the differences between the semantics should also transpire with respect to other speech acts, such as promises, orders, or questions; in order to settle these debates, it might be useful to explore the matter from that perspective.

[24] It might well be that assertion is not *constitutively* normative. On the expressive Gricean account in Bach and Harnish (1979), assertion is constituted by specific communicative intentions of speakers; norms of assertion are *regulative*, deriving from other norms such as moral sincerity rules as in Hindriks (2007). I agree with MacFarlane (ms, 5.4.2) that these accounts are not correct, but for distinguishing indexical contextualist, nonindexical contextualist, and relativist proposals, a regulative norms approach would be equally serviceable.

future, in particular the version outlined a few paragraphs back, which interprets Jake's utterance of (1) as the making of two assertions with the same content that concerns different classes of histories.[25] How do they differ, in pretheoretical terms, when it comes to appraising the extent to which the obligations constitutive of assertions are met?

In order to evaluate these obligations, the values of the open parameters have somehow to be fixed. The temporalist will fix them relative to the context of utterance of the sentence/use of the proposition. Thus, to evaluate whether a speaker who makes an assertion by uttering "It is raining in Barcelona" meets the obligation imposed by (TR), we should consider the world and time of the context of the assertion. What about the relativist? MacFarlane (ms, 5.2, 129) notes: "It makes sense to privilege the context the asserter occupies when she makes the assertion as the one relative to which she should assert only truths." But, if so, he rightly concludes, we will be left without any difference in the pretheoretical terms we are looking for between the nonindexical contextualist and relativist proposals, for the latter will take *the context of utterance/use* as the privileged context of assessment for applying (TR) and thus will assign the same value to the relevant parameter as the former.[26]

Hence, just by appealing to how the obligation imposed by (TR) is met, we cannot appreciate any difference for pretheoretical appraisal between the nonindexical contextualist proposals and relativist ones. In order to distinguish them, MacFarlane (ms, 5.3, 134) appeals at this crucial point to another speech act, *retraction*. "By 'retraction', I mean the speech act one performs in saying 'I take that back' or 'I retract that'. The target of a retraction is another speech act, which may be an assertion, a question, a command, an offer, or a speech act of another kind. […] The effect of retracting a speech act is to 'undo' the normative changes effected by the original speech act. So, for example, in retracting a question, one releases the audience from an obligation to answer it, and in retracting an offer, one withdraws a permission that one has extended. Similarly, in retracting an assertion, one disavows the assertoric commitment undertaken in the original assertion."

The suggestion is that the pragmatic difference between absolutist and relativist semantics manifests itself in *norms for retraction*. While, as we have seen, at the level of the obligations imposed by (TR), there is no difference between a nonindexical contextualist proposal such as temporalism and a relativist one, we do find such a difference when it comes to *obligations to retract*. By contending in our semantics that the truth of an utterance of a sentence/use of a proposition depends on a parameter fixed at contexts of assessment, we are theoretically committing ourselves to the contention *that the utterance or use should be retracted or otherwise,*

[25] This is the version I take to be more adequate for nonindexical contextualists to deal with the open future, although of course there are others; the nonindexical contextualist can also enlist in his own framework the form of contextualism I will finally propose, taking future contingents to make just one claim that concerns the histories overlapping the intended time in the future when the indeterminacy is resolved.

[26] Cf. MacFarlane (ms, 5.2, 127–133); the discussion here follows the course of the one in MacFarlane (2005, 314–317), although the latter work does not contemplate the "constitutive norms" account of assertion I am focusing on here.

depending on the values of those parameters at contexts of assessment other than the context of utterance. We are under no such obligation if, as in nonindexical contextualist proposals, the parameter is fixed at the context of utterance.

To illustrate, consider again the Kaplanian temporalist account of "It is raining in Barcelona," and let us compare it with a corresponding relativist account, which says that the relevant time is given by *contexts of assessment*. I utter the sentence at a time when it is raining in Barcelona. Consider a later time, when it is sunny in Barcelona. The pragmatic effect of the relativist proposal manifests itself in that at that time *I should retract the previous assertion*, in contrast with the nonindexical contextualist account, on which I am under no such obligation. Of course, as MacFarlane (ms, 3.1, 67) grants, a relativist proposal of this kind applied to this case "would be silly," but the important point is that it is indeed a relativist proposal, discernible from the nonindexical contextualist proposal in the pretheoretical terms we were looking for: this is precisely why we can consider it silly, unlike the Kaplanian temporalist account.

Let us thus consider how to apply the suggestion to the open future. A possible analogue of temporalism suggested above is the view on which the utterer of (1) makes in fact two assertions, with a common content; the difference between the two being – in Perry's (1986) terminology – that one *concerns* the class of histories open at the time when the utterance takes place, while the other concerns the future time when the matter is settled one way or the other. The relativist proposal for applying (TR) presented above will not describe the situation as one involving two different assertions. Following MacFarlane's remarks, we assume that the privileged context of assessment for applying the truth rule gives us the class of histories overlapping the time at which the utterance is made, thus accounting for the indeterminacy intuition. Consider now the class given by the time at which the matter is settled. This is, in the relativist characterization, another context of assessment for the same assertion. The pragmatic import that this has is that now the speaker is obliged to retract his previous assertion if it turns out to be false with respect to the set of histories then open. On the nonindexical contextualist proposal, however, that class only identifies which circumstance concerns *a different assertion* that Jake intended at the same time, using the same words. Its evaluation should be irrelevant to the evaluation of the other, as is the case in the examples that we took as our model, say, the undercover cop infiltrating the bank heist ring uttering "Everything is going just as we planned." If it turns out that the assertion is false when "we" refers to the group including the utterer and his fellow policemen, this should not have any normative effect such as an obligation to retract the assertion made when "we" refers to the group including the speaker and his "fellow" gangsters.

In the open future case, unlike the temporalist example above, intuitively, perhaps the difference favors the relativist account, but we can put this issue aside at this point.[27] What matters for us now is that here, at last, we have a sufficiently clear pretheoretical, pragmatic difference between truth absolutist proposals, including

[27] I reserve the final, all-things-considered appraisal for the last section.

so-called "relativist" proposals that simply add further parameters to contents (MacFarlane's *nonindexical contextualism*) and genuinely relativist proposals.

To hammer home this result, we will see how it also fits Egan's account of predicates of taste, a view that (1) assumes a different account of assertion and (2) uses the theoretical apparatus of nonindexical contextualism, without mentioning "contexts of assessment."[28] Egan's account (2010, 276–7) is based on Lewis's (1979) theory of *de se* contents as self-attributed properties, which Egan takes to be motivated by content-commonalities considerations: "There's a certain doxastic similarity between all of the well-informed people with burning pants, and a certain conative similarity between all of the kids who want to grow up to be firefighters. One way to capture these similarities is to say that there's some potential object of propositional attitudes that all of the well-informed people with burning pants believe, and some potential object of propositional attitudes that all of the kids who want to grow up to be firefighters desire." Egan realizes that just positing contents of this sort does not suffice for a truly relativist proposal, for it could just be a form of nonindexical contextualism. We need a story about how it affects assertions. Here he appeals to Stalnaker's (1978) account, on which assertions are proposals to update the context, understood as a set of presupposed contents: "It's absolutely crucial to making this sort of story work that we take the relation between content and assertion to be […] one […] according to which the essential effect of an assertion with content P is that cooperative and credulous audience members *come to accept P*. (Which means, in the case of assertions whose content is some property P, that cooperative and credulous audience members come to self-attribute – i.e., take *themselves* to have – P.)"

We saw before how MacFarlane (ms, 3.1, 67) proposes to transform the temporalist proposal into one that is truly relativist by his lights – concluding that it "would be silly" but also that this very appraisal proves that he has shown how his relativism differs from the original nonindexical contextualist nonsilly proposal. Similarly, Egan (2010, 278) points out that to apply his account to the original cases that motivate the Lewisian view of contents would be silly: "This, incidentally, shows why the very first place in which one might be inclined to look for self-locating content in natural languages – sentences involving first-person indexicals – isn't in fact a very good place to look." Indeed, it would be silly for me to update the conversational score with the *de se* content of "My pants are on fire" after your utterance of that sentence. But the fact that we can make this judgment shows that we understand

[28] Egan's work is also interesting because he carefully formulates the sort of contextualist proposal I tend to find preferable in all cases that have been suggested so far. In the case of predicates such as "tasty," the idea is that it applies to an object just in case it has a disposition to cause certain experiences, which would be manifested under certain idealized conditions; we apply those predicates under more or less general presuppositions of commonality in the conditions for manifestation of the disposition, and usually assuming also conative attitudes pressing for those commonalities to exist, or to create them when they do not. Egan (2010, §5) rejects this sort of view on the basis of concerns that his own previous careful formulation should help to dispel. Cf. López de Sa (2008), García-Carpintero (2008), and Schaffer (2011).

how Egan's proposal differs from a nonindexical contextualist one: in Egan's terms, the nonindexical contextualist does not allow for updating the conversational presuppositional set when the contents he favors are asserted, for, on that view, the relevant claims concern merely *the circumstances of the* asserter (in the case of *de se* contents, his own properties, in the temporalist case, the time of the utterance); it would be silly to update the score when, as is typically the case, the relevant circumstances might have changed. Egan's claim is that this updating would not be at all silly in the case of contents involving predicates of taste but in fact the best account of the case.[29]

Once again, the evaluation of the proposal does not matter for present purposes. What matters is that we can see a difference between truth absolutists and relativists discernible in pretheoretical pragmatic terms, this time invoking Stalnaker's account of assertion. On this way of looking at things, the difference between the double-assertion nonindexical contextualist account given before, and the relativist one, amounts to the following: On the first view, two fully independent proposals for updating the context set are made; whether or not it is legitimate to update with respect to one is independent of whether or not it is with respect to the other. On the latter view, that is not so; if we have updated the context set today when someone utters "It will be sunny tomorrow," we are forced to revise this tomorrow when it rains.[30]

In sum, we have found a substantive way to distinguish absolutist from truly relativist theoretical proposals. The difference does not depend on whether in their theoretical apparatus they use truth relativizations concerning parameters set by

[29] Egan's (2010) argumentative strategy is thus slightly peculiar: he bases his theoretical proposal on a semantic story justified on the basis of cases (those allegedly motivating *de se* and *de nunc* contents) to which applying the full view he advances would be absurd. In a previous article discussing epistemic modals (Egan 2007), though, he does discuss the conditions for the Stalnakerian assertion of *de se* contents to be legitimate. The requirement he poses is one of (presupposed) similarity in the relevant parameter. If I am my only audience, it makes sense to update the context set with my own assertions/judgments of *de se* contents. Similarly, if we are asserting *de nunc* contents concerning sufficiently lasting time intervals, it makes sense to update the context set with those asserted contents throughout the relevant interval. Egan (2007) provides a similar rationale for updating de se-like contents expressed by epistemic modals. Correspondingly, in the case of disputes of taste, Egan (2010) argues that they are nondefective (roughly) when presuppositions of similarity vis-à-vis the relevant standards are in place. This makes it at the very least very difficult to distinguish it in the pretheoretical terms we have been seeking for future contingents in this chapter from the contextualist-presuppositionalist view outlined in the previous note. Egan (2010, 282) contends that the contextualist and relativist proposals can be intuitively resolved in favor of the relativist tale, but I do not think he is right; in my own view, the semantically relevant folks' intuitions simply betray absolutist assumptions at odds with relativism, indexical or otherwise. I leave this for elaboration in future work. Torre (2010) criticizes Egan's account and provides an alternative proposal.

[30] However, to show that Egan's story makes sense with respect to the open future, according to the suggestions outlined in the previous footnote, we should justify the presupposition of similarity in the relevant parameter (the class of histories open at different points in the "conversation"). This cannot be done in this case, under the ordinary assumptions of "branch-pruning" as time goes by; it only makes sense under nonbranching conditions.

what the theories call "context of assessments." All theories relativize truth to some parameters or other; we can have relativist proposals that do not use anything more than traditional parameters, and relativizations to parameters characterized as set by a "context of assessment" might turn out, in their pragmatic application, to be nothing more than what nonrelativist proposals offer. The real difference lies in the use to which those relativizations are put, when it comes to their predictions and explanations concerning the use of language: what they say about when speakers should retract (or otherwise) their claims, what effect those claims should have on the context set, and so on.

So, we are now in a position to apply this result to the form of supervaluationism that MacFarlane (2008) construes as his main contender. As we saw before, he himself (2008, 97, footnote) admits that "True" is *assessment-sensitive* (in contrast with "DetTrue," which, he says there, is merely *use-sensitive*), which could be thought to already grant the point I am trying to make. However, he has pointed out to me (p.c.; cf. also his ms, 9.7.2, 271) that this admission was misleading, and in fact, in a way it is. MacFarlane (2005, 310–11) introduces technical notions of *use* and *assessment sensitivity* that presuppose theoretical metalinguistic truth definitions for utterances of sentences and uses of propositions. A sentence/proposition is *assessment-sensitive* just in case its truth value changes with the context of assessment (keeping the context of use fixed); we can extend these definitions to constituent terms in sentences or propositional constituents replacing "truth value" with "extension" in the previous definitions. Given this, the object-language predicate "True" can only be called "assessment-sensitive" in this technical sense when deployed in the framework of a theoretical semantic apparatus whose metalanguage truth predicate makes use of a notion of extension-dependence with respect to contexts of assessment. Hence, *in this sense*, "True" can only be said to be assessment-sensitive when deployed in the context of a relativistic semantics, not when deployed in the context of the technically nonrelativist supervaluationist semantics. This is why the footnote is misleading; it should perhaps be read as saying that "True" is assessment-sensitive *when embedded in the relativist semantics*.[31]

Nevertheless, we are now in a position to appreciate that *this sense* is a rather superficial, uninteresting one. The interesting issue is whether, given the way that the object-language truth predicate is understood to operate *pragmatically* by the supervaluationist that MacFarlane construes, it behaves as truly relativist technical metalinguistic truth predicates do. And, with respect to this – the really substantive issue at stake here – the answer is, I think, clear. Let us go back again to the comparison we used before. Imagine that Jake asserts a temporalist proposition by uttering "It is raining in Barcelona" at a time when it does rain in Barcelona. If the supervaluationist that MacFarlane describes evaluates "the assertion that Jake made" or "what Jake

[31] I must say that I find "misleading" a bit of an understatement to describe the footnote, if this was the intended interpretation. I think that the only plausible interpretation of the footnote for an ordinary, informed, and charitable reader, given the context in which it occurs, takes it to accept that "True" is assessment-sensitive *in the substantive sense* I am about to describe.

asserted" (i.e., the temporalist proposition) for truth at a later time when it is not raining in Barcelona, he will conclude, given (DIS), that such a thing is not True. However, this theorist should not sanction the appeal to this evaluation *in order to retrospectively assess the use that Jake made of that proposition*. That would be "silly," for the very same reasons that MacFarlane describes in these terms the relativist version of the temporalist account that we considered above. But this is precisely what the supervaluationist that MacFarlane construes intends to do with the evaluation as True or otherwise in Sally's context of the proposition that Jake asserted, on the understanding that in this case it is not at all "silly": that evaluation is deployed to retrospectively assess *the use that Jake made of the proposition*. This is the hallmark of relativism; not, indeed, in that it invokes a relativist technical apparatus (which it does not), but in that it puts its technical apparatus to a relativist pragmatic use – which is, in my view, ultimately what philosophically matters.

So, all in all, it is clear that no sensible truth absolutist should adopt MacFarlane's suggestion. The proposal has the limitations we have observed in the previous sections: it provides an asymmetrical account of the determinacy and indeterminacy intuitions, and it assumes an account of "actual" that only meets the condition of initial redundancy in the way MacFarlane formulates it but not in other forms truer to the intuition underwriting it, and what is much worse, it accepts that our object-language truth predicate behaves as a relativist predicate, in the sense that is the hallmark of contemporary truth-relativist proposals; assertions made relative to a context can be evaluated for their fundamental correctness relative to other context, even context unintended when the assertion was made. To adopt this account is thus to give away the game to the relativist. Hence – as we should *a priori* have expected – after all, it does not really matter whether utterances of sentences or uses of propositions are taken as fundamental truth bearers, for the present disputes. If MacFarlane (2003) had a good argument for truth relativism based on the open future taking sentences and their uses as truth bearers, he has as good an argument when we take instead propositions and their uses as primary truth bearers. Did he?

The Open Future: Truth and Indeterminate Truth

MacFarlane has thus managed to articulate in a precise way a form of relativism that we can understand and appraise, and the open future appears to make a case in its favor. Of course, a view might have these features and be not just false but even incoherent; straightforward contradictions are perfectly intelligible. Or, more to the point – given that the lynchpin between truth absolutists and relativists is pragmatic, having to do with the uses to which propositions are put in assertion and other propositional acts – it might be that the relativist conception of those acts does not make rational sense.

Evans (1985) distinguishes three forms that proposals such as temporalism could adopt. Two of them are semantic proposals to introduce further parameters in the characterization of contents/propositions, without the relativist pragmatic

implications that, as we have seen in the previous section, distinguish MacFarlane's form of relativism. These are in his view coherent proposals that he nonetheless finds insufficiently motivated. I am not sure about this, but in previous work, I (2008) have argued that there might be good "content-commonalities" considerations to posit such contents, for instance, in the vagueness-related cases that Richard (2004) discusses. The third proposal that Evans considers is akin to MacFarlane's form of relativism in its pragmatic consequences. In a short, cryptic passage, he argues that such views are incoherent. Although Percival (1994, §4) – in the most illuminating discussion I know of these matters – questions some of Evans' pronouncements, he (§6, 208–11) ends up agreeing in finding little reason to accept "the doctrine's consequences for the evaluation of utterances."[32]

I also find truth-relativist proposals ultimately incoherent. In a nutshell, the problem is this. As we have seen, such proposals ultimately concern the normative role of truth and its use in the evaluation of acts such as assertions and judgments. These are, in my view, intrinsically normative entities, which to me mean that their nature is intrinsically related to what counts as rational activity. However, I cannot see how it can ever be rational to carry out activities governed by a relativist truth norm, and although it is, in principle, possible that we are foolish enough to have instituted an intrinsically irrational practice, I find it methodologically advisable not to assume that this is so.

MacFarlane (ms, §5.3, 135–6) acknowledges a worry of this kind: "This allows that someone who asserts that p in c_1 might be compelled to retract this assertion in a later context c_2, even though the assertion was permissible for her to make at c_1. (This can happen if p is true as used at and assessed from c_1, but not true as used at c_1 and assessed from c_2.) This may seem odd." In reply, this is what he has to say: "Here it is important to keep in mind that withdrawing an assertion (or other speech act) is not tantamount to conceding that one was at fault in making it. Suppose one's evidence all strongly suggests that Uncle Jack is coming to lunch, and on the strength of that evidence you assert that Uncle Jack is coming. A bit later, Aunt Sally calls to say that Uncle Jack has broken his leg. This makes it quite unlikely that he is coming, so you retract your assertion. Nonetheless, you were perfectly reasonable in making it, and cannot be criticized for having done so. Retracting it is not admitting fault." But there is an obvious asymmetry between this case

[32] For reasons that Percival's (1994, 199–200) nuanced discussion illuminates, as Cian Dorr pointed out to me, "relativism" might be a bad term for the doctrines that MacFarlane's calls "nonindexical contextualism" – which is one more reason for preferring that terminology. The model for those proposals is the standard relativization of truth to possible worlds. But the fact that contents have their truth relativized to worlds does not mean that truth is thereby a relative notion, in any straightforward sense. A clear case of hidden relativization is given by gradable adjectives, such as "tall." Claims involving them are straightforwardly relative in that they ultimately involve a relation to something like a point in a scale (García-Carpintero (2008) has some discussion and references to contemporary linguistic literature). If the standard relativization of the truth of contents to possible worlds was understood in this way, truth-ascriptions would involve reference to specific worlds, and then they would be (counterintuitively) necessary. (Cp., however, Schaffer (2011, §1.2), who defends this "nonindex" view of propositions.)

and the ones that MacFarlane's account contemplates. In this case, the act was constitutively wrong from the beginning[33]; it is just that it was reasonable for the agent to think otherwise. There is nothing strange about doing what is "objectively" wrong when it was "subjectively" acceptable and thus being required to make whatever amendments we can in spite of being entitled to excuse ourselves; this is a distinction we must make wherever norms apply. What MacFarlane's account envisages is rather that I can perform an action that is constitutively legitimate – an assertion that meets it constitutive norm – and later be obliged to take it back. One should be excused for not finding this an intelligible possibility.[34]

So, how should we understand our claims about the future, in view of the open future? In their discussion of vagueness, McGee and McLaughlin (1995) contemplate a nonstandard form of supervaluationism, on which truth is not identified with super-truth, truth in all precisifications; super-truth is just *determinate* truth, while truth remains disquotational, and bivalence is preserved. Greenough (2008, ms) provides a well-grounded theory of indeterminate truth with that shape, which he applies to the case of the open future; Barnes and Cameron (2009) and Iacona (this volume) have a similar proposal. Although I do not find it attractive to envisage ungrounded truths in the original case of vagueness that McGee and McLaughlin discussed (which I take to be one of semantic indecision), I find it a good way to think about the open future, at least when we assume a B-series, atemporal ontology – which is what, following MacFarlane, I have been doing here. Tweedale (2004, 249) articulates the main motivation for this: "The future will decide one way or the other; it will not leave the matter undecided, although at the moment no decision has been made, so to speak. The situation differs from […] cases of vagueness in that there it is dubious whether the conditions for full, as opposed to partial, definition will ever exist, or even could exist, but we can be reasonably certain that the future will eventually fully determine what truth value to assign to our predictions."

This is, of course, a "Thin Red Line" proposal, asking us to abandon the indeterminacy intuition as one about truth (if we held it in the first place) but preserving it when we take it to be just one about unsettledness, not inevitability or indeterminacy. A truth absolutist adopting this proposal would not have any of the problems we pointed out before for the supervaluationist that MacFarlane (2008) takes as his opponent; in addition to dealing in the straightforward way just described with the indeterminacy and determinacy intuitions, and not making any concession to truth relativism, the proposal of course allows for a nonshifty sense of "actual" satisfying intuitively plausible forms of initial redundancy. MacFarlane (2003, 2008) suggests that Thin Red Line views trade on inadequate metaphors (adopting perspectives

[33] I assume we are evaluating a straightforward future-tense assertion, not an epistemic modal.

[34] Marques (ms) elaborates on this, arguing against the relativist contention that truth is to play a normative role vis-à-vis assertion and retraction such that a reflective and sincere speaker who makes a permissible assertion that *p* at *c1* (where *p* is true) but fails to retract at a later context *c2* (where *p* is not true) should be deemed irrational. MacFarlane's most recent version of his forthcoming book (ms) has a final chapter interestingly addressing these worries, which I cannot discuss here.

internal to a particular branch in the tree, moving in a car along the roads/branches). The objection, I take it, ultimately amounts to the one raised by Williamson in the case of vagueness against McGee and McLaughlin's proposal: proponents of these views should distinguish between the ontological indeterminacy they posit and a mere epistemological one. I cannot confront this serious issue here; I refer the interesting reader to the works I have already mentioned.[35]

Additionally, and perhaps even more worryingly, one might doubt whether the tenseless B-series treelike ontological picture we have been assuming is in the end adequate to capture the contrast of the openness of the future with the fixity of the past (cf. Diekemper (2007), but cp. Rosenkranz (this volume), §4). This is another good question that I have to put aside here. Given that MacFarlane also assumed this ontology, one is entitled to take for granted that the plausibility, or otherwise, of his relativist proposal should not depend on it.

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[35] MacFarlane has a new, interesting objection to the "Thin Red Line" proposal in his forthcoming book (§9.4.2), which I cannot confront here. Interestingly, by the way, he has also dropped the 'actually'-based objections against supervaluationism I have been discussing here.

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Timeless Truth

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Abstract A fairly simple theory of the semantics of tense is obtained by combining three claims: (1) for any time *t*, a present-tense sentence 'p' is either true or false at *t*; (2) for any time *t′* earlier than *t*, the future-tense sentence 'It will be the case that p at *t*' is true at *t′* if 'p' is true at *t*, false otherwise; (3) for any time *t′* later than *t*, the past-tense sentence 'It was the case that p at *t*' is true at *t′* if 'p' is true at *t*, false otherwise. This theory, which has been called the *theory of timeless truth*, is often dismissed on the basis of its alleged incapacity to comply with indeterminism. Here, instead, it will be suggested that there is no reason to be dismissive. Once the theory is properly articulated and some common misunderstandings are dispelled, it turns out clear that there is a coherent sense in which (1)-(3) are compatible with indeterminism.

Introduction

According to the theory of timeless truth, the truth-value of a sentence at a time is insensitive to variation of temporal perspective. Suppose that the following sentence is true today:

(1) There is a sea battle.

The theory entails that the following sentence was true yesterday:

(2) There will be a sea battle tomorrow.

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Similarly, it entails that the following sentence will be true tomorrow:

(3) There was a sea battle yesterday.

This means that (1) is true today no matter whether we 'look' at it from a temporal perspective that differs from the perspective we have on today. The truth-value of (2) yesterday and the truth-value of (3) tomorrow depend what the truth-value of (1) today depends, namely, the way things are today. (1)–(3) may be regarded as different descriptions of one and the same fact. Since that fact is in no way dependent on time, the same goes for the truth-value of (1)–(3). This is the sense in which truth is said to be timeless.[1]

At least two things must be clear about the claim that truth is timeless. The first is that the claim concerns utterances, that is, sentences at times. To say that 'p' is true at *t* is to say that it is true that p at *t*. If one utters 'p' at *t*, one says that p at *t*; hence, what one says is true if and only if p at *t*. For example, if one utters (1) today, one says that there is a sea battle today; hence, what one says is true if and only if there is a sea battle today. Timeless truth is taken to be a property of things said by uttering sentences, rather than of sentences themselves. So a tensed use of 'is true' is acceptable when truth is ascribed to sentences: one can say that a sentence is or was or will be true. For a tensed ascription of truth to a sentence is equivalent to a tenseless ascription of truth to the corresponding utterance. Thus, '(2) was true yesterday' is equivalent to 'the thing said by uttering (2) yesterday is true'.[2]

The second thing that must be clear is that timelessness is not quite the same thing as eternity. To say that an utterance is timelessly true is to say that its truth is in no way relative to time. The 'is' in 'is true' is like the 'is' in 'Two plus two is equal to four'. So 'is true' is not to be read as 'is true at every time'. Truth at every time, eternal truth, may rightly be ascribed to sentences. For example, the sentence 'Two plus two is equal to four' is eternally true in that, for every time, it is true at that time. But what is said by uttering the sentence at this or that time is simply true. Obviously, this does not mean that it makes no sense at all to say that an utterance is eternally true. The fact is rather that, in saying it, nothing is added to the claim that the utterance is true.

The simplicity of the theory of timeless truth lies in the logical symmetry it postulates between past and future. The thought that underlies the theory is that past and future do not differ in logically relevant ways. This holds in at least three important respects. In the first place, *bivalence* holds, in that every utterance is either true or false. For example, (2) is either true or false today, just as any other day. The same goes for (3).

In the second place, truth complies with the *disquotation principle*. For any sentence 'p', the following schema is true at any time: 'p' is true if and only if p. Consider:

(4) 'There will be a sea battle tomorrow' is true if and only if there will be a sea battle tomorrow

[1] The label 'theory of timeless truth' goes back to McCall (1966), which dismisses the theory.

[2] Here, no assumption is made about the existence of concrete acts of utterance.

The left-hand side of (4), uttered today, states that (2) is true today, so it is true today just in case (2) is true today. Since the right-hand side of (4) is nothing but (2), both sides are true today if (1) is true tomorrow. The same goes for falsity. So the schema applies to (2), just as it applies to (3).

In the third place, past and future are alike as far as *truth-value links* are concerned. Truth-value links are principles that articulate connections of truth-value between different tensed sentences uttered at different times. Consider the truth-value of (1) today and the truth-value of (2) yesterday. There is a straightforward relation between these two truth-values, and this relation is specular to that between the truth-value of (1) today and the truth-value of (3) tomorrow.[3]

The Aristotelian objection

A foregone objection to the theory of timeless truth comes from a thesis that is very influential in the logic and the philosophy of time. Let a *future-oriented utterance* be an utterance of a future-tense sentence such as (2), that is, a sentence whose truth-value at the time of the utterance depends on the way things are at some later time. The thesis – call it the *necessitation thesis* – goes as follows:

(N) If future-oriented utterances have a truth-value, the future is necessary.

Here, 'truth-value' is understood in the classical sense in which the absence of truth and falsity is not itself a truth-value, and 'necessary' stands for 'historically necessary', that is, 'necessary relative to our past and our present'. Since the theory of timeless truth entails that future-oriented utterances have a truth-value, (N) may be invoked against it: the future is not necessary, so it is not the case that future-oriented utterances have a truth-value.[4]

This objection may be called the Aristotelian objection, as Aristotle was probably the first to suggest that the necessitation thesis may be adopted as a premise of an argument by contraposition to the effect that future-oriented utterances lack truth-value: if (2) is true today, then it is necessary that there will be a sea battle tomorrow, and if it is false today, then it is necessary that no sea battle will take place. In both cases, the consequent must be rejected, so the same goes for the antecedent.[5]

Many logicians and philosophers after Aristotle have pursued the thought that, in order to account for future contingency, future-oriented utterances are to be deemed neither true nor false. One way to articulate this thought is to define a semantics based on a tree model, in which a future-tense sentence 'It will be the case that p at *t*' can be evaluated as true or false at a time *t′* earlier than *t* relative to different possible

[3] Dummett (1996, p. 363), draws attention to truth-value links.

[4] Words such as 'settled' or 'inevitable' are often used as synonymous with 'historically necessary', so they may equally be employed to phrase (N).

[5] Or at least, this is the reasoning that a widely accepted reading of *De interpretatione* 9 attributes to Aristotle.

continuations of the state of affairs obtaining at *t′*. These possible continuations are represented as branches of a tree. So the sentence may be true at *t′* relative to some branches yet false relative to others.[6]

The rationale for (N) that most of its supporters take for granted is that a future-tense sentence has a given truth-value at a given time only if it has that value at that time in all possible futures. Since there are many possible futures, one may think, the only way in which (2) can have a truth-value today is that in which it has the same value in all of them: how can (2) be true today if in some possible future there is no sea battle? The argument goes as follows:

(5) If future-oriented utterances have a truth-value, the sentences uttered have the same truth-value in all possible futures.
(6) If the sentences uttered have the same truth-value in all possible futures, the future is necessary.

(N) If future-oriented utterances have a truth-value, the future is necessary.

The tree model provides a rigorous way to give substance to (5). Suppose, for *t* later than *t′*, that 'It will be the case that p at *t*' is true at *t′* relative to some branches but false at *t′* relative to others. If truth at *t′* is understood as truth at *t′* relative to all branches, the sentence is neither true nor false at *t′*. The motivation for (6) is clear. If there is no difference in the truth-value of the sentences uttered, there is no difference between branches; hence, only one future is possible.[7]

Clearly, those who are sympathetic with this argument are apt to think that what holds for sentences holds for subsentential expressions. Consider the following definite description:

(7) The next president of the USA.

Suppose that (7) is uttered before the next presidential elections as part of a sentence, say

(8) The next president of the USA will visit China very soon.

In this case, the view is that (7) has no reference. For if it had a reference, the result of the next presidential elections would be necessary. The rationale for the conditional is similar to that for (N), that is, having a reference amounts to having the same reference in all possible futures. It is easy to see how the view may be generalized. If 'extension' is understood in the usual way, it may be claimed that what holds for (7) holds for any expression whose extension at the time of utterance depends on the way things are at some later time.

[6] The standard supervaluational account proposed in Thomason (1970) is of this kind. A precursor is Van Fraassen (1966). More recent examples are the account offered in McCall (1976), Belnap et al. (2001) and MacFarlane (2003).

[7] The semantics provided in Thomason (1970) justifies (5) in the way considered. Note that (5) is also justified in a tree-like semantics that does not include a nonrelative definition of truth based on a quantification over branches, such as the semantics offered in Belnap et al. (2001). In that case, (5) holds vacuously, since its antecedent is never satisfied.

The argument for (N), however, is less solid than expected. Its weakness lies in the very notion that seems to make it strong, namely, that having a given truth-value amounts to having that value in all possible futures. According to that notion, 'It will be the case that p at *t*' is true if and only if it is necessary that it will be the case that p at *t*. This is not quite the same thing as to say that 'It will be the case that p at *t*' is equivalent to 'Necessarily, it will be the case that p at *t*'. Only the first equivalence is required, as it is shown by the fact that in tree-like semantics 'It will be the case that p at *t*' and 'Necessarily, it will be the case that p at *t*' can take different values. Yet that equivalence may plausibly be denied.

One way to see the difference between the claim that 'It will be the case that p at *t*' is true and the claim that necessarily it will be the case that p at *t* is to realize that a rational subject may have different attitudes toward them. Suppose that Indy is indeterminist about tomorrow's weather: he believes that it is possible that it rains tomorrow and that it is possible that it doesn't. Indy is planning a day out tomorrow, so he watches a forecast on TV. The forecast says 'Sun tomorrow', and he says 'I hope that's true'. It is plausible that Indy does not hope the negation of what he believes, so he does not hope that necessarily it will be sunny tomorrow. This means that the inference from 'Indy hopes that "It will be sunny tomorrow" is true' to 'Indy hopes that necessarily it will be sunny tomorrow' is not legitimate.[8]

Another way to see the difference between the claim that 'It will be the case that p at *t*' is true and the claim that necessarily it will be the case that p at *t* is to consider retrospective assessments. Suppose that Indy calls Andy after watching the TV forecast, and says 'It will be sunny tomorrow'. If the day after it is sunny, Andy can correctly affirm 'what Indy said was true'. According to Andy's retrospective assessment, 'It will be sunny tomorrow' is true as uttered by Indy the day before. But having this truth-value does not prevent it from being possibly false the day before. Andy may coherently think that what Indy said yesterday was true and it was possible yesterday that today it would rain. Therefore, it seems that the truth of the sentence does not amount to its truth in all possible futures.[9]

Propositional attitude ascriptions and retrospective assessments seem to show, like two faces of the same medal, that there is a difference between saying that 'It will be the case that p at *t*' is true and saying that necessarily it will be the case that p at *t*. Similar considerations hold for subsentential expressions. Suppose that the day before the elections a newspaper publishes an article that contains (8). There is no apparent inconsistency in thinking that (7) refers to Barack Obama, even though it could refer to Mitt Romney. Imagine that Obama wins and that 2 weeks after his inauguration the White House issues a press release saying that he is ready to leave on official visit to China. Then the author of the article may rightfully assert: 'I said he would go!' Since 'he' refers to Obama, this means that the statement made in the

[8] A similar example is discussed in Burgess (1978, pp. 160–161). Further examples involving bets may easily be provided, as in Belnap et al. (2001, p. 160).

[9] MacFarlane (2008, pp. 89–90), recognizes that past unsettledness is consistent with the truth of past claims concerning the present, although the moral he draws is different.

article is reported as a statement about Obama. Nonetheless, the author may firmly believe that the result of the elections was not necessary. Romney could win, so the day before the elections (7) did not refer to Obama in all possible futures.

Future-oriented utterances are occasionally described as utterances that lack *determinacy*: it is said that (2) has no determinate truth-value today, or that (7) has no determinate reference today. The underlying assumption is that having a determinate extension amounts to having the same extension in all possible futures. If this assumption is granted, the point may be stated as follows. It is plausible that (2) has no determinate truth-value today, or that (7) has no determinate reference today. But this does not mean that (2) has no truth-value today, or that (7) has no reference today. Until proved otherwise, an expression may have an extension even though it does not have a determinate extension.[10]

The necessitation thesis again

The foregoing discussion of the argument for (N) is relevant to the assessment of another version of the necessitation thesis, the version that underpins the relativist semantics proposed by John MacFarlane. That semantics is intended to solve a problem that concerns sentences such as (2). MacFarlane says that we are torn between two intuitions. On the one hand, today we are tempted to say that (2) is neither true nor false, because there are possible futures in which it is true and possible futures in which it is false. This is what he calls 'the indeterminacy intuition'. On the other, tomorrow we will be tempted to say that the assertion does have a definite truth-value: once the sea battle has happened (or not), it seems strange to deny that the assertion was true (or false). This is what he calls 'the determinacy intuition'. MacFarlane claims that the two 'intuitions' are incompatible only on the assumption that utterance truth is nonrelative. For no conflict arises if we drop that assumption and accept that the same utterance can have different truth-values relative to different 'contexts of assessment'. His suggestion is that (2), as uttered today, is neither true nor false as assessed today, but true (or false) as assessed tomorrow. Therefore, his version of the necessitation thesis seems to be the following:

(N′) If future-tense sentences have a truth-value as assessed at the time of utterance, the future is necessary

From (N′) and the premise that the future is not necessary, it follows that future-tense sentences lack truth-value as assessed at the time of utterance.[11]

This line of thought rests on the presumption that truth and determinate truth are the same thing. According to MacFarlane, (2) as assessed today lacks a truth-value because it is true in some but not in all possible futures. However, if truth and

[10] The thought that a sentence may be true without being determinately true is entertained in Von Wright (1984, pp. 8–11), Lewis (1986, p. 208) and Horwich (1987, p. 32).

[11] MacFarlane (2003). Brogaard (2008) agrees with MacFarlane on the problem, although not on the solution.

determinate truth are not the same thing, (2) may be true (or false) without being determinately true (or false). More generally, the following conditional is not guaranteed to hold: if future-tense sentences have a truth-value as assessed at the time of utterance, they have the same value in all possible futures. Therefore, (N´) cannot be inferred from this conditional, and the premise that if future-tense sentences have the same value in all possible futures then the future is necessary. MacFarlane's justification of (N´) is nothing but a variant of the argument for (N), with the same flaw.

Not only the equation of truth with determinate truth is vital to MacFarlane's justification of (N´), it is also vital to the statement of the very problem he wants to solve. Consider the 'indeterminacy intuition'. Leaving aside the issue of whether we have evidence about the lack of truth-value of (2) today that is distinguishable from the mere epistemic fact that today we are not in a position to know whether (2) is true or false, the point is that if we do, the evidence must be that (2) is neither determinately true nor determinately false today. Similarly, the 'determinacy intuition' must be that (2) is determinately true (or determinately false) tomorrow. But if truth and determinate truth do not coincide, it is not obvious that these two 'intuitions' are incompatible. (2) may have the same truth-value today and tomorrow, with the difference that tomorrow, not today, that value is determinate. There is no apparent inconsistency in the claim that (2) has a determinate truth-value only tomorrow.

The Aristotelian objection can so be thwarted. On both versions of the necessitation thesis, the argument for the thesis rests on the assumption that having a truth-value amounts to having the same value in all possible futures. But this assumption may be denied if a distinction is drawn between truth and determinate truth. Therefore, unless the distinction is shown to be illusory, the necessitation thesis may be rejected. The next two sections show that there is a way to substantiate the theory of timeless truth that is consistent with the denial of the necessitation thesis.

Ockhamism

The core idea is easy to grasp, as it is the first thing that comes to mind. Consider (2) as uttered today. There is an obvious way to explain what is the condition at which (2) is true, that is, (2) is true if and only if there will in fact be a sea battle tomorrow. If we entertain (2) as a hypothesis about tomorrow, our concern – the question we are addressing – is whether there will in fact be a sea battle tomorrow. As 'in fact' indicates, truth is a matter of *actuality*. Just like a present-tense sentence 'p' is true at *t* if and only if it is actually the case that p at *t* and a past-tense sentence 'It was the case that p at *t*' is true after *t* if an only if it is actually the case that p at *t*, a future-tense sentence 'It will be the case that p at *t*' is true before *t* if and only if it is actually the case that p at *t*.

According to William of Ockham, one among the possible futures has a special status, that of being the 'true' future, and the truth-value of (2) today depends on what happens in it. Here, the idea is essentially the same. Let a *history* be a possible

course of events, and let it be agreed that there is a plurality of histories, one for each possible continuation of the present state of affairs. The truth-value of (2) today depends on what happens in one of these histories, the *actual* history. So the view under consideration may rightly be called 'Ockhamism'.[12]

On this view, the distinction between truth and determinate truth is to be understood in terms of the distinction between actuality and necessity. To say that (2) as uttered today is determinately true is to say that in all histories there is a sea battle tomorrow. In other words, truth is truth in the actual history, determinate truth is truth in all histories. So determinate truth entails truth, but is not entailed by it. A sentence may be true without being determinately true, if it is true in the actual history but false in some other history.

Ockhamism provides a clear explanation of the three elements of symmetry that characterize the theory of timeless truth. In the first place, bivalence holds. A future-tense sentence 'It will be the case that p at *t*' is either true or false at any time earlier than *t*. For either the actual history is such that p at *t* or it is not. So there is no difference between future-tense sentences and past-tense sentences as far as truth is concerned. At most, there may be a difference in determinate truth. It is consistent with the view to hold that a future-tense sentence, unlike a past-tense sentence, can be neither determinately true nor determinately false. Yet bivalence concerns truth, not determinate truth.

In the second place, truth conforms to the disquotation principle. The left-hand side of (4) is true today if and only if its right-hand side is true today. For the left-hand side of (4) as uttered today is true if and only if (2) as uttered today is true in the actual history. This is a result that one wouldn't get if truth were identified with determinate truth. For in that case one would get that today there are possible futures in which the right-hand side of (4) is true while its left-hand side is not.[13]

In the third place, the two truth-value links considered obtain. Suppose that (1) is true today. Then (2) was true yesterday. For the truth of (2) yesterday depended on what would happen today in the actual history. The same goes for the converse entailment. The truth-value link between (1) and (3) is similar. Note that if truth were identified with determinate truth, the first truth-value link would be in question. The supposition that (1) is true today would be consistent with the supposition that (2) was neither true nor false yesterday. For the truth of (2) yesterday would depend on all the courses of events that were possible yesterday.[14]

In substance, according to Ockhamism the theory of timeless truth may be regarded as an adequate characterization of truth, as distinct from determinate truth. The fact that truth does not entail determinate truth makes the denial of the neces-

[12] Øhrstrøm (2009, pp. 17–21), explains Ockham's conception. Adams (1986, p. 329, fn. 20), hints at an account of future-tense sentences along these lines.

[13] As it has been emphasized by the advocates of supervaluationism, this leaves room for a different sense in which ''p' is true' is equivalent to 'p'. See Van Fraassen (1966).

[14] MacFarlane (2008) argues that his semantics squares with the first truth-value link. But the issue is controversial, see Moruzzi and Wright (2009, Sect. 5) and Wright (2008, pp. 182–184).

sitation thesis acceptable. The conclusion that the future is necessary can be inferred from the premise that future-oriented utterances are determinately true or determinately false, but it cannot be inferred from the premise that they are true or false. So the theory is consistent with the assumption that the future is not necessary.[15]

More specifically, Ockhamism is consistent with indeterminism on at least one familiar understanding of indeterminism. Let a *state* be a way in which the world can be at a time. That is, saying that a certain state obtains at a given time amounts to saying that things are in a certain way at that time. If S is a state that obtains at a time t and S' is a state that obtains at a later time t', *determination* may be defined as follows:

(D) S determines S' if and only if the obtaining of S at t and the laws of nature entail that S' obtains at t'.[16]

Determinism may be understood as the claim that, for any time, the state of the world at that time is determined by its state at some earlier time. Indeterminism may be understood as the negation of that claim. Now suppose that two histories are in the same state at t, just as at any earlier time, but that they are in two different states at t', neither of which is determined by their state at t. This supposition is compatible with the hypothesis that only one of the two histories is actual, namely, that only one of the two states at t' is actually instantiated.

Further clarifications

The idea that truth is a matter of actuality naturally fits into a broader picture. Consider (7) as uttered today. There is an obvious way to explain what is the reference of (7), that is, (7) refers to the candidate that will in fact win the elections. Again, 'in fact' indicates actuality. One and only one candidate will actually win the elections, and the intended reference of (7) is precisely that candidate. Thus, a definite description uttered at t can refer to an object that exists at t'. More generally, the extension of an expression e uttered at t may involve a relation that ties e to something that belongs to a time later than t.[17]

Two issues must be addressed to get a better understanding of this picture. The first is metaphysical. One may ask whether it makes sense to talk of a relation as

[15] As Von Wright (1984, p. 9) suggests, determinate truth may be seen as the combination of two components. One, truth, is atemporal. The other, determinacy, is temporal; hence, it accounts for the temporal character of determinate truth.

[16] Hoefer (2003) is one of the works in which a definition along these lines is adopted to characterize determinism.

[17] Kaplan (1985, p. 397) suggests that we refer to future persons through acts of demonstration that essentially involve definite descriptions. Kaplan's suggestion has been discussed in several works, among which Adams (1986). However, that discussion is to a good extent irrelevant here, in that its focus is whether it is possible to have rigid designation towards the future. To ask whether a singular term about the future has a reference is not the same as to ask whether it is a rigid designator, unless having a reference amounts to having the same reference in all possible futures.

obtaining if one of its terms does not exist now. The answer is that it does make sense. A reasoning that seems to lead to the opposite conclusion is the following: a necessary condition for the existence of a relation is the existence of its terms; therefore, if one of the terms of a relation doesn't exist now, the relation itself doesn't exist now. This reasoning, however, is a *non sequitur*. The necessary condition does not entail that in order for a relation to exist at t, its terms must exist at t. If it did, then many relations we are familiar with would exist at no time. For example, if x is ancestor of y, x and y exist at different times. The fact is that many relations we are familiar with are *transtemporal*, that is, they obtain between entities located a different times. If a relation obtains between an expression e uttered at t and something that exists at t', it is simply one of them.[18]

It is not even clear whether it is meaningful at all to talk of transtemporal relations as existing at times. To ask whether a relation that obtains between an entity located at t and an entity located at t' exists at t is like asking whether a relation that obtains between an entity located in a place p and an entity located in a place p' – such as being to the right of – exists at p. This is not to say that there is a clear notion of what it is for a transtemporal relation to exist. Transtemporal relations might exist *simpliciter*, or outside time, or at any time, or for extended periods of time. In any event, all that matters here is that there is no reason to exclude that transtemporal relations can be described without presupposing that their existence is relative to time in the implausible way considered. Therefore, unless one is willing to deny the existence of transtemporal relations, one must agree that no specific metaphysical trouble arises with transtemporality in the case of future-oriented utterances.

The second issue is epistemological. To say that a relation obtains between an expression e uttered at t and something that exists at a later time t' is to say that the second term of the relation, hence, the relation itself is unknowable at t. One may then ask whether it makes sense to talk of a relation when one of its terms is unknowable. As in the first case, the answer is that it does make sense. The unknowability of a relation at a time is not a reason to deny that the relation can obtain. When one utters e at t, one's use of e is guided by the intention to talk about something that belongs to t'. Thus if one utters (7) today, one's use of (7) is guided by the intention to refer to the winner of the next presidential elections. Nothing prevents us from thinking that the utterance, in accordance with that intention, fixes the relation independently of one's state of knowledge at t.[19]

A spatial analogy may illustrate. In many action movies, there is a scene in which the good guy and the bad guy are in different rooms of the same house, each of them slowly walking without making noise in order to kill the other without being killed. Imagine that the following circumstance takes place in a situation like this. Al doesn't know Bob, he has never seen him. But he senses that a man is standing behind a

[18] Adams (1986, p. 320), uses the example of causation against the reasoning considered.

[19] Kaplan (1973, p. 500) considers definite descriptions whose reference is not knowable at the time of their utterance and calls them 'blind'.

door in front of him. He points his gun towards the centre of the door, fires off, and hits Bob. Since Al can't see Bob from his position, Al's intention is generically directed toward the man behind the door. It is not an intention to hit a specific man. However, once the gun fires off, the bullet is able to go through the door and hit Bob without further assistance. The semantic relation that ties an expression *e* uttered at *t* to an entity that exists at a later time *t′* has something in common with the ballistic relation between Al and Bob. Consider (7) as uttered today. Since we are not in a position to know who will win the elections, the intention that guides our use of (7) does not involve specific knowledge of its reference. But the utterance, in accordance with that intention, is able to get to the right person independently of this limitation.

It may be observed that there is an important difference between the man behind the door and an entity that can exist in the future, that is, the latter does not exist now. This is right. But note that the analogy is a spatial analogy, so it represents a relation between entities located at different times as a relation between entities located in different places. The two cases are similar in at least one crucial respect. Even if the spatial relation – the trajectory of the bullet – is not visible from the shooting position, it could be described by an external observer, say, a third man with special x-ray glasses who is above the two rooms and is able to see what happens in both. Similarly, even if the temporal relation – the semantic connection between an expression and the relevant entity – is not accessible at the time of the utterance, it could be described from an external point of view, a perspective from which different times can be ordered in a sequence.

As the shooting analogy suggests, a future-oriented utterance has semantic effects that go beyond our control. The extension of an expression *e* uttered at *t* may reach things that are inaccessible at *t*. On the assumption that extension is part of meaning, this is to say that the meaning of *e* is not transparent to one who uses *e* at *t*, that is, using *e* at *t* does not entail being in a position to know at *t* what *e* means. Non-transparency so construed is easy to accept. Independent evidence shows that a speaker can correctly use an expression without knowing its extension. For example, detectives often use the description 'the murderer' without knowing its reference. Therefore, the way in which meaning fails to be transparent is quite trivial and hardly controversial. A less trivial and more controversial form of non-transparency would involve some component of meaning other than extension: sense, intension or linguistic meaning. But no such component is in question here.

Some arguments against Ockhamism

Even though it is hardly disputable that the theory of timeless truth is indeterministic in the sense outlined in the fourth section, it may be contended that there is some important sense, other than that, in which it is not indeterministic. It is often repeated that indeterminism entails that no history is 'the' actual history. Some advocates of the tree model have suggested that any account of the semantics of tensed discourse

that makes reference to a distinguished history as the actual history is misguided. The distinguished history in question is what Nuel Belnap, Michael Perloff and Ming Xu call the *Thin Red Line*. According to them, even if we are inclined to talk of a unique actual future, this inclination must be resisted.[20]

The considerations in this direction can be divided into two categories. A first claim that has been made about Ockhamism is that the hypothesis that there is such thing as the actual history collides with a metaphysical conception, *branching*, that underlies the tree model. On that conception, two histories can overlap, that is, they can have a temporal part in common. A second claim that has been made is that if the hypothesis is maintained and branching is dropped, genuine indeterminism is lost. In this section, three arguments for the first claim will be examined.

The first argument is intended to show that it doesn't even make sense to talk of the actual history if branching holds. The argument goes as follows. The definite description 'the actual history' has no reference. If it had a reference, it would have the same reference in all branches. But that cannot be the case. Each branch is actual from its own point of view. That is, in each history, 'the actual history' refers to that history.[21]

This argument combines a shared assumption – that in each history, 'the actual history' refers to that history – with an assumption that is welcome among the advocates of the tree model, namely, that a definite description has a reference only if it has the same reference in all possible futures. As it turns out from the second section, however, the second assumption may be rejected if a distinction is drawn between reference and determinate reference. The reference of 'the actual history' is fixed in exactly the same way in which the reference of (7) or any other definite description is fixed: 'the actual history' refers to what in the actual history uniquely satisfies the condition of being an actual history, namely, the actual history itself.[22]

The second argument goes as follows. If a given history is the actual history, there must be something in the world that makes it so. But branching demands that all possibilities are equal. Therefore, it makes little sense to represent a plurality of histories as a tree and mark one of them in red as the actual history:

> What in the structure of our world could determine a single possibility from among all the others to be 'actual'? As far as we know, there is nothing in any science that would help. To the extent that scientific theories require objective possibilities for the future, there is no hint that those theories pick out a Thin Red Line.[23]

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[20] This does not mean that the tree model rules out actuality talk. On that model, it is certainly possible to define an actuality operator, as in Belnap et al. (2001, p. 246), or in MacFarlane (2008, pp. 98–101). But such operator leaves no room for the ascription of actuality to a single course of events.

[21] See MacFarlane (2003, p. 326). A slightly different version of the argument – see Belnap and Green (1994, p. 381), Belnap et al. (2001, p. 164) and MacFarlane (2008, p. 85) – invokes the indexical account of actuality proposed in Lewis (1983, pp. 18–20): if 'the actual history' had a reference, then 'our history' would have a reference, but that cannot be the case, given that we are in more than one history.

[22] Van Inwagen (1980, pp. 410–412), calls 'weak theory' the shared assumption and distinguishes it from the indexical account. As to the version of the argument based on that account, note that it might not be granted that we are in more than one history.

[23] Belnap et al. (2001, pp. 162).

This argument rests on a confusion. One thing is to say that a given history is the actual history, quite another thing is to say that something in the world makes it so. Perhaps there is nothing in 'the structure of the world' that determines a single possibility to be actual, yet this does not prevent that possibility from being actual. No matter whether (D) or some other definition is adopted to characterize determination, the distinction between actual and non-actual can be drawn independently of any consideration about determination. Something may be actual without being determined to be actual.[24]

The third argument goes as follows. Imagine a plurality of histories as a tree. If one of the branches is marked in red as the actual history, it is no longer clear how the other branches can represent genuine possibilities. For their non-actuality seems to rule out that they are genuine continuations of the same past:

> But, in our view, allowing any state to already be marked as that which will become actual, or as that state which is (atemporally) actual, reintroduces the linear conception, because it denies that the other states are real alternatives. That is to say, under such a theory the additional alternatives become mere logical possibilities with no ontological claims whatever.[25]

There is something right and something wrong in this argument. Let h and h' be histories that include different futures f and f', and suppose that only h is actual. It is legitimate to ask whether f' can be a genuine continuation of the part of h that precedes f, hence whether h and h' can overlap. But a negative answer to this question is not to be confused with the claim that f' is not a a genuine possibility. Certainly, f' is non-actual. But non-actuality does not rule out possibility. It is not actually the case that I'm lying on a beach, but this does not prevent such a state of affairs from being possible. Thus, the case of h and h' shows at most that Ockhamism is at odds with branching, which is not the same thing as to show that it is at odds with indeterminism. If what indeterminism requires is that more than one future is possible, indeterminism may equally be framed in terms of the conception that David Lewis calls *divergence*, the conception on which there is no overlap, even though two histories can have qualitatively identical temporal parts. Non-actual futures may be conceived as parts of histories that are wholly distinct from the actual history.[26]

Other arguments against Ockhamism

Let us grant, in accordance with the third argument considered in the previous section, that the first claim is true: the hypothesis that there is such thing as the actual future clashes with branching; hence, it can be held only in combination with divergence. According to the second claim, accepting that combination amounts to giving

[24] Rosenkranz (this volume) spells out the confusion in this argument by distinguishing two senses of 'determine', p.

[25] McArthur (1974, pp. 284–285). The same argument appears in MacFarlane (2003, p. 325)

[26] Lewis (1986) spells out the difference between branching and divergence, pp. 206–209, and argues in favour of divergence.

up indeterminism. In this section, three arguments in support of the second claim will be examined, to show that none of them resists scrutiny.[27]

The first goes as follows. In the scenario envisaged by Lewis, for each utterance there is at most one history to which the utterance belongs. In this sense, the future is determinate:

> Given a context of utterance, there is only one possible future history that contains it: the future is in that sense determined. Granted, there are other possible worlds that are qualitative duplicates of the actual world up to the present and diverge thereafter, but these worlds contain different utterances (and utterers), mere 'counterparts' of the actual ones.[28]

This is not a good argument. To begin with, if divergence is understood as the claim that histories do not overlap – independently of what Lewis adds to that claim – divergence does not entail that each utterance belongs to at most one history. Whether such relation obtains depends on how utterances are individuated. More specifically, it depends on whether contexts are defined in terms of objects that can belong to at most one possible world (including the possible world itself) or in terms of properties that can be instantiated in different possible worlds. All that it is assumed here is that contexts include time as a parameter of the second kind, which leaves unsettled the issue of the individuation of utterances. But even if contexts were so defined as to make utterances relative to possible worlds, it is not clear what should be wrong with that. Suppose that the actual world is part of the context that constitutes my present utterance of the sentence 'I'm writing a paper'. Then what I'm saying concerns the actual world, that is, I'm saying that I'm actually writing a paper. Trivially, my utterance is a necessarily true utterance that belongs only to the actual world. But this is acceptable. In particular, it does not contradict the apparent contingency of the fact that I'm writing a paper. For that contingency can be explained without referring to utterances so individuated: if we define an utterance* in terms of contextual parameters shared by different possible worlds, then my present utterance* of 'I'm writing a paper' is true in the actual world but false in some other world. The case of (2) is similar. If contexts are so defined as to include histories, then the future contingency of the sea battle is not to be phrased in terms of different histories in which the same utterance takes different truth-values, but rather in terms of different histories in which the same utterance* takes different truth-values. So it is hard to see how the uniqueness of the history to which an utterance belongs can have deterministic consequences.

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[27] Note that rejecting branching is not quite the same thing as rejecting the tree model. The tree model is a formal apparatus, and a formal apparatus can be interpreted in more than one way. An alternative and equally legitimate interpretation of the model is that according to which the branches of the tree represent possible sequences of states rather than possible courses of events that instantiate them. Two histories may be in the same state up to a certain time, so a single segment in the diagram can represent the common sequence of states that ends at that time. On this interpretation, no conflict arises between the tree model and Ockhamism. Even if the actual history instantiates a single sequence of states, the other sequences of states are equally possible, as they are instantiated by wholly distinct histories.

[28] MacFarlane (2003, p. 326).

The second argument hinges on a distinction that sometimes is drawn between 'determined', read as 'subject to determination', and 'determinate', read as 'attribute-specific': while the property expressed by the first term concerns some kind of relation between events located at different times, that expressed by the second concerns some sort of completeness in the features that events have at any given time. With this distinction in mind, it might be contended that, even if Ockhamism does not entail that the future is determined, it nonetheless entails that there is a determinate future.[29]

This argument is wrongheaded. The distinction between the two properties is legitimate. But it is questionable that the second property matters to the issue of whether the universe is deterministic or indeterministic. The notion of a determinate possible future is something that an indeterminist can accept, as it is proved by the fact that the friends of branching accept it. If one endorses branching, one contemplates a plurality of possible futures each of which is determinate. What the Ockhamism entails is simply that one of them is actual.[30]

Note that similar considerations undermine the objection that according to Ockhamism the future 'exists'. An indeterminist can accept that there are many possible futures each of which exists. Again, the friends of branching accept it. Ockhamism requires no ontological addition in that sense. What it requires is simply that one among the existing possible futures is actual. Obviously, when one says that a possible future – actual or non-actual – exists, the verb 'exists' is to be read in a tenseless way, since existence is understood as a property that can be shared by past, present and future things. A tenseless reading of 'exists' must be distinguished from a present tense reading, that is, from a reading according to which existence is a property that only present things possess. The claim that the future exists makes little sense on a reading of the second kind. Future things are not present, they are future. However, the claim is almost trivial on a reading of the first kind. The present instant is not our last instant. Many others are to come, and the world will be in some way at each of them. The way it will be is our future, or so we are tempted to say.

The third argument expresses a residual doubt that may be fostered by the way in which branching is usually advertised. According to branching, it might be contended, the future is open. According to divergence, it is not. Since the openness of the future is what we really care about, it is pointless to talk of indeterminism without branching.[31]

The flimsiness of this argument hides behind the meaning of the word 'open', which plays a key rhetorical role. In ordinary talk, 'open' is often used to indicate positive features that could as well be defined otherwise: think about 'open mind', 'open person', 'open society', and so on. The same goes for the future. Few would

[29] The distinction is drawn in McCall (1976, p. 339).

[30] McCall (1976, p. 340), recognizes the irrelevance of the second property.

[31] See MacFarlane (2003, p. 326, 2008, pp. 81–82).

deny that having an open future is good, or that it is better than having a closed future. But the question is why. A natural explanation is that in this case the positive charge associated to 'open' involves a modal connotation: what makes an open future good is that things can go in more than one way. However, insofar as the modal connotation is couched in terms of existence of different histories, any view that postulates such histories is able to account for it. Thus, if 'open' is read in the way that best explains its positive charge, branching is not the only view that makes the future open. By contrast, if 'open' is so construed that it applies only to branching, that is, if 'the future is open' means 'two histories can have as a common temporal part the present state of affairs and what precedes it', then it may be right to say that Ockhamism prevents the future from being open. But in that case 'open' looses much of its appeal, and it is no longer obvious that the future is open.

Neither of the arguments examined puts in jeopardy Ockhamism, and it is not clear whether better arguments can be provided. Of course, there may be readers who are so in the grip of the metaphor of the tree that they are incapable of conceiving indeterminism in any way other than branching. They may still contend that indeterminism without branching isn't 'really' indeterminism. No attempt will be made to argue with them. Unless an adequate justification is provided for that contention, to insist on it is simply to beg the question.

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Determinism, the Open Future and Branching Time

Sven Rosenkranz

Abstract In this chapter, I argue that on a natural understanding of both views, indeterminism and branching time are incompatible, contrary to what recent literature on the open future suggests. In the first section, I introduce two notions of truth-determination that importantly differ from the notion of truth-making. In the second section, I use these notions to devise a definition of determinism that captures the central idea that, given the past and present, the future cannot but be a certain way. Indeterminism is then defined in opposition to determinism in the third section. In the fourth section, I argue that the tree-like representation of future possibilities is not suggestive of branching time and that indeterminism is perfectly consistent with assumption of a Thin Red Line, that is, a unique way things will turn out to be, a claim shown to be unthreatened by considerations concerning human freedom. In the fifth section, I argue that taking branching time seriously implies commitment to determinism. In the sixth section, I consider a recent attempt to capture the open future and show that it is naturally seen to draw on a conception of the determinately true as what is determined to be true in the second of the senses introduced in the first section. In the seventh section, I argue that the authors' suggestion that determinism is nonetheless consistent with admission of a multitude of future possibilities is at best unmotivated and at worst misguided. Section eight summarises the results.

Two Notions of Truth-Determination

It is a widespread assumption in discussions about the open future that indeterminism and branching time are natural companions. Here I shall argue that, first appearances notwithstanding, this assumption is mistaken and that, on the contrary, branching

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time implies determinism. This thesis will be based on conceptions of determinism, indeterminism and branching time that I consider to be the most natural. However natural they may be, they are not uncontroversial. For this reason, I shall use labels in small caps for the particular conceptions of determinism, indeterminism and branching time to which my thesis is meant to apply, while reserving labels in normal font for the generic notions.

If branching time implies determinism, indeterminism had better be compatible with linear time. Indeed it is, or so I shall argue. Indeterminism can be combined with assumption of a *Thin Red Line*, that is, of a unique way things will turn out to be, without one of the principal motives for accepting it thereby being undermined: human freedom remains untouched by admission of such a Thin Red Line.

The conceptions of DETERMINISM and INDETERMINISM to be proposed essentially involve two notions of *truth-determination*, one a special case of the other, which importantly differ from the notion of truth-making (cf. Correia and Rosenkranz 2011: 28–29). Before I can begin arguing my case, these notions must be made explicit. Although their explicit definitions are rather involved, the notions themselves are in the end fairly easy to grasp, as testified by the informal glosses they allow.

To begin with, and mostly for ease of exposition, let us make the following assumptions and adopt the following conventions. Let the variable 't', and primed versions thereof, range over times, and let the variable 'f' range over facts, where we will assume facts to be tensed and will be very liberal as to what tensed facts there are, admitting, in particular, the existence of negative facts. It will be assumed throughout that the debate between determinists and indeterminists does not turn on these issues.[1] Let us choose a day as our unit for measuring temporal distances. Finally, let us use 'n days from the present, q' for 'Presently, q' in case $n=0$, for '$-n$ days ago, q' in case $n<0$, and for 'n days hence, q' in case $n>0$. Correspondingly, 't is n days from t'' will be used for '$t=t'$' in case $n=0$, for 't is $-n$ days earlier than t'' in case $n<0$, and for 't is n days later than t'' in case $n>0$. Unless indicated otherwise, all truth-functionally simple statements will be assumed to be of the form 'n days from the present, q'.

Now say that a statement p is *determined*$_1$ to be true at t iff$_{df}$ there is a collection of statements Σ and a function δ from the members of Σ to numbers suitable for measuring temporal distances such that:

(i) $\forall q \in \Sigma(\exists t'(t' \text{ is } \delta(q) \text{ days from } t \text{ \& at } t', \exists f(q \text{ is made true by } f)))$
(ii) $\Box\forall t'[(\forall q \in \Sigma(\exists t''(t'' \text{ is } \delta(q) \text{ days from } t' \text{ \& } q \text{ is true at } t''))) \rightarrow p \text{ is true at } t']$.

Crudely put, for a statement to be determined$_1$ to be true at a given time is for its truth at that time to be necessitated by truth-makers that are, at that time, past, present

[1] Assuming facts to be tensed has the advantage that we can sensibly talk about facts existing at certain times but not at others, for example, at past times but not at future times. Yet, most of what follows could be recast in terms of tenseless facts that have the relevant times as constituents. However, such reformulations would be unnecessarily cumbersome. For suitable accounts of tensed facts, see Correia and Rosenkranz 2011.

or future (is for that statement to be true at that time in virtue of what then has been, is or will be the case).

By contrast, say that a statement p is *determined*$_2$ to be true at t iff$_{df}$ there is a collection of statements Σ and a function δ from the members of Σ to numbers suitable for measuring temporal distances such that:

(i) $\forall q \in \Sigma(\exists t'(t'$ is $\delta(q)$ days from t & at $t', \exists f(q$ is made true by $f)))$
(ii) $\Box\forall t'[(\forall q \in \Sigma(\exists t''(t''$ is $\delta(q)$ days from t' & q is true at $t'')))) \rightarrow p$ is true at $t']$
(iii) $\forall q \in \Sigma(\delta(q) \leq 0)$.

Less formally, for a statement to be determined$_2$ to be true at a given time is for its truth at that time already to be necessitated by truth-makers that are, at that time, past or present but not future (is for that statement to be true at that time already in virtue of what then has been or is the case).

Note that while 'p is determined$_2$ to be true at t' straightforwardly entails 'p is determined$_1$ to be true at t', the converse does not hold. While truth-determination$_2$ is just a special case of truth-determination$_1$, the contention that whatever is determined$_1$ to be true is determined$_2$ to be true requires substantive argument. Note also that while to say that p is *made* true at t is to say that there is, at t, some fact that makes it true, to say that p is determined$_1$ to be true at t is not yet to say that there is, at t or any earlier time, some fact that does the determining$_1$. Thus, it is perfectly consistent to say that a future-tensed statement such as 'n days from the present, p', with $n>0$, is determined$_1$ to be presently true in virtue of there being n days from the present, a fact that then makes 'Presently, p' true but does not exist -n days from then (cf. Dummett 2004: 81; Correia and Rosenkranz 2011: 28–29).

The contrast between truth-determination$_1$ and truth-determination$_2$ may successfully be exploited in order to account for the problem of *foreknowledge* (cf. Prior 1967: 113–21). Very plausibly, 'Yesterday, God knew that 50 days thence a sea battle would take place' will be determined$_2$ to be presently true only if '50 days hence, a sea battle will take place' was determined$_2$ to be true yesterday, and hence only if '49 days hence, a sea battle will take place' is determined$_2$ to be true today. But then, provided that what is temporally necessary, or *pre*determined, is determined$_2$ to be the case, if the latter statement is not determined$_2$ to be presently true, the statement concerning God's foreknowledge will not be temporally necessary, its relation to the past notwithstanding. Yet, all this is quite consistent with saying that this statement is determined$_1$ to be presently true *inter alia* in virtue of there being, 49 days from now, the fact that a sea battle is then raging in the Gulf of Aden.

To be sure, if one thinks that it is part of the very concept of *truth* that whenever a statement is true it is determined$_2$ to be true, then 'p is determined$_1$ to be true at t' will also entail 'p is determined$_2$ to be true at t', already because the former entails that p is true at t. The contrast between these notions of truth-determination will then be lost. However, there is nothing that would force such a conception of truth upon us (cf. Greenough 2008). So if one wishes to exploit the contrast between truth-determination$_1$ and truth-determination$_2$ in the way suggested, this tells against adopting such a conception of truth. (For further discussion, see next section).

Determinism

According to one attractive and initially plausible conception of causation, if *c* is a cause of *e*, *e* would not occur if *c* had not occurred (cf. Lewis 1986).[2] If every event *has* a cause and *is* a cause in this sense, then a difference in initial conditions implies a difference in terminal conditions: from each terminal condition, there is but one way back.[3] Determinism adds something distinctive to the causalist doctrine that every event has a cause and is a cause in this sense, viz. that for any event *e* and the conjunction of its causes *C*, *C* would not occur, if *e* was not going to occur. Thus, according to determinism, a difference in terminal conditions implies a difference in initial conditions: from each initial condition, there is but one way to go.[4] Generalising from talk about the occurrence of events to talk about things being thus and so, and assuming that natural laws are amongst the present facts, we may accordingly

[2] As Lewis notes, this at most holds for cases of immediate causation, as we wish to say that *c* causes *e* if *c* causes *e′* which in turn causes *e*. In other words, we take causation to be transitive, while counterfactual dependence is not. The obvious remedy is to define causation in terms of causal chains, that is, chains of pairwise counterfactually dependent events (Lewis 1986: 167). For simplicity's sake, I will stick to the above formulation. Consequently, 'cause' should here be taken to mean 'immediate cause'. For further provisos, see next footnote.

[3] This reasoning relies on '$\Box((\sim A \Box\!\!\rightarrow \sim B) \rightarrow (B \Box\!\!\rightarrow A))$' which is uncontroversial given only that no world is closer to the actual world than the actual world itself. Note that since '$\Box\!\!\rightarrow$' is transitive, the existence of causal chains involving intermediate causes will leave the claimed inference from terminal conditions to initial conditions unaffected. See previous footnote.

As Lewis reminds us, there are likely to be cases of causal preemption (and overdetermination) so that *c* would have caused *e* if *c′* had not occurred. In such cases, we would still want to be able to say that *c′* causes *e*, although there is no counterfactual dependence (Lewis 1986: 171–72). The causalist doctrine mentioned in the text does not exclude such cases, even if they render doubtful that the suggested counterfactual characterisation captures our ordinary concept of causation, for note that causal preemption and overdetermination are relations between *particular* events. Yet, even if *c′* preempts *c*'s causing *e*, or *c* and *c′* overdetermine *e*, so that, either way, it is not the case that *e* would not have occurred if *c′* had not occurred, there may still be a *c″* such that *e* would not have occurred without it and an *e′* such that it would not have occurred without *c′*. To skirt any further issues, let '(immediate) cause', as it occurs in the causalist doctrine, henceforth be a technical term understood to imply counterfactual dependence.

[4] Often, determinism is identified with the combination of this thought and the causalist doctrine. However, since indeterminists may endorse the latter, it will be more convenient to reserve 'determinism' for the former. (As we shall see in section 'Branching Time and Determinism' below, if time exhibits forward branching, the 'one way to go' from the initial conditions may consist in a unique manifold of continuations spread across distinct time-series just like the crown of a tree.)

Note that I here diverge from Lewis who explicitly denies that determinism should be understood in either of these ways because, for him, the direction of time is to be explained in terms of causation *and causation is analysed* in terms of counterfactual dependence (see Lewis 1986: 32–38, 167). By contrast, merely to say, as I do, that causation *implies* counterfactual dependence neither precludes the thought that the past and present might also counterfactually depend upon the future, nor renders that thought incompatible with the idea that time's arrow can be explained in terms of causal asymmetry.

describe determinism as the view that, for every statement p and every time t, at t, past and present facts already jointly necessitate the truth of p or of its negation.[5] In particular, this is meant to apply to statements about the future.

By contrast, indeterminism is typically understood to be the doctrine that just as not all that has happened was bound to happen before it did, not all that will happen, if anything, is bound to happen before it does. Thus, indeterminists will typically deny that for every statement and every time, at that time, the present and past facts jointly necessitate the truth of that statement or of its negation, even if the former include the natural laws. In particular then, determinists will hold, while indeterminists will deny, that every future-tensed statement is, if presently true, determined$_2$ to be presently true, that is, determined$_1$ to be presently true in virtue of past and present facts alone.

In the light of the foregoing, determinism can be rendered more precise as follows. Say that the world is DETERMINISTIC iff$_{df}$ all of the following hold:

(1) A given statement is true at t iff it is determined$_1$ to be true at t.
(2) Either a given statement is true at t or its negation is.[6]
(3) A given statement is determined$_1$ to be true at t iff it is determined$_2$ to be true at t.

Classically, (1), (2) and (3) are jointly equivalent to:

(4) Either a given statement is determined$_2$ to be true at t or its negation is.[7]

Note that DETERMINISM, as defined, is compatible with:

(5) For all t, all $n>0$ and all tense-logically simple p, 'n days from the present, p' is determined$_1$ to be true at t iff n days from t, 'Presently, p' is made true by some fact.

[5] I here take it that, according to determinism, the connection between initial and terminal conditions is law-governed so that, where A states the initial conditions and B states the terminal conditions, if '~B □→~A' holds in the actual world, it will also hold in all nomologically possible worlds, and consequently that if '~B □→~A' holds, 'A→B' will hold in all nomologically possible worlds (see last but one footnote). If A itself entails the conjunction of the relevant laws as well as the claim that they are laws and nothing else is, 'A→B' will furthermore be necessary *simpliciter*: any metaphysically possible world satisfying A will then be a nomologically possible world. See footnote 8 below for the assumption that A, though made true by present and past facts alone, can nonetheless be understood to entail the relevant laws as well as the claim that they are laws. For the thought that the causalist doctrine need not issue in a corresponding claim of necessitation, see footnote 16.

[6] I here ignore statements affected by semantic indecision, presupposition failure, and comparable linguistic or pragmatic shortcomings. I will also ignore the intuitionists' view according to which there is a gap between affirming that no statement is such that neither it nor its negation is true at t and affirming (2). There is no evident reason why there shouldn't be an intuitionistically acceptable version of determinism that foregoes commitment to (2) but affirms its double negation instead. Accordingly, any indeterminist view that takes issue with (2) will here be conceived of as taking issue with its double negation, too.

[7] See previous footnote.

That is to say, DETERMINISTS may allow for truth-making by future facts. What they will, however, insist on is that the future existence of such truth-makers, if any, is jointly necessitated by what is and what has been the case. This combination of ideas may not be the most parsimonious of views, but it is consistent nonetheless.[8] Since (5) is plausible quite independently from the issue about determinism, this is as it should be.

One might still wonder whether (4) gives full expression to determinism, since the definition of truth-determination$_2$ clearly allows for present-tensed statements being determined$_2$ to be presently true solely in virtue of facts that are present. In other words, it would seem that, for all that (4) implies, the present might have 'popped into existence' without being the outcome of any law-governed processes initiated in the past, and this would clearly be at odds with deterministic thinking.

However, if (3) holds, then any statement determined$_2$ to be true at *t* thanks to truth-makers that are, at *t*, present will likewise be determined$_2$ to be true at *t* thanks to truth-makers that are, at *t*, past. Thus, let 'Presently, *p*' be determined$_2$ to be true at *t* because, at *t*, 'Presently, *p*' is itself made true by some fact. Given the truth-value link

(L) □('Presently, *p*' is true at *t* ↔ '*n* days from the present, *p*' is true at *t*′(−*n*) days from *t*),

it follows that '*n* days from the present, *p*' is determined$_1$ to be true at a time -*n* days from *t*. By (3), '*n* days from the present, *p*' is also determined$_2$ to be true at a time -*n* days from *t*. For simplicity's sake, assume that, -*n* days from the present, '*n* days from the present, *p*' is itself made true by some fact. But then given (L), there is a statement *s* such that -*n* days from *t*, *s* is made true by some fact and necessarily, if *s* is true -*n* days from *t*, 'Presently, *p*' is true at *t*. Accordingly, 'Presently, *p*' is also determined$_2$ to be true at *t* thanks to truth-makers that are, at *t*, past.[9]

[8] It might be thought that DETERMINISM, as defined, is after all incoherent because it will have to postulate *laws* which connect the past and present with the future and, as such, are partly determined$_1$ to be true by what will be the case in the future. If so, what will be the case in the future cannot be said to be determined$_2$ to be true, that is, determined$_1$ to be true by present and past facts alone (cf. Barnes and Cameron 2009: 300). However, rather than confuting the present characterisation of DETERMINISM, this consideration suggests that DETERMINISTS had better reject the Humean regularity-based conception of laws and instead conceive of laws as facts relating (potentially uninstantiated) properties or relations. There are independent reasons for construing laws in these terms (cf. Dretske 1977; see Maudlin 2007 for a primitivist alternative to Dretske's account). Plausibly, if laws are construed as facts relating properties and relations, the existence of such facts metaphysically entails that they are laws.

[9] The proof assumes that for any time *t*, there are times earlier than *t*. Accordingly, if time has a beginning, the conclusion cannot be proved for all times. But then, under that same assumption, there is no reason to think that determinism involves the idea that, for all times *t*, including the first time, what is true at *t* is predetermined by what was the case before *t*.

Indeterminism

All INDETERMINISTS reject (4) and so must reject at least one of (1), (2) and (3). (1) would seem to be unobjectionable to the INDETERMINIST, as its right-to-left direction would seem trivial, while prescinding from worries about negative truth-makers, its left-to-right direction expresses the seemingly innocuous thought that, for any statement *p* and any time *t*, if *p* is true at *t*, then there is, was or will be something in virtue of which *p* is true at *t*. Thus, (1) is naturally seen as common ground between DETERMINISTS and INDETERMINISTS. As we shall see in due course, however, matters are not necessarily what they seem.

What about (2)? It might be suggested that INDETERMINISTS may reject (2) while nonetheless accepting both (1) and (3). Let us see whether this is a tenable combination of views. Suppose then that (2) is said to fail because future contingents are neither true nor false. Let us for the moment assume that the right logic for the suggested view is Kleene's strong 3-valued logic, and let us use $\mathcal{T}$ for (present) truth, $\mathcal{F}$ for (present) falsity and *I* for the status of being neither (presently) true nor (presently) false. Then we have the following (cf. Urquhart 1986: 76):

(a) $\mathcal{T}(A \rightarrow B)$, $\mathcal{F}(B)$ / $\mathcal{F}(A)$

(b) $\mathcal{F}(A \,\&\, B)$, $I(A)$ / $\mathcal{F}(B)$

(c) $I(A)$, Not: $\mathcal{T}(B)$ / $I(A \rightarrow B)$

Accordingly, assume that there is some future contingent of the form '*n* days from the present, *p*', with $n > 0$, such that neither this statement nor its negation is true at t_0, where t_0 is the present time. Assume that (1) is true, and so *a fortiori* true at t_0:

(1) A given statement is true at *t* iff it is determined$_1$ to be true at *t*.

Given that (1) is true at t_0, it is true at t_0 that if '*n* days from the present, *p*' is determined$_1$ to be true at t_0, then '*n* days from the present, *p*' *is* true at t_0. If a statement *s* is neither true nor false at t_0, then it is false at t_0 that *s* is true at t_0. So by rule (a), it must then be *false* at t_0 that '*n* days from the present, *p*' is determined$_1$ to be true at t_0. It follows from the definition of truth-determination$_1$, and so is true at t_0, that if

(i′) at some particular time *t n* days from t_0 there is a fact that makes 'Presently, *p*' true,

and

(ii′) necessarily, for every time *t′*, if 'Presently, *p*' is true at some time *n* days from *t′*, '*n* days from the present, *p*' is true at *t′*,

then '*n* days from the present, *p*' will be determined$_1$ to be true at t_0. By another application of rule (a), it follows that the conjunction of (i′) and (ii′) is false. Since (i′) is a future contingent, given that $n > 0$, (i′) should be regarded as neither true at t_0 nor false at t_0. Hence, by rule (b), we are committed to saying *that (ii′) is false at* t_0.

What would it take for (ii′) to be false at t_0? There would have to be a world centred on a time – its present time – such that the embedded generalisation is false in that world at that time. If the world is DETERMINISTIC, then this generalisation will be true at its present time. So we must enquire whether the embedded generalisation may be false in an INDETERMINISTIC world at its present time. *Ex hypothesi*, in such a world, (2) will fail for future contingents. *Ex hypothesi*, the actual world is a world of this kind. So if, by assuming no more about the actual world with its present time t_0 than that it is INDETERMINISTIC in this sense, we can show that the embedded generalisation is *not* false at t_0, then we can show that (ii′) is not false at t_0, in which case (1) is not true at t_0.

Let us therefore ask what it would be for the embedded generalisation to be false at t_0. There would then have to be a time t such that the conditional

(#) If 'Presently, p' is true at some time n days from t, 'n days from the present, p' is true at t

is false at t_0, where again $n>0$. For any time t, there is an m such that t is m days from t_0, where m may be positive, negative or 0. Either $n+m\leq 0$ or $n+m>0$. Suppose that $n+m\leq 0$. Then since '$n+m$ days from the present, p' will be either true at t_0 or false at t_0, either both the antecedent and the consequent of (#) will be true at t_0 or both will be false at t. In either case, (#) will be true at t_0. Suppose instead that $n+m>0$. Then the antecedent of (#) will be a future contingent and so be neither true at t_0 nor false at t_0, while the consequent will not be true at t_0. So, by rule (c), (#) will be neither true at t_0 nor false at t_0, and so *not* be false at t_0. Therefore, we may conclude that (ii′) is not false at t_0, whence it follows that it is not false at t_0 that 'n days from the present, p' is determined$_1$ to be true at t_0. But then, contrary to what was assumed, (1) is not true at t_0, and so not true.

What about (3)? Consider the following relevant instance:

(3′) 'n days from the present, p' is determined$_1$ to be true at t_0 iff 'n days from the present, p' is determined$_2$ to be true at t_0.

Proponents of the view under consideration are still, *qua* INDETERMINISTS, committed to taking future contingents to present counterexamples to (4) and so to rejecting the right-hand side of (3′) as false at t_0. But we just saw that the left-hand side is *not* false at t_0, whence by rule (a), (3′) cannot be true at t_0. It follows that (3) cannot be true at t_0 either.

So, assuming Kleene's strong 3-valued logic, the suggested combination of (1) and (3) with the rejection of (2) proves untenable. At this stage, proponents of the suggested combination will deny that Kleene's strong 3-valued logic is at all suited to give expression to their view. Instead they are likely to go for some kind of *supervaluationism* and define truth at a time as truth relative to all the possible courses of events that include what is past and present at that time and continue indefinitely into what is future at that time, consistently with what went on before (cf. Thomason 1970; MacFarlane 2008). Kleene's strong 3-valued logic is ill-suited to formalise this supervaluationist conception. Thus, if $\mathcal{F}$ stands for superfalsity and I for the status of being neither supertrue nor superfalse, rule (b) will be invalid, and the conjunction of (i′) and (ii′) will be superfalse at t_0 although neither (i′) nor (ii′) is superfalse at t_0.

To see the latter, let t in (#) be identical to t_0, that is, let $m = 0$. Then, at t_0, all possible future courses of events are either such that both (i′) and the antecedent of (#) are false with respect to them, or such that both (i′) and the antecedent of (#) are true with respect to them, while the consequent of (#) is anyway superfalse at t_0. Since there are, at t_0, possible future courses of events of both categories, neither will (i′) be superfalse at t_0 nor, at least for this choice of t and m, will (#) be superfalse at t_0. But given that, at t_0, all possible future courses of events are continuations of the same present and past, the reasoning a few paragraphs back already shows that (#) will not be superfalse at t_0 for any other choices of t and m. The same will hold for all other centred worlds and *their* present times. So (ii′) will not be superfalse at t_0.

So it seems that by opting for supervaluationism and adopting a logic suited to express it, proponents of the view under consideration can after all reconcile their rejection of (2) with their acceptance of both (1) and (3).

But now note that on this conception of truth as supertruth, not only will the distinction between truth-determination$_1$ and truth-determination$_2$ be obliterated (see section 'Two Notions of Truth-Determination'), it will also follow that truth-value links of the kind exemplified by

(L) □('Presently, p' is true at $t \leftrightarrow$ 'n days from the present, p' is true at $t'(-n)$ days from t)

will no longer hold on conceptual grounds, for, on the conception of truth as supertruth, a future-tensed statement is true at a time only if, at that time, it is inevitable that the corresponding present-tensed statement is going to be true, and it is a substantial metaphysical thesis that, necessarily, what has come to be the case was inevitably going to be the case.

As we saw towards the end of the previous section, DETERMINISM, as defined by the conjunction of (1), (2) and (3), deserves to be called by that name only if it can avail itself of truth-value links of the kind (L) exemplifies. On the conception of truth as supertruth, that is, truth on all possible continuations of the past and present, (1) and (3) will be conceptually necessary, while (2) proves to be a substantial metaphysical thesis. So on that conception, the only tenet of DETERMINISM that has any metaphysical import is (2). But (2) alone will not be sufficient to license (L). What would rather be needed in order to license (L) is the *necessitation of (2)*.[10] But on any adequate construal of determinism, determinists *qua* determinists should not be obliged to regard the *metaphysical tenets* defining their view as being themselves necessary. Thus, it should be open to them to concede that there are possible worlds that are INDETERMINISTIC. Given $\Box A \vdash \Box\Box A$, this problem is not solved by saying that DETERMINISM underdescribes determinism proper and that the central

[10] On the intuitionists' view, less is needed, viz. merely the necessitation of 'No statement is such that neither it nor its negation is true at t'. However, as already indicated in footnote 6, once intuitionism comes into view, there is no evident reason why DETERMINISM must be construed as involving (2) rather than this (intuitionistically) weaker tenet. The present considerations would *mutatis mutandis* carry over to this (intuitionistically) weakened version of DETERMINISM.

metaphysical tenet defining the latter should be the necessitation of (2) rather than simply (2).[11, 12]

All in all, it would therefore seem most natural to assume that (3), far from being a conceptual truth, is one of the DETERMINISTS' central metaphysical tenets and that INDETERMINISTS should at least reject (3), whether or not they also reject (1) or (2).

However, there is still one pertinent view that suggests otherwise, viz. the radical view according to which there is no future at all.[13] On such a view, it is most natural to reject the inference from '~(n days from the present, p)' to 'n days from the present, ~p', whenever $n>0$ and p is tense-logically simple: if there is no time n days from the present, no statement implying that there is such a time will be true, and it is most natural to assume that both 'n days from the present, p' and 'n days from the present, ~p' have this implication. Once this inference is rejected and all relevant statements of the form '~(n days from the present, p)', with $n>0$, are accepted as true, (2) can be retained. But by the same reasoning, (3) turns out trivially true: if there are no future times, then there are no future facts and all statements of the form 'n days from the present, p' and their negations will accordingly be determined$_1$ to be true iff they are determined$_2$ to be true.

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[11] Federico Luzzi suggested to me that the present issue might be resolved by conceiving of DETERMINISTS and INDETERMINISTS as having a disagreement about what the DETERMINISTS' metaphysical tenets are: while the INDETERMINISTS regard (3) as a conceptual truth and take the DETERMINISTS' controversial thesis to be (2), the DETERMINISTS themselves may rather regard (2) as a conceptual truth and take their controversial thesis to be (3). DETERMINISTS would not then be pictured as treating their central metaphysical tenet as necessary. On this way of construing the debate, however, not only would each party charge the respective other with conceptual error; the conception of truth as supertruth would furthermore involve a bias in favour of INDETERMINISM, given only that it is implausible to think that DETERMINISM is true only if necessary. There would thus seem to be no neutral ground from which to argue, as is familiar from the debate concerning logical revisionism. As long as alternative construals are available that do not have this consequence, abandoning the idea of a neutral standpoint would seem to be undesirable already for methodological reasons.

[12] Even if we replaced clause (iii) in the definition of truth-determination$_2$ by '$\forall q \in \Sigma(\delta(q)<0)$', thereby sidestepping the difficulty mentioned towards the end of the previous section, and understood DETERMINISM's tenet (3) accordingly, it would still, thanks to clause (ii) of that definition, hold that DETERMINISM requires necessary links between the present truth of present-tensed statements and the past truth of future-tensed statements, which unnecessitated (2) cannot deliver. In any case, though, after the envisaged redefinition of truth-determination$_2$ and of DETERMINISM's tenet (3), the conception of truth as supertruth would imply that (2) is not the only metaphysically controversial tenet the DETERMINIST accepts: if '0 days from the present, p' is true at t_0, then, insofar as both (1) and (3) hold, 'n days from the present, p' will have to be true at t-n, for some positive n. But what holds on all possible continuations of both what is past at t_0 and what is present at t_0 may not hold on all possible continuations of both what is past at t-n and what is present at t-n. Accordingly, if truth-determination$_2$ and DETERMINISM's tenet (3) were redefined in the way suggested, supervaluationist INDETERMINISM would no longer be a position of the kind we are here considering, that is, a position that accepts (1) and (3) but rejects (2). Thanks to Graham Priest for pressing me to elaborate on this point.

[13] There are fairly obvious problems with 'alwaysing' a view such as this. But even if it cannot be part of such a view that it is available at each time and so available at earlier times, this does not alter the fact that, at each time, some view of this kind is available (albeit one which is no longer available at later times, if any).

Whether (1) can be retained on such a view accordingly depends on whether there are any past or present facts whose existence necessitates that there are no future times. If there are such facts, the proclaimed end of time is compelled by what happens before it and so is inevitable, and this is surely a deterministic thought. If there are no such facts, by contrast, then it is consistent with what goes on before the end of time that time extends into the future, even if it does not so extend. So it seems that there are two versions of the 'no future' view, one that involves acceptance of (1) and one that involves its rejection. Only the latter qualifies as a version of indeterminism, which finding is in line with the definition of DETERMINISM given in the previous section.

Thus, our conclusion should be appropriately qualified: unless they opt for the radical'no future' view and so reject (1), INDETERMINISTS should at least reject (3). This is how INDETERMINISM will be understood in the remainder of this chapter. Since rejection of (3) also suffices for INDETERMINISM, and since (2) is well-entrenched and anyway consistent with the 'no future' view, I will, until further notice, only be concerned with forms of INDETERMINISM that involve acceptance of (2).

Indeterminism and the Thin Red Line

It is a common thought that an indeterministic universe is best modelled by tree-like structures. It is equally common to think of these tree-like structures as models of *branching time*, that is, as structures that reflect the structure of time and hence of temporal reality (cf. Thomason 1970; Belnap et al. 2001; MacFarlane 2008). As I shall argue in this section and the next, there is reason to think that these are inconsistent demands on what such tree-like structures should accomplish.

If, in accordance with the first demand, the many branches of the tree merely represent those continuations of present and past history that are consistent with the totality of present and past facts, the tree will represent a mere range of possibilities. As such, it suggests as yet *nothing whatsoever* about the structure of time – just as its being both possible that there is an accident ahead and possible that there is no accident ahead suggests nothing whatsoever about whether the road ahead forks. The existence of many branches is then quite consistent with the idea that there is now a unique answer to the question of what will come to be the case, even if what will come to be the case is not compelled by what is or has been the case. To *infer* from the observation that many future courses of events are consistent with what is or has been the case, that there is now no such unique answer, is either to succumb to DETERMINISTIC reasoning or to rely on the INDETERMINISTIC version of the 'no future' view. Yet, it was INDETERMINISM, and not DETERMINISM, that was meant to be modelled by the tree-like structure, and the 'no future' view is anyway best represented by a decapitated trunk rather than a tree whose branches extend into the future. On this radical view, time itself would again be linear and not branching.

Belnap et al. argue that there is no *Thin Red Line* (TRL), marking out the one and only actual future. They ask, merely rhetorically, 'what in the structure of our world could determine a single possibility from amongst all the others to be "actual"', and go on to add that 'as far as we know, there is nothing in any science that would help' (Belnap et al. 2001: 162). This rhetoric makes perfect sense if 'determine' is here understood to mean the same as 'determine$_2$' and any TRL would already have to be singled out by the totality of present and past facts alone, and so be a TRL$_2$, for short. But once 'determine' is understood to mean the same as 'determine$_1$' and the TRL is thought not to be singled out by past and present facts alone but only in conjunction with future facts, and so is thought of as a TRL$_1$, the authors' misgivings would seem entirely misplaced. (For a similar complaint, see Iacona, this volume.)

Surprisingly, however, Belnap et al. take their considerations to show that postulating a TRL$_1$ is unfounded (Belnap et al. 2001: 135–36).[14] Worse still, at a later stage, they themselves suggest that in order to know the truth about what will come to be the case, one must wait and see until it has come to be the case (*ibid.*: 175–76). But then there would seem to be a TRL$_1$ after all, viz. the course of those events that will have come to occur at the time at which we, or our successors, have waited long enough to be in a position to know that they were going to occur! Accordingly, and by the authors' own lights, we should distinguish between TRL$_1$s and TRL$_2$s: even if there is no TRL$_2$, there may nonetheless be a TRL$_1$. If there is such a TRL$_1$, then for all that has so far been said, time is linear and not branching.[15]

A worry one might have is that once such a TRL$_1$ has been postulated, it becomes difficult to see how we can be free to choose and act. If the future is presently determined$_1$ to be a certain way, even if it is not compelled to be that way by any present or past facts, then how can my present acts have any impact on that future? And how can what I will do then be said to depend on my present choices? This worry can be answered as follows. If INDETERMINISM reigns, there is indeed no basis for saying that whenever I presently act in a certain way my acts compel future events, or that whenever I will act in a certain way after presently choosing to do so that I will do so is compelled by my present choices. If 'to have an impact' means 'to compel', my present acts or choices can indeed have no impact on the future. But for all that, my present choices and acts may still make a difference by *causing* future events that otherwise would not be going to happen, including the actions I will perform (see section 'Determinism' above'). So, if 'to have an impact' just means 'to be causally relevant', which is by far the most natural reading, my present acts or

[14] Belnap et al. identify the doctrine of the open future with 'the view that in spite of indeterminism one neither needs nor can use a Thin Red Line', where the latter is meant to refer to a TRL$_1$ (Belnap et al. 2001: 136). But then why isn't this suggestive of a decapitated trunk rather than a branching tree? The answer presumably is that only a branching tree can represent future possibilities. But this, as argued, is not suggestive of branching time and neither rules out, nor makes it superfluous to think, that there is a TRL$_1$.

[15] See footnote 20 for further discussion. MacFarlane seeks to discredit assumption of a TRL$_1$ by suggesting that it rests on the confused idea that we move through time as a car moves along a road (MacFarlane 2008: 85–86). I fail to see any such connection.

choices can after all have an impact on the future. Since neither my choices nor my actions are compelled by what goes on before them, I am in a relevant sense free to make or perform them and so to impact on the future.

Dummett suggests that if, contrary to fact, I knew what was going to happen or what I was going to do, this knowledge would affect my present deliberations (Dummett 2004: 81). However, if what is going to happen counterfactually depends on what I presently do or choose to do, then I could not presently have that knowledge unless I nonetheless did or chose to do what I presently do or choose to do. At most, such knowledge would make my deliberations phenomenologically awkward. Maybe what will happen in part counterfactually depends on my giving in to fatalist thinking, but then again it may in part counterfactually depend on my resisting this temptation. Whichever case obtains, my foreknowledge would depend on what will happen, which in turn depends on whatever it is without which it would not be going to happen, and not the other way round. Recall that a statement like 'Captain Nishky knows that a sea battle will take place' is not determined$_2$ to be true unless 'A sea battle will take place' is so determined$_2$ (see section 'Two Notions of Truth-Determination'). Postulation of a TRL$_1$, rather than a TRL$_2$, would thus seem to have no implications for human freedom.

Accordingly, when Diekemper argues that it would be bad enough for our self-conception as free subjects if the future was merely 'contingently fixed', where 'contingent' here contrasts with 'compelled', this thought must remain unpersuasive if 'contingently fixed' just means 'determined$_1$' (see Diekemper 2007). Diekemper invokes time travel in order to drive his point home. But surely insofar as, for some such time traveller, part of the future is also his personal past, its description is *in his personal time* also determined$_2$ to be true, and so the idea of equating the fixity of the future with its description being determined$_2$ to be true, rather than merely being determined$_1$ to be true, still stands. (The contrast between something's being determined$_2$ to be true in a time traveller's personal time and its not being determined$_2$ to be true in objective time is no more puzzling than the contrast between personal time and objective time that time travel requires, and it is Diekemper who invokes time travel.)

Arguably, this is not yet to answer Diekemper's quest for an account of the *asymmetry* of fixity between past and future (Diekemper 2007), for, unless we are content to trivialise matters, we cannot simply equate the fixity of the past with *its* description being determined$_2$ to be true: to say just this much at most implies that past-tensed statements are, if presently true, presently true in virtue of past facts. However, given the distinction between DETERMINISM and the causalist doctrine that every event both has a cause on which it counterfactually depends and is a cause on which other events counterfactually depend (see section 'Determinism'), we may instead venture to say that the present past is fixed iff its present description is determined$_3$ to be presently true, where a statement p is *determined*$_3$ to be true at t iff$_{df}$ there is a collection of statements Σ and a function δ from the members of Σ to numbers suitable for measuring temporal distances such that:

(i) $\forall q \in \Sigma(\exists t'(t' \text{ is } \delta(q) \text{ days from } t \text{ \& at } t', \exists f(q \text{ is made true by } f)))$
(ii) $\Box\forall t'[(\forall q \in \Sigma(\exists t''(t'' \text{ is } \delta(q) \text{ days from } t' \text{ \& } q \text{ is true at } t'))) \rightarrow p \text{ is true at } t']$
(iii′) $\forall q \in \Sigma(\delta(q) \geq 0)$.

In other words, a statement is determined$_3$ to be true at a given time just in case its truth at that time is necessitated by truth-makers that are, at that time, present or future but not past. The claim that the past is fixed in this sense is open to an INDETERMINIST who accepts the causalist doctrine (see sections 'Determinism' and 'Indeterminism').[16]

As we shall see in due course, however, under certain specifiable assumptions, the thought that the past is fixed in this more demanding sense conflicts with *epiphenomenalism* according to which there are past events that have had, and will have, no effects. Yet arguably, this is no objection to the cogency of the contemplated proposal, for, on the one hand, epiphenomenalism is itself a controversial doctrine which may have unexpected and controversial implications.[17] On the other hand, if the fixity of the past really consists in more than just the innocuous thought that past events *are* past, or that *given* how the past is we cannot undo it (Lewis 1986: 77–78) – which would either give us asymmetry on the cheap or symmetry on the cheap as soon as we said corresponding things about the future – an imperfect fit between what is past and what is fixedly past need not necessarily count against an explication of the latter.

Whether we think of fixity in general in terms of truth-determination$_2$ and so regard it as trivial that the past is fixed, or whether we aim for something more ambitious and explain the fixity of the future, or rather the lack thereof, in these terms but the fixity of the past in terms of truth-determination$_3$, either way there is no reason specifically to do with human freedom or the asymmetry of fixity that could oblige us to deny that there is a TRL$_1$. If there is such a TRL$_1$, however, then the tree-like structure, though apt to represent future possibilities, does not adequately reflect the structure of time or of temporal reality, which will then rather be linear.

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[16] To accept this claim may not be unproblematical, though. Let A be the initial conditions and B be the terminal conditions; then, according to the causalist doctrine, '~A $\Box\!\!\rightarrow$ ~B' holds. Now if '~A $\Box\!\!\rightarrow$ ~B' holds in all nomologically possible worlds, so will 'B $\rightarrow$ A'. If B entails the natural laws as well as the claim that they are laws and nothing else is – call the combination of these claims 'N' – then 'B $\rightarrow$ A' will be not only nomologically necessary but necessary *simpliciter*: every metaphysically possible world satisfying N will be a nomologically possible world. On this kind of view, true statements about the past (initial) conditions will indeed be determined$_1$ to be true in virtue of the present (terminal) conditions and so be determined$_3$ to be true. However, it is hard to see how 'B $\rightarrow$ A' may be necessary without 'A & N $\rightarrow$ B' being necessary, unless some of the laws in N are *asymmetric*. Yet, science would only seem to provide us with *symmetric* laws (Hoefer 2010: §2.3), while INDETERMINISTS reject that 'A & N $\rightarrow$ B' is necessary (see footnote 5). If, in the light of this, INDETERMINISTS forego commitment to the claim that '~A $\Box\!\!\rightarrow$ ~B' is nomologically necessary, they will lose any basis for claiming that the past is fixed in the sense suggested.

[17] Epiphenomena are phenomena that lack causal powers. Yet, it is one thing to say of a given phenomenon that it lacks causal powers and another to say that it contingently fails to exercise any of its causal powers. Accordingly, it might now be suggested that the idea that the past's present description is determined$_3$ to be presently true is already undermined by humdrum cases in which an event's causing another is preempted by a third. However, that a given event does not cause another but could have done so if things had been slightly different does not yet imply that that event causes nothing at all, and the idea that a given event is absolutely causally inert, even if only for contingent reasons, strikes me as just as hard to believe as epiphenomenalism (see footnote 3).

There is a more indirect way of showing that, conceived as delineating a space of mere possibilities, the tree-like structure implies nothing about the structure of time or of temporal reality. For argument's sake, assume that with the sole exception of the natural laws, only statements of the form 'Presently, *p*', with *p* being tense-logically simple, are ever made true by facts so that, for example, neither 'Two days ago, a sea battle took place' nor 'Presently, more energy is released than was needed before *e*′ came to pass' is ever made true, their being determined$_1$ to be true notwithstanding. Now suppose we accepted epiphenomenalism and thus held that some event *e*, occurring in the past, has had, and will have, no effects whatsoever. Past-tensed statements about the epiphenomenon *e*, even if presently true, will not then be regarded as being determined$_3$ to be presently true: whichever way the present and future facts are or will be, they could have come to be or be going to be that way consistently with different past histories – in some *e* occurred, in others it did not. If we wished to represent these past possibilities, we could use an upside-down tree that displayed backward branching. Would this make us inclined to say that the structure of time or of temporal reality exhibits backward branching? Hardly. After all, *e did* occur. But then by parity of reasoning, neither does the tree-like representation of future possibilities as yet have any implications for the structure of time or of temporal reality, for equally, whatever will be *will* be.

In order for the tree-like structure to have such implications, the many branches of the tree must receive a rather different interpretation. As we shall see in due course, once such an alternative interpretation is provided, the tree-like structure ceases to be a representation of an INDETERMINISTIC universe.

Branching Time and Determinism

Suppose that time itself branches and so is not linear. If time exhibits forward branching at *t*, then, literally understood, for any time *t*′ which is *n* days from *t*, with $n > 0$, there will be a time *t*″ distinct from *t*′ which is also *n* days from *t*. The branches of the tree will then correspond to distinct time-series Π such that for any *t* belonging to Π and any $n < 0$ suitable for measuring temporal distances, there is a unique time *n* days from *t* and that time also belongs to Π, and for any two times *t*′ and *t*″ in Π, there is an *m* such that *t*′ is *m* days from *t*″. The first condition excludes backward branching, while the second ensures that all times in the series are connected. To call these distinct time series, and the events that occur at their respective members, equally real is then just as consistent as saying, on a linear conception, that it rains at *t* but does not rain at *t*′, where *t*′ is later or earlier than *t*.[18]

The conception I shall call 'BRANCHING TIME' goes beyond this minimal characterisation in two respects. First, BRANCHING TIME implies that whenever branching

[18] In other words, the problem of temporary intrinsics, that already arises for linear time, does not get any worse once time is taken to branch in the way suggested.

occurs and time continues along distinct time series, there will be a qualitative difference between any two such time series in the sense that the courses of events that respectively unfold along these series differ. In other words, according to BRANCHING TIME, time never branches into numerically distinct but otherwise indistinguishable time series. On a tensed conception of facts, this will be straightforwardly so, whether one takes individual times as entities *sui generis* or rather identifies them with sets of tensed facts: the fact that t is present surely differs from the fact that t' is present whenever t and t' are numerically distinct. But even on a tenseless conception of facts (see footnote 1), it seems entirely unmotivated, and ontologically extravagant, to posit branching into qualitatively identical time series. So I shall take it for granted that this addition to the minimal characterisation of branching time is harmless.

Secondly, and slightly more contentiously, according to BRANCHING TIME, whether a time series is real solely depends on the consistency of what occurs in its course with the totality of past and present facts. For instance, whether or not a time series counts as real that has a time n days hence at which it rains as member will depend on whether the totality of past and present facts, including the laws, permit that at a temporal distance of n days it rains. If, for any of its members, what happens at those members is thus permitted, the time series is real and not merely possible. This would seem to be what one must say as soon as one takes the branches of the tree to represent more than merely possible continuations of the past and present (and this is precisely what proponents of the so-called many worlds interpretation of quantum mechanics do say).

Of course, there is conceptual room for the idea that more than one but not all possible continuations of the past and present are real. We would then still have branching as minimally characterised, and so there would be no Thin Red Line. But a proper part of the crown of the tree would still be marked out as real, and so, in a sense, there would be many thin red lines. Thus, for example, on a view such as this, even if, for all positive integers k with $k<6$, it is consistent with the past and present that one day from the present k goals are scored, it may nonetheless be that there is a time one day from the present at which exactly three goals are scored and such a time at which exactly five goals are scored, but no such time at which exactly four goals are scored. But if, as we have assumed, all the nomological constraints are to be found amongst the present and past facts, it is hard to make sense of this suggestion – for neither the topology of time, nor the totality of present and past facts, nor their combination can explain both (i) why there is no time one day from the present at which exactly four goals are scored, if there is a time one day from the present at which exactly three goals are scored, and (ii) why there is a time one day from the present at which exactly five goals are scored, even if there is a time one day from the present at which exactly three goals are scored. On the linear conception of time, (i) is true and easily explained by the topological structure of time, while (ii) is false and *a fortiori* in no need of explanation. According to BRANCHING TIME, (ii) is true and explained in terms of both the initial conditions and the topological structure of time, while (i) is false and *a fortiori* in no need of explanation. The hybrid view according to which time branches into many thin red lines is committed to the possibility of pairs of true

conditionals of this kind, but unable to account for their truth. In any case, to the best of my knowledge, nowhere in the extant literature has such a hybrid view ever been defended, which is why I take BRANCHING TIME to be the only relevant branching view to be addressed.

Let us now say that a statement *s* is *genuinely* future-/past-/present-tensed iff$_{df}$ *s* is equivalent to some statement of the form '*n* from the present, *p*', with *p* being tense-logically simple and *n* being positive/negative/zero (cf. Prior 1967: 122–26). It is then a consequence of BRANCHING TIME, as characterised, that genuinely future-tensed statements become systematically ambiguous.[19] Thus, we must now distinguish between at least three readings. On the first reading, such a statement is equivalent to 'For some time *t n* days from the present, at *t*, *p*'. On the second reading, it is equivalent to 'For all times *t n* days from the present, at *t*, *p*'. On the third reading, at last, it is equivalent to 'At the time *n* days from the present, *p*' and hence to 'There is a unique time *n* days from the present, and for any time *t n* days from the present, at *t*, *p*'. As long as time was assumed to be linear, these readings could be treated as equivalent, and consequently there was no need to distinguish between them. But things are importantly different as soon as time is taken to exhibit forward branching. (By contrast, for $n \leq 0$, the equivalences will then still hold.)

There is, however, a fourth suggested reading which deserves comment, even if only for the purpose of setting it aside. Belnap et al. take (unembedded) genuinely future-tensed statements to be true only relative to a specified history parameter (or in my parlance, a specified time-series parameter) (Belnap et al. 2001: 141–56). Accordingly, (unembedded) genuinely future-tensed statements are treated like open sentences whose only free variable ranges over histories (or in my parlance, time series). Thus, '*n* days from the present, *p*', with $n > 0$ and *p* being tense-logically simple, can be read as 'At the time *n* days from the present on Π, *p*', where 'Π' occurs free. If time really exhibits forward branching, the context of use will fail to fix a unique value for 'Π', and consequently (unembedded) genuinely future-tensed statements will lack a truth value.

As Belnap et al. (2001: 156–60) are aware, it is difficult to square this fourth reading with the idea that genuinely future-tensed statements are ever assertable. Their solution to this problem follows a suggestion made by Prior (1967: 131) and likens assertions to bets. The authors argue that the assertoric content of a genuinely future-tensed statement 'is the sort of thing that can be borne out or not, depending upon what comes to pass' (Belnap et al. 2001: 175). And now, just as 'it makes sense to wonder about what history has not yet decided as long as history will decide the matter' (Belnap et al. 2001: 171), betting on a certain future outcome makes sense as long as history will decide the matter. And according to the authors, history *will* decide the matter: 'time will tell whether we arrive at a moment at which the truth value (at the moment of assertion) becomes settled' (Belnap et al. 2001: 175), *while to claim of two future possibilities that they 'will each be realized'*

[19] Note that this is not a claim about ordinary language but about the language of metaphysical theory. See footnote 23 (and also footnote 6).

is to claim 'an absurdity' (Belnap et al. 2001: 207). Given what was said in the previous section about the distinction between TRL_1s and TRL_2s, these afterthoughts make their preferred reading of genuinely future-tensed statements entirely unmotivated.[20] But more importantly, as the last quotation makes clear, the account of assertoric content with which this reading is supposed to be combined is at odds with BRANCHING TIME. So at least in the present setting, I take this to be sufficient reason to disregard the fourth reading of genuinely future-tensed statements that Belnap et al. propose.

Accordingly, consider the first of the three initially mentioned readings and thus statements of the form 'For some time *t n* days from the present, at *t*, *p*', where *p* is tense-logically simple and $n>0$. Recall that, according to BRANCHING TIME, anything that, consistently with the present and past facts (including the laws), *can* happen *n* days hence *does* happen at some future time *n* days from the present: every nomological future possibility is in fact realised on some time series. Let A be the conjunction of all the laws conjoined with the claim that they are laws and nothing else is. Let B be the conjunction of all nomologically contingent genuinely past- and present-tensed statements true at *t*. Let '$T_t\alpha$' be short for 'α is true at *t*'. Now assume C to be a statement of the form 'For some time *t′ n* days from the present, at *t′*, *p*', with $n>0$ and *p* being tense-logically simple. Assume that 'T_t(A & B & C)' is consistent. Then BRANCHING TIME entails that '$T_tA \rightarrow (T_tB \rightarrow T_tC)$' holds.[21] BRANCHING TIME should itself be nomologically necessary and so be entailed by A. Accordingly, given that 'T_t(A & B & C)' is necessarily consistent if consistent at all, the conditional '$T_tA \rightarrow (T_tB \rightarrow T_tC)$' should likewise be nomologically necessary and so be entailed

[20] If we merely have to sit and wait until history decides the matter, it becomes entirely unclear why the context of utterance fails to fix a unique value for the history parameter: even if nothing that has come to be the case up to the moment of utterance, including the utterance itself, determines$_2$ what comes to pass thereafter (Belnap et al. 2001: 151), the contention that amongst the equally possible future courses of events there is a unique such course of events that will unfold after that moment is enough to vindicate the claim that the identity of that moment uniquely fixes that course of events. (Belnap et al. themselves profess that if the history parameter '*can* be fixed by the context, then we automatically *do* let the context fix it for stand-alone sentences' (Belnap et al. 2001: 148).) Of course, Belnap et al. deny that amongst the equally possible future courses of events, there is a unique such course of events that will unfold after that moment, even if they affirm that it will be the case that a unique such course of events unfolds. But, contrary to what they suggest, such denial is not sanctioned by indeterminism which is after all consistent with genuinely future-tensed statements being determined$_1$ to be presently true courtesy of what will happen, as long as what will happen will do so contingently. If time will tell whether there is a sea battle tomorrow, then an utterance of 'One day hence, there will be a sea battle' may presently have a definite truth-value that it has only courtesy of what time will tell. If waiting until tomorrow will be enough for it to be settled whether there will be a sea battle tomorrow, 'One day hence, there will be a sea battle' may be presently true solely in virtue of there going to be a sea battle after one's having waited 24 hours. Similarly, the present assignment of a particular value to the history parameter may be correct courtesy of all that will happen after the moment of utterance, even if nothing that is present or past at the moment of utterance grounds that assignment. A moment of utterance can thus fix a unique future without determining it, just as a shadow can fix a unique object without determining it (see Rosenkranz 2012).

[21] Note that BRANCHING TIME alone does not entail that 'T_tC' holds, even if 'T_t(A & B & C)' is consistent, since as far as that conception goes, A and B may respectively state laws and initial conditions that do not actually hold at *t*.

by A. Accordingly, given that A, if true, is always true, '$T_tB \rightarrow T_tC$' will be nomologically necessary. Given how A was defined, to render A true, a metaphysically possible world must be a nomologically possible world. Consequently, '$T_tA \rightarrow (T_tB \rightarrow T_tC)$' will be metaphysically necessary, and so will be 'T_tA & $T_tB \rightarrow T_tC$'. Insofar as both A and B are determined$_2$ to be true at *t*, so will be C. Since 'T_tC' holds only if 'T_t(A & B & C)' is consistent, C is true at *t* iff C is determined$_2$ to be true at *t*. Given that consistency claims are bivalent, so are statements like C.

As a corrollary, given that C is true at *t* iff 'T_t(A & B & C)' is consistent, and that '~C' is true at *t* iff C is not true at *t*, '~C' is true at *t* iff 'T_t(A & B)' entails 'T_t(~C)'. Accordingly, '~C' is true at *t* iff '~C' is determined$_2$ to be true at *t*. But '~C' is equivalent to a statement of the form 'For all times *t′ n* days from the present, at *t′*, *q*', with $n > 0$ and *q* being tense-logically simple. So given BRANCHING TIME, DETERMINISM applies to all genuinely future-tensed statements on both their first and their second readings.[22]

Let us lastly consider statements of the form 'At the time *n* days from the present, *p*', with *p* being tense-logically simple and $n > 0$. If *t* does not branch in the sense that there are no two distinct times which both are *n* days from *t*, then at *t* such a statement will be equivalent to a statement of the form 'For some time *t′ n* days from the present, at *t′*, *p*' and so, by the reasoning above, will both be bivalent and be true at *t* iff determined$_2$ to be true at *t*. By contrast, if *t* does branch in the sense that there are two distinct times which both are *n* days from *t*, then the definite description 'the time *n* days from the present' will fail to denote at *t*, and hence statements of the form 'At the time *n* days from the present, *p*' will be uniformly untrue at *t* and *a fortiori* not be determined$_2$ to be true at *t*. Note that this will not conflict with (2) and its underlying identification of non-truth with falsity, as the negations of statements of that form are of the form '~(There is a unique time *n* days from the present, and for any time *t′ n* days from the present, at *t′*, *p*)', and given branching we can no longer infer from the latter that 'At the time *n* days from the present, ~*p*' holds, even if we take time to extend indefinitely into the future.[23]

What remains to be shown is that these negations themselves are true at *t* iff determined$_2$ to be true at *t*. Given BRANCHING TIME, *t* branches in the aforementioned sense because there is a tense-logically simple *q* such that both the truth at *t* of 'For some time *t′ n* days from the present, at *t′*, *q*' and the truth at *t* of 'For some time *t″ n* days from the present, at *t″*, ~*q*' are consistent with 'T_t(A & B)'. Whether

[22] If a statement *s* is true at *t* iff it is determined$_2$ to be true at *t*, then it follows both that if *s* is true at *t*, *s* is determined$_1$ to be true at *t*, and that if *s* is determined$_1$ to be true at *t*, *s* is determined$_2$ to be true at *t*. Since the converse conditionals are uncontroversial, (1) and (3) follow.

[23] Supervaluationists treat future contingents of the form 'At the time *n* days from the present, *p*' as being neither true nor false and so deny (2). They do so ultimately because they aim to account for the fact that ordinary speakers tend to treat 'At the time *n* days from the present, ~*p*' as the negation of 'At the time *n* days from the present, *p*'. However, we are not here concerned with salvaging ordinary language, spoken by potentially uninformed speakers, but with the true description of what temporal reality is like, assuming that we know what it is like. See footnote 19 (and also footnote 6).

this is so, however, will already be settled by facts that obtained before *t*. But then, whether or not *t* branches in that sense, statements of the form 'At the time *n* days from the present, *p*' as well as their negations will both be bivalent and be true at *t* iff determined$_2$ to be true at *t*. Consequently, (4) will hold for all statements of the form 'At the time *n* days from the present, *p*', with *p* being tense-logically simple and $n>0$, and so will (3). Thus, given BRANCHING TIME, DETERMINISM also applies to statements of this form.

We can therefore conclude that it follows from BRANCHING TIME that genuinely future-tensed statements are bivalent and are true at *t* iff determined$_2$ to be true at *t*, on all of the aforementioned three readings. Hence, BRANCHING TIME implies DETERMINISM.

Determinacy by Truth-Determination (and Indeterminacy by Lack Thereof)

Recently, Barnes and Cameron have proposed an account of determinism and its relation to the open future that crucially differs from the one advocated here (Barnes and Cameron 2009). In this section, I argue that their elucidation of what it is for the future to be open needs backing by some antecedent notion of what it is for a world description to be determinately true of the actual world. Of the two notions introduced in the first section, only the notion of truth-determination$_2$ will serve this purpose. However, since Barnes and Cameron claim determinism to be compatible with the open future, it transpires that they must either reject the characterisation of determinism given in the section 'Determinism', or else deny that truth-determination$_2$ is the right notion to back up their characterisation of the open future. In the next section, I will accordingly first review and criticise their own preferred characterisation of determinism and then consider what alternatives to the notion of truth-determination$_2$ they might appeal to in order to substantiate their account of the open future.

According to Barnes and Cameron, the possible continuations of the past and present ought to be conceived as possible ways the one and only concrete world @ might turn out to be in the future. Let {Future} be the set of all such possible ways, agreeing on the present and past, which, for convenience's sake, we might think of as Priorian world propositions (Barnes and Cameron 2009: 295–96; cf. Prior 2003). Barnes and Cameron contend that 'it's determinately the case that exactly one of the worlds in {Future} is actualised', while for any *w* in {Future}, it is indeterminate whether *w* is actualised (Barnes and Cameron 2009: 296), where here 'actualised' just means 'true of @'. This is what they take the open future to consist in. Just before making this claim, they contend that the operators 'it is determinately the case' and 'it is indeterminate whether' underwrite the following equivalences (Barnes and Cameron 2009: 295):

(6) It is determinately the case that *p* iff for all *w* in {Future}, *w* says that *p*.
(7) It is indeterminate whether *p* iff for some *w* in {Future}, *w* says that *p*, and for some *w′* in {Future}, *w′* says that not-*p*.

Given (6) and (7), it is perfectly intelligible how it may be determinately the case that exactly one member of {Future} is actualised, while for any such member *w*, it is indeterminate whether *w* is actualised. Applying (6) and (7) to the case at hand, we get

(8) For all *w* in {Future}, *w* says that exactly one of the members of {Future} is actualised, and for any *w′* in {Future}, there is a *w″* in {Future} such that *w″* says that *w′* is actualised, and there is a *w‴* in {Future} such that *w‴* says that *w′* is not actualised.

(Naturally, if *w* says of *w′* that it is actualised, then *w*=*w′*.) According to Barnes and Cameron, then, (8) is apt to capture the thesis that the future is open.

However, even if every *w* in {Future} says that exactly one member of {Future} is actualised, that is surely not what metaphysically *determines* it to be the case that exactly one member of {Future} *is* actualised. World propositions may be complete in that for any *p*, they either entail *p* or entail its negation, but they are surely not self-authenticating (cf. Frege 1892 on whether a thought can ever contain its own truth value). *A fortiori* that they are unanimous that exactly one member of {Future} is actualised cannot be what makes it, in any metaphysical sense, *determinately* the case that exactly one such member is actualised. Similarly, the mere fact that there is no member of {Future} that is said by all members of {Future} to be actualised cannot be what *precludes* that it is metaphysically determined of any particular such member that it is the one and only member that is actualised, and so cannot be what makes it metaphysically *indeterminate* which member is actualised. (The fact that each of the candidates for being in charge proclaims 'I am in charge' does not preclude its being determinately the case that John, and only John, is in charge, just as the fact that each of the candidates says 'One of us is in charge' does not determine that anyone is.)

Of course, given that {Future} is the set of all possible, yet mutually incompatible ways @ might continue to be and given that @ *must* continue to be one way or other, it indeed *follows* from the fact that every *w* in {Future} says that *p*, that *p* is determined to be actualised (i.e. to be true of @).[24] But that *p* is determined to be actualised does not consist in this unanimity. The matter comes out more starkly in the case of indeterminacy: it simply does not follow from the fact that some members of {Future} say that *p*, while others say that ~*p*, that *p* is not determined to be actualised (i.e. determined to be true of @).

In fairness to Barnes and Cameron, it must be noted that they consider (6) and (7) merely as *elucidations* of their preferred notions of metaphysical determinacy and indeterminacy, and not as analyses. Yet, as long as we lack any insight into the relation that a member of {Future} must bear to @ in order for it to be *determined*

[24] On any view that implies that there is no future at all, the second assumption will only be acceptable provided that {Future} may be said to include a way the world might be in which there is no future way at all for it to be. However, Barnes and Cameron (2009) make no explicit provision for this.

to be true of @, we have no guarantee that these elucidations are even extensionally adequate. Accordingly, we must look beyond (6) and (7) in order to get a clearer view of what these equivalences are meant to elucidate.[25]

A natural way to conceive of the relation of being determinately actualised is in terms of truth-determination. According to this suggestion, the authors' characterisation of the open future can be restated thus:

(9) The disjunction of all the members of {Future} is determined to be presently true, while none of its disjuncts is determined to be presently true.

Here, 'determined' can again be understood in either of two ways. It may mean the same as 'determined$_1$', as the latter was defined in the first section, or it may mean the same as 'determined$_2$', as there defined. Thus, we may either consider all facts, past, present and future, or restrict attention to those facts that constitute @ either at the present time or at past times, while excluding those facts, if any, that only come to constitute @ in the future. Only on the latter reading is there any reason to maintain that none of the members of {Future} is determined to be presently true, for, as Barnes and Cameron remark, 'the unfolding of the future settles which truth value [presently made future-tensed statements] in fact have' (Barnes and Cameron 2009: 298; see also Belnap et al. 2001: 171, 175–76, where a similar thought is broached). *Pace* the authors' avowed primitivism about metaphysical determinacy and indeterminacy, their conception of the open future would thus naturally be seen as lending itself to recapture in terms of truth-determination$_2$.

Determinism, Metaphysical Indeterminacy and the Open Future

It would accordingly appear that all is well. But all isn't well, for Barnes and Cameron go on to argue that the present truth of some future-tensed statements (unaffected by semantic indecision, presupposition failure and the like) may fail to be settled by past and present facts, *and yet determinism holds* (Barnes and Cameron 2009: 300). Thus, provided that the interpretation offered in the previous section is correct, they are bound to reject the characterisation of determinism given in the section 'Determinism' above.

Using the terminology introduced in the first section, we may say that, according to Barnes and Cameron, determinists merely claim that *if* all the present- and past-tensed statements (and laws) are determined$_2$ to be presently true, *then* the present truth of all future-tensed statements will likewise be determined$_2$. On this construal, determinism is alleged to be consistent with admission of some genuinely present- and past-tensed statements failing to be determined$_2$ to be true.

[25] Barnes and Cameron themselves take metaphysical determinacy and indeterminacy to be primitive notions and so presumably deny that we can look beyond (6) and (7) to get a clearer view of what they involve. But, as we shall see in due course, with the conceptual tools introduced in the first section being at our disposal, such pessimism is quite unwarranted.

It is, however, hard to make sense of this, for, plausibly, genuinely present- and past-tensed statements are determined$_1$ to be presently true only if they are also determined$_2$ to be presently true. If (2) is to be retained, and the authors are adamant about this (Barnes and Cameron 2009: 296–97), (1) must accordingly fail:

(1) A given statement is true at *t* iff it is determined$_1$ to be true at *t*.
(2) Either a given statement is true at *t* or its negation is.

But then, some present- or past-tensed statements would have their truth value groundlessly, in Sorensen's sense of 'groundlessly', and this would make their indeterminacy quite unlike the indeterminacy of future-tensed statements, contrary to what Barnes and Cameron suggest (Sorensen 2001; Barnes and Cameron 2009: 303), for recall that with respect to the latter kind of statements the authors claim that 'the unfolding of the future settles which truth value they in fact have' (Barnes and Cameron 2009: 298). The TRL$_1$ would thus be said to extend only into the future, while it frayed out in the other direction. This is certainly nothing determinists are willing to buy: if the TRL$_1$ extends into the future and (2) is assumed to hold, then determinists will say that for any *p* and any *n* and *m* such that $n \geq m > 0$, either '*m* days hence, *n* days ago, *p*' is determined$_2$ to be presently true or '*m* days hence, *n* days ago, ~*p*' is determined$_2$ to be presently true, which excludes the possibility that neither '$n-m$ days ago, *p*' nor '$n-m$ days ago, ~*p*' is determined$_2$ to be presently true. But even if Barnes and Cameron's remark only applies to *genuinely* future-tensed statements (as they were defined in the last but one section), it is highly unlikely that determinists are willing to reject the causalist doctrine according to which every difference in initial conditions implies a difference in terminal conditions, so that from every terminal condition there is but one way back (see section 'Determinism' and footnote 4).

To be sure, Barnes and Cameron do not themselves invoke talk about truth-determination$_1$ or truth-determination$_2$. Yet, we may still bring out a relevantly similar tension once we revert to the authors' own preferred terminology. Given how {Future} was defined, then in the light of (6), for all tense-logically simple *p* and all $n \leq 0$, it is the case that *n* days from the present, *p* iff it is determinately the case that *n* days from the present, *p*. As already mentioned, Barnes and Cameron accept (2) (Barnes and Cameron 2009: 296–97). Yet, if (2) holds, then, for all tense-logically simple *p* and all $n \leq 0$, either it is determinately the case that *n* days from the present, *p* or it is determinately the case that *n* days from the present, ~*p*.[26] Accordingly, when Barnes and Cameron argue that it may in part be indeterminate what the present or past is like, they evidently have another notion of 'indeterminate' in mind.

If one consequently replaced reference to {Future} in (6) and (7) by reference to the set of all the possible ways @ might be in the past, present and future, then only necessary propositions would ever be determinately true. Consequently, it would then be indeterminate whether I had breakfast this morning – which would hardly

[26] The reasoning relies on the inference from '~(*n* days from the present, *p*)' to '*n* days from the present, ~*p*', but nothing in Barnes and Cameron's paper suggests that they deny the soundness of this inference.

be a desirable result. But irrespectively of the oddity of such claims about the present or past, the whole enterprise of giving sense to the openness of the future would thus be undermined: certainly, as long as we wish to resist the radical view according to which there is no future at all, we want to say things like, 'When I am masticating my buttered toast, it may then still be open whether I will have a fruit afterwards, but it is settled that the buttered toast will be mash'. I cannot have my toast and eat it, as it were, while I still can eat the toast and have a fruit. Yet, since 'The toast will be mash' is neither metaphysically nor nomologically necessary, it would have to be just as open whether the toast will be mash as it is open whether I will finish off with a banana. This is surely nothing Barnes and Cameron wish to hold.

In the previous section, it was argued that (6) and (7) presupposed a conception of what it is for a world proposition to be determinately actualised. However, as argued three paragraphs back, replacing talk about what is determinately the case in the sense of (6) by talk in terms of truth-determination$_2$ leads to trouble once we try to make sense of the alleged compatibility between determinism and denial of (4):

(4) Either a given statement is determined$_2$ to be true at *t* or its negation is.

But then it remains thus far unclear what notions of determinacy and indeterminacy Barnes and Cameron do have in mind.

Other work by Barnes and Cameron suggests that what the authors here have in mind is rather that it is *indeterminate whether a given statement is determined to be true*, in one of the two senses of 'determined' (Barnes 2010; Cameron 2009). If both (1) and (2) are assumed to hold, there are then two possibilities: either it is claimed that it is determinate which facts there are, were or will be, but indeterminate whether they determine *p* to be true or rather determine ~*p* to be true, or else it is claimed that it is indeterminate which facts there are, were or will be. It remains to be seen whether these notions of indeterminacy of truth-determination are of any use in the context of discussions about the open future.

The first option either collapses into a claim of semantic indeterminacy about fact descriptions or else misconstrues the nature of facts and of truth-determination: for the fact that presently, *q* to make 'Presently, *q*' true at *t*, *all that is required is that that fact exists at t*, and truth-value links will then ensure that all relevant past- and future-tensed statements are determined to be true at the correspondingly relevant times (cf. Correia and Rosenkranz 2011: 89).

The second option, favoured by both Barnes and Cameron, is again prone to collapse into a claim of semantic indeterminacy about fact descriptions, if read as suggesting that for some facts *f* and for all *q* (or all *q* in some nomologically relevant range), *f* does not determinately satisfy 'is a fact that presently *q*'. Alternatively, if it is claimed that there is no such semantic indeterminacy involved, acceptance of both (1) and (2) will then imply commitment to the idea, explicitly endorsed by Cameron (2009), that it may be indeterminate whether the fact that presently *q* exists at *t*, while it nonetheless *does* exist at *t*. But whatever 'indeterminate' might here be understood to mean, given what was just said about the nature of facts and of truth-determination, this fails to substantiate the claim that it is in any relevant sense of 'open' *open* whether 'Presently, *q*' is determined to be true at *t*.

The topic of metaphysical indeterminacy is intricate, and a thorough discussion of it would take us too far afield. Suffice it to say that for reasons similar to those mentioned in the previous section, *indeterminacy of truth-determination* is not yet adequately captured by (6) and (7), and that it is anyway not the kind of indeterminacy relevant for capturing the open future.

Conclusion

I take all this to suggest that, for want of any clear alternative, the characterisations of determinism and indeterminism given in the sections 'Determinism' and 'Indeterminism' respectively' are after all the correct ones when it comes to discussions about the open future, and that the open future is best conceived in terms of indeterminism thus characterised. Whether one opts for determinism or for indeterminism, one may consistently take time to be linear and not branching. If the future is said to be open merely in the sense of not being compelled by present or past facts alone, then the open future, while inconsistent with admission of a TRL_2, is nonetheless consistent with admission of a TRL_1, which latter rules out branching time. By contrast, if the future is said to be open in a sense of 'open' that is incompatible with there being any TRL_1, then there *is* no future and the best representation of this idea is by means of a decapitated trunk rather than a branching tree. In neither case does indeterminism suggest that time itself branches. On the contrary, as argued in the section 'Branching Time and Determinism', on a reasonable account of what the conception of branching time involves, indeterminists have reason to deny that time branches and should rather consider the tree-like structure as representing nothing more than a range of possibilities one, and only one, of which is determined_1 to be actual, provided that there is any future at all.

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Branching Time and Temporal Unity

E.J. Lowe

Abstract In this chapter, it is argued that an important condition on the *unity* of time excludes the possibility of *branching* time. The condition in question is that two moments of time can belong to the same time series only if, for each moment that lies between them, at least one simple substance *persists through* that moment. Since simple substances, by definition, cannot *divide*, it appears that time could not branch *at* any particular moment, contrary to a core assumption of theories of branching time.

Keywords Temporal branching • Temporal unity • Substance • Persistence

There is an important but rather neglected issue in the philosophy of time—namely, the problem of its *unity*. The question at stake may be expressed in this somewhat grandiose way: in virtue of what is the world *one* world in time? What makes it the case that all of the times in 'our' time series do genuinely belong to *one and the same* time series, as opposed to different and disconnected ones? Of course, to express the question in this way is to use the reificatory language of 'time' and 'times'—but this is harmless enough, provided that we do not necessarily take it too seriously, and is certainly convenient. Our question does not really arise for those who hold an *absolute* conception of time, for whom the time series is just an essential feature of time itself. Nor does it really arise for those who hold a *relational* conception of time because for them the time series emerges automatically from the set of cross-temporal relations between things and events out of which time, according to them, is constructed. And yet it does seem to be a deep and interesting question—and this in itself suggests that both absolutists and relationalists, to the extent that the question does not really arise for them, have not penetrated to the bottom of the nature of time.

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In order to motivate an answer to our question, I propose the following simple thought experiment (compare Lowe 1998: 121–7). What would happen if *everything* presently existing were to go out of existence simultaneously? I think that the correct reply is that this would be *the end of the world* and therewith *the end of time*. It makes no sense, I think, to say that there could be things existing *after* such a total existence change. Similarly, it makes no sense to say that certain things *did* exist *prior* to a total existence change. If there was a time at which everything then existing *did not exist prior to that time*, then that was, *ipso facto*, the *first* moment of time. However, I have argued elsewhere (Lowe 2006a) that the passage of time requires the continual *coming into and passing out of existence* of at least some things, whether these things be substances or their qualities and external relations (such qualities and relations being conceived as *tropes* or *modes* rather than as universals). Putting these two thoughts together, we can conclude that, while the *passage* of time requires something to come into or go out of existence at each moment of time, the *unity* of time requires that, for any two adjacent periods of time, there be at least something that persists across the boundary between those periods. More specifically, we can say that, for any such boundary, a *substance* must persist across it because individual qualities and relations cannot persist unless their bearers do—for they are dependent for their *identity* upon their bearers and consequently cannot be transferred from one bearer or set of bearers to another (Lowe 2006b: 26–7). Even more specifically, we can say that a *simple* or *non-composite* substance must persist across such a boundary because a *composite* substance (one that has other substances as its component parts) cannot persist unless at least some of its parts do. In short, then, the unity of time rests on the persistence of simple substances in an 'overlapping' fashion, like the fibres in a rope. Although no single fibre need extend throughout the whole length of a rope, there can be no cross section of it through which at least *some* fibres do not extend, on pain of dividing the one rope into two separate ropes. Similarly, then, although no single simple substance need persist for all time in order to sustain the unity of time, there can be no moment of time through which *no* simple substance persists.

The rope analogy can perhaps most easily be conveyed by the depiction of *a rope in Flatland*, as in Fig. 1 below:

Flatland, of course, is supposed to be a world of just *two* spatial dimensions. Each line in Fig. 1 represents a single fibre in a two-dimensional rope. It can easily be seen that although no single fibre extends throughout the whole length of the rope, at any point at which one fibre terminates, at least one other fibre is unbroken. If there were any point at which *all* the fibres extending up to that point terminated, then we would clearly have a break in the rope itself at that point and thus two separate ropes rather than just one, as in Fig. 2 below. (Note that we would still have two separate ropes even if the ends of their respective fibres were *touching*, reducing

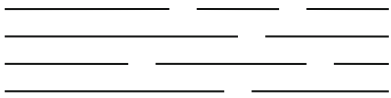

Fig. 1 A rope in Flatland

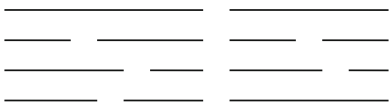

Fig. 2 Two separate ropes in Flatland

the gap shown in Fig. 2 to zero: to have a genuinely unified single rope, one or more single fibres must extend *through* any point in the rope.)

Similarly, then, I maintain that if there were a point in time, *t*, at which *all* simple substances persisting up to that time ceased to exist, then *t* would be a terminus to time itself, although there could well be 'other' times, not temporally connected to this one, in which other simple substances existed.

This conclusion, if correct, is a remarkable and important one. Naturally, it might be challenged. The most obvious way to try to challenge it would be to argue that there are and must be some *real external relations* which obtain over time. If there were real cross-temporal relations analogous to spatial relations like distance, then they would do the job. But I have contended elsewhere that there are none (Lowe 2009). Now, of course, many philosophers think that *causal* relations are real external relations: and most of them also hold that such relations obtain between entities—individual events—*existing at different times*. *Causal* theories of time assume precisely this. Clearly, however, I cannot accept the reality of causal relations conceived in this fashion: for if the cause of an event, *x*, is supposed to be another event, *y*, which has already *ceased to exist* by the time that *x* exists, then *x* and *y* are not, according to my view, parts of *the same sum total of reality*, so that no real external relation can obtain between them. (Of course, the sort of theorist I am opposing will not want to say, in any serious sense, that an event can *cease to exist*, only that it may exist *at* one time and yet not *at* another, later time. However, from my point of view, this failure to take seriously the notion of ceasing to exist is just symptomatic of the deficiency of my opponent's view of time and change in general.)

In any case, I do not agree with the foregoing conception of what causation fundamentally *is*—that it is fundamentally a relation between *events*. I think that all talk of 'event causation' is ultimately merely a convenient *façon de parler* and that individual *substances* are the only entities that really *cause* anything (Lowe 2008: 3–5). That is to say, all causation is fundamentally *substance causation*, which is a matter of individual substances exercising or manifesting their various causal powers and liabilities. This being so, no appeal to facts about causation can undermine my earlier conclusion that it is the *persistence of substances* that ultimately underpins the unity of time. For how could a substance, by exercising its causal power at an earlier time, have any effect on another substance at a later time, unless at least *some* substance persisted between those times to *transmit* this causal influence? A *complete* existence change between those times would terminate any such transmission process and thereby prevent the causation of the putative effect. Causation, I believe, works something like this: when a substance exercises one of its causal powers, its *immediate* effect is simultaneous with that exercise and consists in an existence change in that or one or more other substances—either a substantial change or else and more commonly a qualitative or relational one. The affected substances may then persist in their altered state for a while until they in turn exercise one or more of their causal powers. This, in my view, is how causal influence is propagated across time. Strictly speaking,

all of the propagation *across time* is secured by the persistence of substances. Hence, once more, no appeal to causal considerations can threaten my claim that it is ultimately the persistence of substances that is responsible for the unity of time.

Remember, however, that my claim is, more specifically, that it is the persistence of *simple* substances that underpins the unity of time. I see no way to weaken this claim so as to allow merely composite substances to shoulder this burden, since they can persist only provided that at least some of their *substantial parts* do—and an infinite downward regress of substantial composition does not look to be either metaphysically feasible or empirically plausible. This leaves us, of course, with another pressing question: what *are* the simple substances that underpin the unity of time? However, although I have speculated about the answer to that question elsewhere (Lowe 2009), for present purposes, I do not need to answer it. I shall also assume, in what follows, that the key condition on the unity of time for which I have just been arguing—namely, that it depends upon the overlapping persistence of simple substances—does indeed hold. My concern here is only to examine its implications for the notion of *branching* time.

The implications in question are, I believe, serious and indeed fatal. The foregoing condition on the unity of time renders branching time *metaphysically impossible*. To show this, I need to make only two further assumptions, which seem to be uncontentious. The first is that simple substances *cannot divide*—and this would appear to be true by definition. The second is that if time ever branches, it must branch at some specific *moment* of time. That is to say, there must be a last moment which is common to both of the future branches, after which, moments in one of the branches are not temporally related to—do not belong to the same time series as—moments in the other branch (I am assuming for simplicity, but without real loss of generality, that branching is always *bi*furcation). See Fig. 3 below.

Now, clearly, if the unity of time in a certain possible world depended, at a putative branch point, *t*, upon the persistence of a *single* simple substance, *S*, then *t* could not *in fact* be a branch point. For in that case, *S* would have to persist through *t* into *both* of the putative temporal branches. (If it failed to, then at least one of the putative branches would be such that its first moment was a moment *through which* nothing persisted in the time series to which that moment belonged, thereby making that moment the beginning of a distinct time series and hence severing the supposed branch from the stem.) And this means that *S* would have to *divide* since it would subsequently have to exist in both of two separate time series. In terms of the rope analogy, this would be like a rope consisting of a single fibre branching in two, which would obviously require that fibre to *split*. But the fibres in our analogy are supposed to correspond to *simple substances*, which by definition *cannot* split. Hence, the only way in which our condition on the unity of time could be satisfied in branching time would be by having time branch without any simple substance being required to divide.

Before I pursue this line of thought, however, I need address a certain challenge that may be made to my claim that, in order to persist into two different temporal branches, a simple substance *S* would have, *per impossibile*, to *divide*. It might be said that it is no more difficult (though, by the same token, also no *less* difficult) for

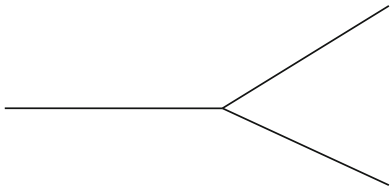

Fig. 3 Time branching at a moment

the same substance *S* to exist 'undivided' in both of two different temporal branches than it is for it to exist in two different *possible worlds*. But, whatever one may think about the metaphysics of possible worlds—and I, for one, am not at all attracted by it—I believe it is dangerous to suppose that what might make sense in the language of possible worlds need also make sense in the language of branching time, unless, of course, one just regards the latter as a special case of the former, which would in my view be to treat the notion of branching time without due ontological seriousness. To take the notion of branching time seriously is to suppose that *time itself* can branch: that is, that there can be two distinct times, t_1 and t_2, *both* of which are later than a certain time t_0, but such that t_1 is not later than t_2 nor t_2 later than t_1—in other words, such that t_1 and t_2 stand in no direct temporal relation to *each other*. This is the situation that Fig. 3 depicts, with t_0 being the branch point and t_1 and t_2 being points in the two different branches. If time is taken to be a *linear dimension* which branches in this fashion, then it seems to me that it must indeed be the case that a substance *S* can persist into both of two such branches only by somehow *dividing*. For then, it must be the case that *S* exists both *at* t_1 and *at* t_2 and yet not by *persisting from* t_1 *to* t_2 or vice versa. It can only do so, then, by persisting *twice*, once from t_0 to t_1 and again from t_0 to t_2—and this double persistence surely requires *S* to *split*, quite as much as it would need to in order to persist in two wholly separate *places* (in the way that an amoeba may be supposed to do).

Now, of course, some advocates of branching time might respond at this point that I am taking the notion of 'branching' too literally and that all they mean to imply by it is that, at some points of time, it is possible for things to develop or evolve in more than one way. However, even if they mean only this, they need to be careful about exactly what they say. Thus, while they may say that at t_0 it is possible for *S* to exist at t_1 and also possible for *S* to exist at t_2, this is clearly not the same as saying that at t_0 it is possible for *S* to exist *both* at t_1 *and* at t_2. And, indeed, I do not see how the latter *is* possible unless *S* can somehow divide. To this, it might be replied that I only have difficulty in seeing this because I am thinking of t_1 and t_2 as being *really distinct temporal locations*, each of which is later than t_0. But if that is *not* how to think of t_1 and t_2, then the expression 'branching *time*' is really a complete misnomer. If what the theorist really has in mind is that at some *single* point of time, *t*, later than t_0, there is, relative to t_0, *more than one possible way for things to be*, then it is utterly misleading to represent this idea by a branching diagram like Fig. 3. For, on this view, time itself *never* branches: there is just a *single* time series in which all possibilities are to be housed. But then this is at best just a theory of 'branching' *possibility*, not branching *time*. And it is, moreover, one that seems to

involve some serious difficulties of its own. For instance, on this view, it appears that facts about the time series itself are *necessary* facts: it cannot be the case, for example, that at a certain time t_0 it is both possible that time will have a last moment and possible that it will not have a last moment—whereas on a genuinely branching conception of time, this can indeed be the case because one of two branches originating at t_0 may have a last moment while the other does not.

In any case, in what follows, I shall assume that we are to take the notion of branching time seriously even if some of those who speak in terms of it apparently do not, while others have not adequately thought about the matter. It seems to me that there are sufficiently many philosophers who give every sign of taking it seriously for a serious discussion of its implications to be worthwhile. So at this point, I return to the conclusion that I reached three paragraphs ago, namely, that the only way in which my proposed condition on the unity of time could be satisfied in branching time would be by having time branch *without any simple substance being required to divide*.

At first sight, however, this may seem to present no serious difficulty because—pursuing further our rope analogy—it is clear that a rope can in fact branch in two *without* any single fibre having to divide. The following diagram illustrates this possibility:

Nevertheless, it is immediately evident upon inspecting Fig. 4 that, although the rope depicted there does indeed *branch in two*, there is no *point* at which it can be said to branch. For every fibre in the upper branch *overlaps* with some fibre in the lower branch, even though, of course, no fibre belongs to *both* branches. Consider each of the last four fibres depicted in Fig. 4 (those furthest to the right of the diagram), labelled *A*, *B*, *C*, and *D* respectively. *A* and *B* belong to the top branch, while *C* and *D* belong to the bottom branch. *A* begins 'earlier' than both *B* and *C* but 'later' than *D* ('earlier' being towards the left of the diagram and 'later' towards the right). Hence, we cannot say that the rope branches where *A* begins because *D* begins earlier than *A* but is in a different branch. Nor can we say that the rope branches where *B* begins, for the same reason. Nor yet can we say that the rope branches where *C* begins because *A* begins earlier than *C* but is in a different branch. Finally, we cannot even say that the rope branches where *D* begins because at that point, *D* overlaps with fibres which do not belong to either branch. To put it another way, the point at which *D* begins is a point at which we still clearly have a single, undivided rope. It may seem odd to say that a rope can branch or divide without dividing *at* any particular place along its length, but this, it seems, is precisely what

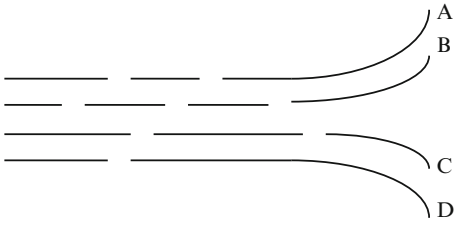

Fig. 4 A branching rope in Flatland

we do have to say. Indeed, it seems that a rope *could not* divide *at* a particular place, without thereby being severed into *three separate ropes*—one thick one and two thinner ones.

But this, of course, is where the rope analogy begins to bite with respect to the notion of *branching time*. For our second assumption made earlier was that if time ever branches, it must branch at some specific *moment* of time. Now, however, we can see that our condition on the *unity* of time excludes the possibility of time branching at any specific moment, just as the corresponding condition on the unity of a rope excludes the possibility of its branching at any particular *place*. Perhaps, however, this will just encourage some advocates of the notion of branching time to question the assumption that time can only branch *at* a particular moment of time. Why should not they take the analogy of a rope in Flatland to support the idea that just as such a rope can divide without dividing at any particular point along its length, so time can in fact branch without branching at any particular moment? To this question, I have three responses. First, the proposal seems *ad hoc*, being designed merely to save the notion of branching time from the problem that I have identified. Second, the proposal is incompatible, as far as I am aware, with existing theories of branching time, all of which assume that temporal branching is momentary in character. Third, we need to examine exactly *why it is* that a rope in Flatland can branch without branching at any particular point along its length. It appears to be essential to the possibility of such branching that such ropes are conceived as being *two-dimensional* entities, extended *both* along their lengths *and* across their widths. After all, this is the only way in which they can be conceived as being composed of many overlapping fibres. We have already observed that it makes no sense to think of a rope consisting of a *single* fibre branching, since fibres are, in our analogy, taken to be indivisible entities. Applying this point to the notion of branching time, then, it would seem that we could make sense of time branching and yet not branching *at* any particular moment only if we could conceive of time itself as being analogously somehow *two dimensional*. (Bear in mind here that time, if it is one dimensional, can only be represented by a *line*—and then it can be represented as branching only at a particular *point*, as depicted in Fig. 3.) Now, of course, two-dimensional theories of time have been mooted—for instance, in attempts to make sense of the notions of time travel and the 'rate of flow' of time (see MacBeath 1993)—but these are, to say the least, extreme theories, and it should not be welcome news for advocates of branching time to learn that they are committed to any such a theory.

I am happy to leave it to determined friends of the notion of branching time to try to make sense of a two-dimensional version of their view if they can—and if they succeed, then they are welcome to deploy my analogy of a branching rope in Flatland to explain how our key condition on the unity of time may be satisfied in branching time without having to suppose that simple substances can divide. Meanwhile, my own provisional conclusion is that branching time is metaphysically impossible. Does this commit me to some kind of determinism or fatalism? Not at all, I believe. I am a keen advocate of the notion of *the open future* and indeed of indeterminism and libertarian free will (Lowe 2008). It is just that I see no prospect of cashing out

these notions satisfactorily in terms of that of branching time. As I see it, the 'openness' of the future does not, and cannot, consist in there being many alternative possible futures lying ahead of us temporally, like the branches of a tree that we are climbing (presumably lopping off the lower branches as we proceed upwards). It consists, rather, in there being *nothing* ahead of us, like the open sky above our heads when we are on a hilltop. The future is not *ready made*—neither one inevitable future nor many alternative ones. Rather, *present* reality continually *gets made and remade* by the passage of time as new things come into existence and other things pass away into non-existence. But for this to *go on happening* and hence for *time to continue*, at least some simple substances must go on *staying in existence*, since if everything were to cease to exist at once, time itself would come to an end.

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Fictional Branching Time?

Craig Bourne and Emily Caddick Bourne

Abstract Some fictions seem to involve branching time, where one time series 'splits' into two or two time series 'fuse' into one. We provide a new framework for thinking about these fictional representations: not as representations of branching time series but rather as branching representations of linear time series. We explain how branching at the level of the representation creates a false impression that the story describes a branching of the time series in the fictional world itself. This involves explaining away the illusion of various causal connections which may at first appear essential to understanding the story as a unified whole. This provides a more accurate account of the relationship between the representation and what is represented, which in turn reveals the extent to which it is legitimate to draw conclusions about actual time from fictional representations.

Keywords Fiction • Time • Branching • Representation

Events within fictions are ordered in time. In the standard case, a fiction represents time as linear. But some fictions apparently involve branching time, where one time series 'splits' into two (or more) or two (or more) time series 'fuse' into one.

It is sometimes said that fictional representations of time's topology tell us something about how time could actually be; fictions with branching time show that branching time is coherent. On the other hand, it is sometimes said that we cannot draw conclusions about real metaphysics from fiction since fictions can (seemingly)

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have impossible contents. We wish to provide a new framework for thinking about the fictional representations at issue: not as representations of branching time series but rather as branching representations of linear time series. This provides a more accurate account of the relationship between the representation and what is represented, which reveals the extent to which it is legitimate to draw conclusions about actual time from fictional representations.

Fictional Branches

Fictions are representations. We say that they describe fictional worlds – collections of the fictional facts or events the fiction tells us about. There are two options for how to characterise branching. We could say that the fiction describes a single world in which time branches. In that case, the story is a representation of branching time. Or we could locate the branching at the level of the representation rather than the things represented. Here, we say that the two branches correspond to two descriptions of two different fictional worlds, each with a single, non-branching time series. In that case, the story is a branching representation of time.

To establish whether fictional time series might have interesting branching characteristics, we need to know what these two options involve, how they differ, and what – if anything – would mean we are dealing with the first kind of story rather than the second.

Take this case. A story begins normally, describing a morning in the life of the main character. Call this portion of the story the 'trunk'. Then things change: we get two competing descriptions of the afternoon. In the first, our hero decides to buy a newspaper from a newspaper stand, whereas in the second, he walks past; in the first, he reads some significant story in the paper and decides to make radical changes to his life, whereas in the second, nothing makes him question the way he lives; in the first, delayed by the paper, he arrives at the pub late, a few seconds after a beautiful girl has left, whereas in the second, he arrives on time and meets her in the doorway, and so on. Perhaps there is some lynchpin event between the trunk and the branches (he steps into the road just as a car is coming so that one branch is supposed to be one along which he just nipped across in time and the other one along which he had to step back and wait).

Note that this is not a story in which a *person* fissions, where both products go on sharing the same time. Rather, we are given two different ways things pan out, not one way things pan out involving two distinct products of personal fission. What we have is two different distributions of events over time. In one case, the hero arrives at the pub after the girl leaves; in the other, he arrives simultaneously with her leaving. (There are also differences in whether certain events – such as his buying a paper – take place at all.)

We can compare processes on different branches. Normally, we are to assume that events on each branch have the same rates of change. The event of the girl's leaving the pub is, say, four hours later than the trunk-event of the hero's stepping into the road, *no matter which* branch we are considering. Despite this, the event of her leaving on one branch is not simultaneous with the event of her leaving on the other branch since there is not a time series they both occupy.

Is this story a representation of branching time or a branching representation of time? This depends, we propose, on how many distinct time series there are along the trunk.

Branching Representations of Time

It should be uncontentious that the story above sometimes represents more than one time series. The description of his reading the paper, changing his life, and missing the girl represents events in one time series, and the description of his walking past the newspaper stand, going on as normal and meeting the girl represents events in a distinct time series. Where there are two branches, there are two time series.

We have a case of branching time only if the different time series corresponding to the different branches belong to the same world. Suppose they do not. Then, we have two fictional worlds with one time series each. This would deal with our having two branches, but where does it leave the one trunk?

Events along the trunk must stand in temporal relations to events along the first branch *and* to events along the second branch. So the description of the trunk cannot be a description only of the world which contains the events along the first branch. For that would miss out the temporal relations of trunk-events to events along the second branch; likewise, vice versa. And the description of the trunk cannot be a description of a third world, distinct from the world containing the events along the first branch and from the world containing the events along the second branch. That would just double the problem by failing to account for *two* sets of temporal relations.

Our answer is to treat the story in something like the way David Lewis (1976) treats fissioning persons. Lewis thinks identity is preserved in cases of fission. But, since one person cannot become two, he says there must have been two persons all along. Persons are aggregates of temporal parts or 'person-stages', and one part (stage) might appear in more than one aggregate. In cases of fission, we have two aggregates which share their parts up until the time of fission, but not beyond.

But we do not want to follow this model to the letter. Lewis's account, unlike ours, is designed to explain fission within a shared time series. Two things which share temporal parts must share a common time series. Worlds are not like this. Things *within* worlds may share a time series but worlds themselves do not. This means we should resist talking of stage-sharing between worlds.

What the two worlds share along the trunk is not their *stages* but their *representation*. When the story describes events along the trunk, it describes not just one world but two worlds in which the same events (i.e. qualitatively the same) happen. The description of events along the trunk is a description *both* of part of the first world's total history *and* of part of the second world's total history. In telling the story, two portions of two worlds are described. But we do not need to say everything twice! Along the trunk, one representation does double duty because the two portions of world-history match.

On this model, two fictional worlds are represented all along. This allows for trunk-events to stand in temporal relations to two distinct sets of branch-events because really there are two distinct sets of trunk-events, too.

How does this compare to Lewis's fissioning persons? In his proposal, distinctness between persons is given by distinctness between aggregates. For there to be two persons sharing stages pre-fission just *is* for there to be two sets of stages post-fission since it is this that renders two ways of making an aggregate. Likewise, for there to be two worlds sharing one representation along the trunk just *is* for there to be two distinct representations of qualitatively distinct sets of events along the branches.

But there is an important difference between Lewis's fissioning persons and our proposal. So far as persons go, belonging to different aggregates is compatible with being numerically the same stage. But belonging to different worlds guarantees numerical (though not qualitative) distinctness of stages. The trunks of branching representations are characterised by there being a single description of the two worlds, not a single set of stages shared by the two worlds.[1]

For persons, fission is the cessation of stage-sharing combined with the continuation of aggregates. Branching representation, on the other hand, involves a move from a story's describing two worlds by saying the same thing to its describing those two worlds by saying different things.[2] The branching in the story is explained not by the nature of the fictional world it represents but by the nature of the representation itself.

We will give the same account of 'fusion' in fiction. It is not that two time series join up. It differs from 'fission' only in that the matching portions of total history which the story describes are, in their respective worlds, *later* than the unmatching portion of total history which the story describes. (Of course, this allows for stories with fission then fusion, fusion then fission, fission then fusion then fission, and so on.)

Ersatz Worlds

The claim that two worlds cannot share stages seems to rely on a particular conception of worlds, as distinct concrete things, as in the view preferred by Lewis (1986). But what if we treat other worlds in an ersatz way: as collections of representational

[1] Compare our view with Lewis's (1986: 206) distinction between what he calls 'divergence' and what he calls 'branching' of worlds. In what Lewis calls 'branching', two worlds overlap and share stages, whereas in 'divergence', two worlds 'have two duplicate…segments, not one that they share in common'. When we have talked about branching time, we have used it to mean branching of time within a single world. It is a question for the advocate of branching time how, if at all, the branching of worlds which Lewis describes is to be distinguished from the branching of time within a single world.

[2] Although, saying is not the only way of describing a world. Pictures, for example, describe worlds by showing.

vehicles, such as propositions? Then two worlds could share parts: proposition *p* may be a part of many overlapping collections.

This would not do any real damage to our picture; it would just make it more similar to Lewis's picture of fissioning persons since in both cases, we have stage-sharing along the trunk. But it is an overhasty modification. Ersatz worlds are substitute worlds: representations of concrete worlds, usually invoked to provide modal statements with truth-conditions which do not require us to believe in non-actual concrete things. If two ersatz worlds share stages, this does not mean they represent stage-sharing between concrete worlds. A neater explanation is gained by applying the same idea – of branching representation – once more. Where two ersatz worlds share stages, what we have is one representation doing double duty. Just as with branching stories, some parts of ersatz worlds represent two portions of two distinct worlds in one go.

Branching Representations and Impossible Fiction

Robin Le Poidevin (2007), in a discussion of stories concerning more than one time series, considers how the possibility or impossibility of genuinely disunified time – two or more time series within one world, with or without 'fission' and/or 'fusion' – relates to the nature of such stories. He suggests that if disunified time is in fact impossible, then these stories are simply stories in which the impossible happens. And we are already familiar with these. Stories can (it appears) represent the impossible as well as the possible; things that could not happen in fact can still happen in fiction.

But if what appears to be a story with branching time is in fact a branching representation, the possibility or impossibility of branching time is by the by. What we have is a description of two worlds, neither of which involve branching time. So even if branching time is impossible, we do not (other things being equal) have an impossible story on our hands.

Disunified Times, Unified Stories

Le Poidevin considers the view that 'no story could be about two unconnected time-streams' (2007: 171), encapsulated in E.M. Forster's (1927) claim that narrative unity requires at least some kind of temporal unity. Le Poidevin summarises the view as 'what makes two events, or characters, part of the *same fiction* is that they are represented…as being in a single time series' (2007: 174). Where does this leave stories which involve more than one time series?

Le Poidevin is concerned with two sorts of temporal disunification: first, that in stories which have two time series but no branching and, second, that in stories which apparently involve branching time. He wants to defend the second kind,

saying that whatever temporal disunity they have need not be a block to narrative unity. But he dismisses the first kind, leaving unchallenged the view that 'no story could be about two unconnected time streams: anything that presented itself as such a story could only be two stories, with no connection at all, arbitrarily bundled together' (2007: 171).

If this view is correct, it is a worry for our proposal. Treating stories involving branching as branching *representations* of *non-branching* time series collapses the second type of story into the first; stories with apparent branching time are actually stories with temporal disunification, but no temporal branching. For we have two non-branching and completely separate time series, belonging to two different worlds. Any branching which takes place is to be located on the level of the representation, not its contents.

But it would be wrong to think that this leaves us with an arbitrary bundle. There may be a relationship between the two: for example, the description of the first world tells us how things *would* have been in the second world had some small thing gone differently (such as the character's stopping to buy a newspaper rather than walking on). Or events in one may shed light on the nature of events in the other (such as how some character ought to be grateful for some event he takes for granted). Or there may be interesting similarities between characters in the two worlds, which do not require occupation of a common time series in order to be notable. Or the happiness of a character in one world may draw our attention to his sadness in the other. Or the story might be an exercise in applying similar narrative techniques to very different sets of events; there is no good reason why features of style rather than of content cannot make for a non-arbitrary bundle.

At this stage, it is useful to depart from Le Poidevin's use of 'story' and 'fiction' as interchangeable. We say that one story may involve more than one fiction. Where two worlds are described, we have two fictions, but these two fictions may nevertheless be parts of the same story.[3]

In the case of our branching representations, there is something more to be said about how unification is secured despite the total separateness of the two time series. Just as branching occurs on the level of representation, unification does too. Along the trunk, the two time series are described by just one representation. The representation does double duty, describing both time series at once. If that is not a legitimate form of unification, what is?

The notion of narrative unification which led Le Poidevin to talk about arbitrariness in stories with non-branching disunified time is, then, too narrow. But this

[3] Our distinction between fictions and stories also calls for supplementing the notion of truth in a fiction (which has received much attention) with the distinct notion of truth in a story. In cases where the story includes just one fiction (probably, the majority of stories are like this), what is true in the story will be all and only what is true in the fiction. It is in unusual cases, where the story involves the description of more than one fictional world, that it becomes interesting to spell out truth in a story in its own terms. This is the topic of a chapter in Bourne and Caddick Bourne (forthcoming).

raises another issue: what, for Le Poidevin, supplies narrative unification in those stories which seem to involve branching time?

The significant feature Le Poidevin identifies is causality. He writes, 'different time series can be combined with a causally coherent narrative', and, focussing on what we have called 'fusion' cases, suggests that events along different branches can have narrative unity 'by virtue of having common effects' (2007: 173). Presumably, something similar could be said in 'fission' cases: causal chains can be traced back from events along either branch to events along a common trunk.

Le Poidevin has it in mind that stories which apparently involve branching time really do involve branching time; one fictional world has two time series in it, time series which overlap in some places and not in others. If, instead, we treat the relevant stories as branching representations of two non-branching time series in separate worlds, it seems we do not have the causal connections Le Poidevin wants. The time series do not really have any part in common; instead of splitting off or joining up, they each progress non-branchingly in their separate worlds.

This would mean we cannot appeal to causal links as a source of narrative unity between the branches. That need not worry us; as we have seen, there are plenty of other ways narrative unity might be secured. Nevertheless, there is a different concern. Does a view which misses out these causal connections not also miss the point of the stories in question?

Branching Time, Causality, and Branching Representation

Considerations of causality might be taken to suggest that it is sometimes untrue to a story to label it a branching representation rather than a representation of branching time. It might be said: the *point* of the story is that two distinct sets of events, on two distinct branches, are causally related to the *very same* trunk-events. Not just the 'same' events in the sense in which the 'same' events can happen in more than one world, rather the same world-bound token events – the same events located in the same world.

Here are two cases which seem to tell in favour of this objection:

Case 1

Suppose we have a 'fusion' case where our branches concern two different characters leading two separate lives. Events along the trunk, however, involve the two characters meeting and telling each other about the separate lives they have led. The suggestion is that it is only the period of shared time which allows the characters to exchange information about the unshared times.

Case 2

Or suppose we have just one character, not two, but one character who is supposed to live two distinct lives, along two distinct branches. Then we have a 'fusion'

into a trunk – only one set of things happens to the character, not two – and then 'fission' into branches again. Suppose, finally, that after 'fission', the character is able to utilise, in *each* of the time series he inhabits, information he acquired in *either* of the time series he inhabited before 'fusion'. This trades on the idea that the period of shared time is causally and temporally related to both pre-'fusion' time series and to both post-'fission' time series.

But there are ways, we think, to capture what is special about cases 1 and 2 without admitting that branching occurs in the world represented rather than in the representation itself. And there is every reason to expect that the strategies employed will apply equally well to other cases which might be taken as having causal characteristics which need a branching-time rather than a branching-representation view. Here is how we deal with the cases:

Case 1

We have two characters, A and B. We also have two worlds, W_A and W_B. Certain things happen to A along a pre-trunk branch. Those events take place in world W_A, but not in W_B. Certain things happen to B along the other pre-trunk branch. These events take place in world W_B, but not in W_A. This allows for the events along A's branch to stand in no temporal relations to the events along B's branch.

As for the trunk, we allow for a period of W_A's history in which a counterpart of B features and a period of W_B's history in which a counterpart of A features. Call the counterpart of B in W_A 'B_{WA}' and the counterpart of A in W_B 'A_{WB}'. Similarly, call B in world W_B 'B_{WB}' and A in world W_A 'A_{WA}'. While A_{WA} reports his life story in W_A, B_{WA} reports his purported life story in W_A, as part of a conversation with A_{WA}. Likewise, while B_{WB} reports his life story in W_B, A_{WB} reports his purported life story in W_B, as part of a conversation with B_{WB}. When the story tells us about an apparent exchange of information between what it calls 'A' and 'B', it actually represents two exchanges of information: that between A_{WA} and B_{WA} and that between A_{WB} and B_{WB}.

But what happens to B_{WA} when he is not conversing with A_{WA} and to A_{WB} when he is not conversing with B_{WB}? Should we say – as it appears we have to when treating the case as a branching representation – that B_{WA} suddenly appears in W_A? This initially sounds odd and thus sounds like an objection. But it cannot be an objection. For it is no odder than what we end up saying if we treat the story as one about a single world with branching time. Use 'B_{WBr}' and 'A_{WBr}' to name what the story would call 'B' and 'A' if it were a story about a single world with branching time. B_{WBr} shares A_{WBr}'s time but only part of it (and vice versa); just as, for us, B_{WA} shares A_{WA}'s world but only part of it (and likewise for A_{WB} in B_{WB}'s world). In both cases, something suddenly acquires causal and temporal relations to something else.

Alternatively, we might say that what happens to B_{WA} when not talking to A_{WA} is something the story leaves indefinite, just as a story might leave it indefinite what day of the week a character was born on, what he ate on his last day of school, how many eyelashes he has, and so on. Then we do not say that B_{WA} is absent from W_A before the conversation, just that the story does not fix what B_{WA} is doing in W_A during that period.

Thus, there is no need to interpret the story as one in which time branches. We can explain what is significant about it by characterising it as a branching representation of two distinct worlds.

But it might seem that this interpretation still misses something out, namely, the causal connections between events of the story. When the story tells us about what it calls 'B', it seems to be telling us a causally connected life story. The experiences which this so-called B is reported as having along a pre-'fusion' branch are supposed to be causally responsible for the reports he gives to 'A' along the trunk. But our account does not preserve this. It is in world W_B that B_{WB} has the pre-'fusion' experiences detailed by the story. Experiences had in W_B cannot be causally responsible for the information A_{WA} receives in W_A. Likewise, the pre-'fusion' life of A_{WA} cannot be causally responsible for the report given to B_{WB} in W_B. Causal chains cannot span worlds, which – it might be alleged – is exactly why we should think the story tells us about *one* world with two time series which fuse.

We answer the objection by saying that the two worlds *do* give us all the causal connections we need. When the story tells us about the conversation between 'A' and 'B', it describes two worlds at once. In W_A, A_{WA}'s report of his history stands in normal causal relations to his history; in W_B, B_{WB}'s report of his history stands in normal causal relations to his history. In W_A, B_{WA}'s report of his history stands in normal causal relations to the later beliefs A_{WA} has about B_{WA}; in W_B, A_{WB}'s report of his history stands in normal causal relations to the later beliefs B_{WB} has about A_{WB}. So the worlds the story describes *do* provide all the causal connections we need to relate what happens along the branches to what happens along the trunk. Everything that is important to the story is preserved by our account. To think there is something lacking is to focus on one world only, which would be a mistake. Just as it would be a mistake to focus on one time series if the story really was about a world with two!

Our account explains – indeed, explains away – the appearance that a *single* post-'fusion' period of time is causally related to pre-'fusion' branches which are distinct from each other. This appearance is created by features of the representation, namely, that sometimes two different descriptions (one of W_A and one of W_B) are run in parallel, whereas elsewhere, the representations are run together (one description describes both W_A and W_B). In the case we are considering, this creates the (false) impression that two pasts have fed into one future.

Case 2

It might not be obvious what is supposed to be going on in this kind of case. Does the character believe that he has two past lives? Or are his thoughts about one set of pre-'fusion' events somehow isolated from his thoughts about the other? If he came to believe that *p* along one pre-'fusion' branch and came to believe that *q* along the other, does he thereby, after 'fusion', believe that *p* and *q*, or does he just believe that *p* and believe that *q*? Set these questions aside; the issue here is whether to choose branching time or branching representation, and these complications are neutral between the two.

We can give a two-world model of the story almost the same as the one given above for case 1. In case 1, the story seemed to say that a conversation took place between 'A' and 'B', characters from different branches. We say that what really happened is this: A_{WA} had a conversation with B_{WA}, and A_{WB} had a conversation with B_{WB}, and what was said was the same in each case. In case 2, the story seems to say that each post-'fission' 'A' remembers the lives of both pre-'fusion' 'A's. We say there are two worlds: W_L and W_R.[4] A_{WL} lives in W_L and A_{WR} lives in W_R. A_{WL} acquires memories based on his past experience. But he also acquires apparent memories of events which, in fact, did not take place – mere quasi-memories – and likewise for A_{WR}. The story tells us that 'A' goes into the post-'fission' left-hand branch having, on the trunk, acquired memories of life on the pre-'fusion' right-hand branch. We say that A_{WL} acquires quasi-memories with the same content as the memories A_{WR} has of the life he has lived. The story tells us that 'A' goes into the post-'fission' right-hand branch having, on the trunk, acquired memories of life on the pre-'fusion' left-hand branch. We say that A_{WR} acquires quasi-memories with the same content as the memories A_{WL} has of the life he has lived.

W_L provides the causal connections between one life and one set of genuine memories. W_R provides the causal connections between the other life and the other set of genuine memories. The story asks us to consider both worlds at once. As long as we are doing this, we have all the causal connections we need. This mirrors the explanation given of case 1, where world W_A provided the causal connections between A_{WA}'s past and his contributions to the conversation with B_{WA} and world W_B provided the causal connections between B_{WB}'s past and his contributions to the conversation with A_{WB}.

Is the sudden appearance of the quasi-memories strange? No stranger than what we end up saying if we treat the story as one about a single world with branching time. On our view, two persons suddenly think they are temporally and causally related to past events which never happened. On the rival view, one person suddenly acquires the property of being temporally and causally related to two pasts rather than just one.

Both our worlds happen to be ones in which the mere quasi-memories (as well as the genuine memories) furnish successful action at later stages. We might ask why they should be. For instance, A_{WR} put some keys in a drawer in W_R; A_{WL} quasi-remembers putting some keys in a drawer in W_L, and when he goes to the drawer in W_L, he finds keys. Is it not suspicious that both worlds just *happen* to be this way? The answer is that those are the worlds which are going to make for an interesting story with a decent plot development and so on. So it is not odd at all that the worlds described by a story are like that.[5]

[4] In this case, we only need two worlds in order to model the story. Other cases might require more; it depends on the particulars of the story.

[5] We develop this idea in Bourne and Caddick Bourne (forthcoming), paying particular attention to problems concerning future-tensed fictional truths.

As in case 1, the appearance of post-'fission' branches becoming causally and temporally related to pre-'fusion' branches is created by features of the representation. Sometimes two different descriptions (one of W_L and one of W_R) are run in parallel, whereas elsewhere, the representations are run together (one description describes both W_L and W_R). In the case we are considering, this creates the (false) impression that a single person's two pasts have both fed into that person's two futures. Creating this impression might be an interesting feature of the story in its own right, which is itself a good reason for choosing to bundle together descriptions of those two worlds.

The Double Take

One quite common feature of stories which apparently involve branching time is the 'double take'. The story looks like it tells us about the following situation: a character, 'A', appears along branches *X* and *Y* and has been involved in some way with another character, 'B', along branch *X* but not along branch *Y*. However, 'A' sees 'B' in some casual situation along branch *Y* (e.g. they pass each other in the street), at which 'A' performs a puzzled double take before dismissing his feeling that they have met before. In our terms, there are two worlds: W_X and W_Y. A_{WX} and B_{WX} live in W_X, and A_{WY} and B_{WY} live in W_Y. A_{WX} and B_{WX} have a history of interaction. A_{WY} and B_{WY} do not, yet for some reason, A_{WY} performs the double take when he encounters B_{WY}. Someone might think the effectiveness of the double take as part of the story is captured better by a branching-time view than by our branching-representation view.

We think this is incorrect. For a start, the double take is an odd event by anyone's standards. Suppose we hold the branching-time view. Are we really supposed to accept that, when the double take occurs, A has in some sense seen B *before*? That requires us to take A's meeting B on branch *X* as happening before (or in the past of) A's seeing B on branch *Y*, which is disallowed as much by the view that the events belong to different time series as by the view that they belong to different worlds. Or is it that A on branch *Y* is supposed to have some faint memory of events along branch *X*, as the result of some fusion somewhere? Then we simply apply our account of case 2 (above). Or is it that A on branch *Y* has magical access to events along a branch which ought to be inaccessible? Then, if the branching-time account claims magical access to other time series, we will claim magical access to other worlds and the lives of other-worldly individuals. If magic is what is wanted, we as much as anyone else can pull it out of our hat.

The best way to read the double take is as a stylistic joke. It emphasises the combination of fictions involved in the story. We have said that events along branch *Y* happen in a different world from events along branch *X*. The well-used double take trades on this. It is effective not because it does make sense but because it does not. The point of the double take just *is* that the content of the story does not explain it. It cannot be that A_{WY}'s double take is a result of A_{WX}'s life in another world.

To recognise this is to get the joke. This explains why the double take is conspicuous and (mildly) amusing. It also explains why the double take is irritating when employed by a storyteller who wrongly takes it to form a working part of the content of the fiction, rather than a dysfunctional joke.[6]

Note that this treatment of the double take could be translated into branching time, rather than branching representation, terms. It should be viewed not as a reason to prefer one account over the other but rather as revealing something interesting about both.

Thematic Evidence for Branching Time?

We have argued that taking stories which apparently involve branching time as being, in fact, branching representations is adequate to capture causal connections within the story. But is it inadequate in some other way? Take case 3:

Case 3

Suppose we had a story which, in addition to having a trunk-and-branch structure, takes branching time as a theme. Perhaps it has physicist characters who work on the topology of time, for example. Is that not enough to indicate that the story is supposed to be one in which time branches? After all, it indicates that whoever made the story (the writer, director, etc.) was preoccupied with the topic and intended it to pervade the story.

Here the pressure to treat the story in terms of a single world with branching time comes not from alleged relations between events along the trunk and events along the branches but from taking branching time as an evident theme. But things are not so clear. The physicist characters' preoccupation would be salient to the story if it described a world with branching time but just as salient if the story, *despite appearing to describe branching time*, did not. That their work looks to reflect a feature of their world but ultimately *does not* is just as interesting – maybe more – as if it simply did.

Perhaps it will be said that the story is clearly *meant* to describe a fictional world in which time branches. Even if taking it as a branching representation of non-branching time is relevant to its themes, that was not what its author had in mind for it. The events and characters the storyteller decided to include suggest that he is trying to make it true in his story that time branches.

But evidence that a storyteller is *trying* to describe a certain fictional world with certain fictional truths is not necessarily evidence that he has *succeeded* in doing so.

[6] We could have a story which only included the fiction which describes events along branch *Y*. In that case, A_{WY} would be performing a double take when confronted with a character who has not previously appeared, nor had a counterpart previously appear, in the story. This would be conspicuous without having the usual point of a double take. (It might have a different point, such as to parody a film where the double take would play its usual role, and that might be funny in its own right.)

If there are no features of the time series represented which a branching-representation reading cannot capture, then the case for favouring a branching-time reading instead is weak. Themes of the story manifested elsewhere may well make it obvious that the storyteller was attempting to describe a branching time series. But that counts for nothing if his description attributes no feature to the temporal structure which identifies it as branching. For in that case, it is *impossible* to describe the time series *as branching* while describing it *just* as that storyteller has. Intending to do something gets you nowhere when the thing you intend to do is not possible with the resources you have. It is clear that even decisive evidence that this storyteller means to describe branching time should not be taken to establish that he does do so.

A Preference for Branching Representations?

The argument so far could be taken as a case for *agnosticism* over whether stories which apparently represent branching time series are to be taken at face value or are instead to be treated as branching representations. That is a result in its own right. At the outset, we considered two rival views. One said that stories in which time apparently branches give us reason to think that branching time is coherent and that time may in actuality branch. The other said that even the impossible can happen in fiction, so we should resist extrapolating to conclusions about real metaphysics. Now, we can agree that we should not take fictional stories as a reason to believe that time may actually branch, but not because the story might have impossible contents. Rather, it is because we should reject an assumption common to both of the positions: we are not licensed to take these stories as representations of branching time in the first place.

This is not to say we should be agnostic forever, over every story which tries to represent branching time. Our understanding of branching time will progress – if it is possible, how it works, and if it is impossible, what feature it has that makes it so. With this in place, it is likely that there will be some metaphysical feature of branching time series which would not be at home in a branching representation instead. We will decide which kind of story we are dealing with based on whether it picks out this feature. We have seen that causal connections (at least, those considered above) are not that feature, but that is not to say there is nothing else to do the job.[7]

But even before we have identified any such feature of branching time, we still might not opt for agnosticism. For there are reasons to favour a branching-representation view of the stories in question. The view is appealingly neat. It gives a clear explanation of how such stories work, whereas whether, and if so how, time

[7] A storyteller who does not know the discriminating feature will be unlikely to alight upon it by accident. However hard he tries to write about branching time (rather than produce a branching representation), he will lack the resources. This chimes with a rule of thumb most of us accept: ‘write about what you know’. Or rather, the inverse: ‘don’t write about what you don’t know’. Or better: ‘heed that an attempt to write about what you don’t know is unlikely to be successful’ (although what this gains in accuracy, it loses in pithiness).

series (fictional or otherwise) branch is still contentious. And there is a further pragmatic consideration which favours the branching-representation view. If we say the stories represent branching time series, it is as yet unclear whether we are dealing with possible or impossible stories. This would mean there is much we cannot currently say about the nature of these particular stories.[8]

Perhaps most importantly, thinking in terms of branching representations has useful applications outside the context of fiction. One motivation for taking statements about the future to be indeterminate in truth-value is thinking that time branches in the direction of the future. But it may be fruitful to think of this in terms of branching representation instead. If future times are ersatz times (as in Bourne (2006)), they are themselves representations. Each ersatz future follows the ersatz past and present which represent the way things actually were and are. Treating this as a case of branching representation, we would say that the ersatz past and present represents many worlds – one for each ersatz future – which match in a particular portion of total history (everything that has happened so far).

Notice first that this picture allows for future contingents to be indeterminate; indeed, it gives us a way to articulate what this indeterminateness consists in. What is indeterminate is which world, out of all those represented, we live in.[9] Notice secondly that, supposing we think ersatz times are the only times there are, times just *are* representations. So this special case of branching representation really is a case of branching time. Thus, making the best sense of branching time may well involve thinking in terms of branching representations.

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[8] Especially if the best account of impossible stories makes them significantly different from possible stories, as we think it does. This, again, is a topic for Bourne and Caddick Bourne (forthcoming).

[9] Note that this is a metaphysical issue, not an epistemic one. The indeterminateness does not amount to our not *knowing* which world we live in.

The Open Future and Its Exploitation by Rational Agents

Storrs McCall

Abstract Branching along the time dimension provides a dynamic, four-dimensional, treelike space-time structure that explains many features of the physical world. The list includes temporal asymmetry and directionality, time flow and the existence of "now," physical versus logical possibility, the openness of the future, quantum probabilities, and superpositional collapse. This chapter discusses these and how agents use the open future in order to act intelligently and rationally.

Branching Along the Time Axis

A single four-dimensional manifold or "history" of the world (a "Minkowski world," or, to allow for general relativity, a curved space-time manifold) extends from the Big Bang to the end of time if there is one, or indefinitely, if there is not. A "slice" of a history is a three-dimensional instantaneous state of such a manifold. In branching space-time, histories branch along such instantaneous slices, that is, "spacelike hypersurfaces," and the branching is toward the future, not the past. (The fact that there is no branching toward the past reflects our conviction that the world has a *unique* past. It could not be true both that the man from Stratford was the author of *Hamlet* and also that Bacon was.) A fan of branches above the first branch surface connects with a single history extending below. The overall structure

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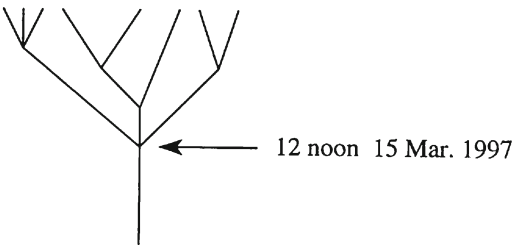
is that of a tree, with an unbranched trunk up to a certain point and a multitude of branches above that. Since the branches themselves branch upward, the branching is very dense.[1]

The Direction and Flow of Time

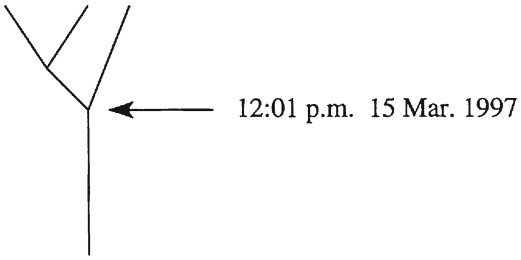
Because branching is only toward the future, temporal asymmetry and directionality are built into the structure of the universe. By definition, the "past" is constituted by the single trunk, the "future" by the branches, and the "present" by the lowest branch point or branching hypersurface on the tree. The "flow" of time consists of the progressive movement of the first or lowest branch point up the tree, brought about by "branch attrition".[2] Branch attrition consists in the following. Of all the branches which split off at the lowest branch point, one and only one is selected to become part of the trunk, and the others vanish.

The progressive disappearance or vanishing of all branches but one, at the lowest branch point of the tree, results in a new branch point becoming lowest and therefore "present." This is a fairly heavy-laden metaphysical idea. It is both ontological and dynamic and is not intended as a metaphorical or analogical description of the world, but as literal and precise. In the branch model presented here, the branches really do fall off in the way described, and their falling off constitutes the flow of time. Their progressive disappearance can also be compared to Aristotle's "transition from actuality to potentiality," which in modern physics consists of the collapse of the wave function brought about by interaction with a measuring device (Heisenberg 1958, pp. 53–58). Unlike the "mind-dependence" theory of temporal becoming (see Grünbaum 1963, Chapter 10), in which the passage of time is a subjective illusion, time flows in the dynamic branched universe whether conscious beings perceive it or not. This is illustrated by Figs. 1 and 2 below:



[1] McCall (1994) contains a detailed account of the branching space-time model discussed here. Belnap (1992) and Belnap et al. (2001) introduce a similar model, the details of which differ from McCall's. The two models bear only a superficial resemblance to the Everett-Wheeler many-worlds interpretation of quantum mechanics.

[2] For an account of how branch attrition in the model corresponds to the flow of time, see McCall (1976, 1984, 1994, 1997).



Physical Possibility and Openness

Indeterminism is built into the model. In the set of all branches that extend into the future at the first branch point, each has an equal chance of being selected as the "actual" branch that becomes part of the past. At the level of the present, branch selection is random. Branching in the model is discrete rather than continuous, there being a small finite, nonzero interval between successive branch points. A future event is *physically possible*, relative to the present state of the world, if it occurs on some future branch. More precisely, E at time t_2 is possible, relative to conditions prevailing at a branch point or branch surface X at time t_1, if E at t_2 is on some branch above X at t_1. For example, it is physically possible, in 2010, for a traveler in Montreal to be in Vancouver 5 h later, but it is not possible to be there 5 min later.[3] This holds even though it is *logically possible* to be there 5 min later or 5 nanoseconds later. The branched model yields a clear, unambiguous difference between logical and physical possibility. The same holds of physical necessity. What is physically necessary, relative to time t, is what is on all branches above t. It is physically necessary for water heated in an open container above 150 °C to boil, but it is not logically necessary. An open future is a future that contains mutually incompatible, physically possible events.

Probability, and Superpositional Collapse

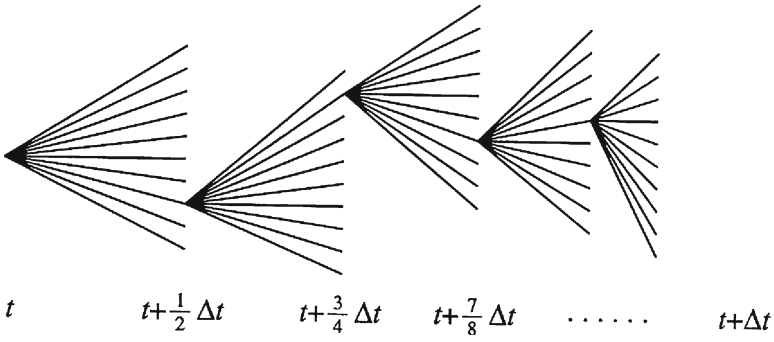
The *probability* of a future event is given by the *proportionality* of future branches on which the event occurs. For example, if there are 100 future branches above the first branch point of a tree at time t_1, and if an event of type E occurs at time t_2 on 67 of them, then p(E-at-t_2), relative to t_1, is 0.67. Of course p(E-at-t_3), relative to t_1, may take a different value. The notion of "proportionality" among sets of future branches is tricky and needs to be defined precisely.

[3] Concerning the concepts of physical possibility and physical necessity, see McCall (1969).

Some probabilities in the physical world take irrational values and require careful handling. For example, a vertically polarized photon about to enter a two-channel polarization analyzer oriented at an angle of 34° to the vertical has a probability of $\cos^2 34°$ of emerging in the "+" channel and a probability of $\sin^2 34°$ of emerging in the "–" channel. These are irrational numbers. $\cos^2 34° = 0.68729\ldots$, a non-repeating decimal, and $\sin^2 34° = 0.31270\ldots$. How can an irrational probability value be represented by a relative proportion of branches above a branch point?

The answer lies in considering a decenary tree, a space-time tree that splits into 10 branches at the first branch point, with every branch dividing in 10 at each successive branch level.[4] A decenary tree can be compressed into an arbitrarily short but nonzero temporal interval, say Δt, as follows. The tree branches in 10 at $t = 0$, and each branch divides in 10 at time $t + ½\,\Delta t$, at $t + ¾\,\Delta t$, at $t + \frac{7}{8}\Delta t$, …. etc. By $t + \Delta t$, the decenary tree will contain a non-denumerable infinity of branches. See Fig. 3 below:

How does it come about that exactly $\cos^2 34° = 0.68729\ldots$ of these are + branches, and $\sin^2 34° = 0.31270\ldots$ are − branches? Well, suppose that six of the first ten branches are + branches, three are − branches, and one branch is "open," meaning that it is neither + nor −. Once a branch is +, or −, it stays that way till the top of the decenary tree. At the second level, at $t + ½\Delta t$, the one open branch divides into eight + branches, one − branch, and one open branch. At $t + ¾\Delta t$, the open branch divides nto seven + branches, two − branches, and one open branch. At $t + \frac{7}{8}\Delta t$, the open branch splits into two + branches, seven − branches, and an open branch. And so forth. The decimals 0.68729… and 0.31270… are simply reproduced in the decenary tree. At the end, $t + \Delta t$, exactly $\cos^2 34°$ of the totality of branches in the tree will be branches in which the photon exits in the + channel, and $1 - \cos^2 34° = \sin^2 34°$ of the totality will be – branches. In addition, there will remain one open branch, which can become arbitrarily either + or − at the initial node of the next level of decenary trees. (When a non-denumerable set is divided into two proper subsets, the addition of one more unit to either of the subsets makes no difference to the overall relative proportionality.)



[4] Decenary trees are described in McCall (1994), pp. 88–92.

We may call a decenary tree a "prism" of temporal height Δt. The entire branched space-time universe is a *prism stack*, with a new prism standing at the upper (i.e., later) end of each complete path through the prism immediately below it. Despite what Georg Cantor says about there being no well-defined relative proportionalities in infinite sets, decenary trees provide exact probability values for future events, even when these values are irrational numbers. The reason why decenary trees are exceptions to Cantor's generalization is because of the particular structure of the set of their branches. Suppose a vertically polarized photon enters an analyzer oriented at 34° to the vertical at time *t*. The probability of its emerging in the + channel, a result which corresponds to a + branch being the sole survivor of branch attrition in the appropriate prism stack, is precisely 0.68729…, and the probability of its emerging in the – channel is precisely 0.31270….

In quantum mechanics, the incoming photon, about to enter a measuring device (in this case a polarization analyzer), is said to be in a *superposition* of polarized states, written $|+> + |->$. On measurement, the superposition *collapses* into one of these states. In dynamic branching space-time, the selection of one single branch out of a multitude of branches at a branch point provides an "objective" theory of superpositional collapse, that is, a theory of collapse that makes no reference to the existence of an observer.[5]

Branching Space-Time and Human Deliberation

As was said earlier, a branching future that contains physically possible, mutually incompatible events is "open." When human beings deliberate over what to do (practical deliberation), or what to believe (cognitive deliberation), there are different options open to them. Let's focus on practical deliberation. I have the choice of leaving early and walking home tonight or leaving later and taking the Metro. Each alternative is physically possible, and each has its advantages and disadvantages. In branching space-time, relative to "now," there are walking branches and Metro branches, in relative proportions that yield $p(\text{walking}) = p_1$ and $p(\text{Metro}) = p_2$. Is it a truly random matter as to which "actual" branch is selected, among the huge number of future branches that confront me? If p_2 is considerably larger than p_1, the chances of my taking the Metro would seem to be a lot greater than walking. But is this all that can be said? Do I simply wait to see what set of future branches, the "walk" set or the "Metro" set, the actual branch falls into, much as I wait to see, in the polarization experiment, whether the actual branch turns out to be a "+" branch or a "–" branch? No. In day-to-day living, human beings are agents, not observers. The reason I eventually find myself on a Metro branch, rather than a walking branch, is not that random branch selection resulted in the actual branch falling into the larger of the two sets of future options. Instead, after due deliberation, I *chose* or *decided* not to walk. If the "walk" set had contained only a single branch, could I not have chosen it? Probably I wouldn't, but *couldn't* I have?

[5] See McCall (1995b, 2000a, b).

The process of deliberation, which Aristotle calls *bouleusis*, consists of three stages:

(i) Listing the alternatives that are open.
(ii) Evaluation, that is, assigning each alternative a weight, either positive or negative, and then weighing one alternative against another.
(iii) Choice of one alternative, resulting in a bodily movement that realizes it. Aristotle calls this *prohairesis*, deliberative choice.[6]

The history of philosophy has witnessed centuries of debate, beginning with the Stoics and St. Augustine, over whether in a world that is deterministic, or in which God knows what the future is going to be, humans can exercise free will. In the case of determinism/indeterminism, either (i) the action A that we perform is deterministically caused by our beliefs and our desires, which would make the performance of a different action B physically impossible, or (ii) the performance of A is a purely chance event. Both alternatives do violence to our deeply felt conviction that what we do is under our control, in some sense "up to us." Branching space-time, considered as a preferable replacement for rigid 100% determinism,[7] would not be much of an improvement if all it did was put human agents at the mercy of "probabilism" rather than determinism. Are human choices to depend on random branch selection, operating over different-sized sets of alternatives? This does not sound like a satisfactory basis for controlled human action, arising from deliberative reasoning. If the choices we make are under our control, they have to be to be grounded on something other than branch attrition.

Control

What exactly does it mean to say that, most of the time, we "control" our actions? A skilled golfer can play a "controlled slice," while a beginner can be plagued with uncontrolled slices. An emotional person may weep uncontrollably; a reserved person tightly controls any display of emotion. Interestingly, much human behavior falls into the category of being both controlled and indeterministic.[8] People walking in opposite directions down a crowded street, for example, rarely if ever bump into one another, but even a Laplacian demon could not predict the exact path that any individual chooses to follow. Brownian movement, exhibited by the random motions of molecules in a gas, differs in being indeterministic and *un*controlled. Small bumps and irregularities in the snow make a skier's precise trajectory indeterministic, but each turn is beautifully controlled. As every skier knows, there is a world of difference

[6] McCall (1987, 1999, 2008) and McCall and Lowe (2005).

[7] Branching space-time does in fact allow for particular instances of 100% determinism, in cases where all the branches above an A node are B branches. For example, in all instances where the two ends of a copper wire are connected to a battery, current flows in the wire.

[8] McCall (2009), pp. 146–48 and McCall (forthcoming).

between skiing in control and skiing out of control. Another indeterministic example, in this case highly rational and highly controlled, is playing chess. Chess-playing is an indeterministic process because the moves made by one's opponent are unpredictable. If they were predictable, chess would lose much of its allure.

Rational, Controlled, Indeterministic Processes

The vital step in understanding how deliberative action is rational, controlled, and indeterministic, as opposed to probabilistic, that is, based on random branch selection over sets of possible futures, lies in recognizing the mental element in action. If a human being consisted solely of a probabilistically functioning neural mechanism directing the movements of a material body, then indeed there would be nothing to deliberative choice above and beyond the random selection of an "actual" bodily movement from among different-sized sets of future alternatives. But in addition to brains, human beings have minds. The branching space-time model of the world, and the definition of what it is for the future to be "open", are conceived exclusively in the third-person mode, exemplified by how a scientist would describe an atom or a whale. But our direct experience of the world, and of ourselves, and how we interact with the world, is conceived in first-person terms, not third-person terms. In thinking, dreaming, desiring, intending, planning, and deciding what to do, we adopt a subjective stance, not an objective one. Human choices are essentially personal, subjective, and mental. This does not prevent their consequences from being far-reaching and objective. It is the subjective, mental element that makes deliberation rational and controlled, in addition to being indeterministic.

Without indeterminism, there would be no such thing as deliberation. As a matter of logic, one cannot deliberate and decide what to do if there is only one course of action open. As Richard Taylor remarks (1964), one can *seemingly* deliberate and decide to take a late train home, under the mistaken belief that the trains are still running. One can *seemingly* decide (and try) to move one's leg, unaware that the spinal anesthetic administered some hours earlier in the operating room has not yet worn off. In the train case, one can start the process by going to the station, that is, one can *initiate* the implementation of the decision to take a late train. But one can't *fully* implement it. In the leg case, one can't even initiate it. Unbeknownst to you, the alternative you chose was not open and did not exist. But these are pathological cases, in which two different alternatives seem to be open, but in reality only one is. The standard instances of practical deliberation logically require that there be at least two different alternative courses of action, and this implies indeterminism.

The mental element enters into practical deliberation at every stage. First, the deliberator must be *aware* of the existence of different possible options. Second, during evaluation, the assignment of appropriate positive and negative weights to the options is a judgemental activity of the mind, involving the use of practical reason. The process is a rational one, taking into account the strength of possibly conflicting impulses and desires, balancing short-term versus long-term considerations, and influenced by the probable impact of one's actions on others. ("Why did you even

consider putting in a side order of clams when they always make you sick?" "Because I knew George was crazy about them and would lick the platter clean.") Third, the final choice at the end of the deliberative process can be a "difficult" one, meaning that its consequences may be grave, or that two different options are equally balanced. Buridan's ass starved to death, equidistant between two equally tempting piles of hay. A more intelligent being would flip a coin or simply make the kind of arbitrary choice we make at the supermarket in choosing one of a hundred identical cans of tomato soup. In all cases, the subjective role of the mind in decision-making is critical.

John Searle points out a characteristic feature of the subjective, first-person stance, one that sets it apart from third-person affirmations. This is, that in the realm of subjectivity, the distinction between appearance and reality no longer holds (see Searle 2004, p. 85). There is, for example, no difference between saying "I am in pain" and "It seems to me that I am in pain." In the case of practical deliberation, a strong subjective element characterizes both the evaluation of alternative courses of action and the eventual choice. Weighing options is not like weighing sugar. Options do not come with ready-made weights. Before one option can be weighed against another, it must be *weighted*, and the weighting process is a subjective one. One who *seems* to attach more weight to comfort than to convenience in traveling *really does* weight comfort over convenience. It is in the assignment of weights to options that deliberators exercise the first dimension of their control over the deliberative process. The second dimension emerges in the final choice.

Like the weighting of options, choice is a subjective phenomenon. In the world of the first-person, to *seem* to choose *is* to choose. To *seem* to be in pain *is* to be in pain. In order to appreciate the crucial role that subjective choice plays in decision-making, consider the difference between human decisions, in which the mind plays an essential role, and the decisions made by a probabilistically functioning neural mechanism. As was described above, probabilistic behavior in the objective third-person world is based on global random selection of an actual future from among sets of possible futures, these sets being of different relative proportions. If "persons" are merely neural mechanisms, then their "decisions" are modeled on this pattern. But in fact, a choice made by a human deliberator is very different. It is a mental event, not caused by or supervenient upon random branch selection in the physical world, but itself the cause of branch selection, and the accompanying bodily movement. A mental choice, with physical effects, is a paradigmatic example of mental causation. (On mental causation, see Kim 1998.) Significantly, this is not a case of causal overdetermination, since the physical event that the mental event causes, that is, the bodily movement, does not already possess a physical cause. This needs to be made clearer.

Indeterminism in the Brain

As was stressed above, without indeterminism, without at least two different possible optional actions stemming from the same set of initial conditions, there would be no such thing as practical deliberation. Suppose someone, X, is deliberating

about whether to do A, B, or C. Throughout the entire deliberative process, these options remain "open," meaning that X can make a bodily movement initiating the implementation of any one of them at any time. In X's brain, there are motor neurons, the activation of any one of which will lead to implementation. Let n(A) be the neuron, the activation of which initiates the implementation of A, and similarly for n(B) and n(C). Before X reaches a decision, each motor neuron is potentially activat*able*, but it is undetermined which one will be actually activat*ed*. It is the indeterministic functioning of X's brain that keeps the options A, B, and C open. When X reaches a decision and chooses one of the three options, say option B, what causes the activation of motor neuron n(B)? We have already examined, and rejected, the hypothesis that n(B) is activated by random branch selection in the space-time model. There remains only one possibility, that the activation of n(B) is caused neither randomly nor physically, but by the mental, phenomenological event that we call "X's choice." Despite the misgivings of generations of philosophers since the time of Hobbes and Descartes, it would seem that mental causation plays an essential role in deliberation, decision, and action. One of the principal objections to invoking a mental cause in this context, namely, the easily made philosophical assumption that every physical effect must have a physical cause, is vitiated in this case by the fact that, because of the indeterministic functioning of the brain, the activation of the motor neuron n(B) has *no* physical cause. Instead it has a mental cause. Having no physical cause, the activation of n(B) is not causally overdetermined.

How Rational Agents Exploit Neural Indeterminism

Can the overall indeterministic functioning of the billions of neurons in the human brain be given a naturalistic explanation? Does such functioning have "survival value"? It seems logical to suppose that it does, and that the role of "keeping one's options open," played by neural indeterminism, was one of the most important factors in human evolution. Compare a human brain, that behaves indeterministically, with a deterministic neural mechanism functioning on a "stimulus/response" basis. When confronted with a challenge, whether for living space, or food, or physical combat, a creature with a one-option brain would seem to be at a disadvantage compared to a creature with a multi-option brain. An essential component of human rationality is *practical reason*, the ability to examine different courses of action and select the best. Without multiple options, generated by neural indeterminism, an agent is incapable of reasoning in a practical way. Of course, practical reasoning comes with a risk, namely, that one may choose the wrong option, a course of action unsuited to the prevailing situation. But human evolution demonstrates, I think, that living riskily brings higher rewards, and a higher level of development, than living safely and predictably.

A long time ago, Plato and Aristotle differed on the question of the Good, and its relationship to human action. Plato, the idealist, maintained that all of us, at all times, seek the good in the sense of acting in accordance with what we believe to be best. If we behave badly, it is through ignorance of where our true good lies.

Aristotle, the realist, believed that it was possible to know what is best, but not to do it. Of the two philosophers, Aristotle seems to be closest to recognizing not only the judgemental role of practical reason but also the possibility that ultimate choice may not accord with deliberative evaluation, with "what one thinks is best." Aristotle judged that this was an evidence of human *akrasia* – "weakness of will." This may or may not be so, but the possibility of "knowing the good and not doing it" seems an inevitable consequence of the power of deliberative free choice.

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The Metaphysics of the Thin Red Line

Andrea Borghini and Giuliano Torrengo

Abstract The thin red line is the view that time branches towards the future, but future contingent has already in the present a determinate truth-value. On the face of it, such a view avoids determinism and fatalism, while also representing the fact that there is a future which is 'special' because it is the one that will be the case. However, many have objected to the tenability of the thin red line theory by arguing that either it collapses on linear time or it compels us to endorse thick metaphysical theses about the future. In this chapter, we argue against such attacks and show that TRL's metaphysical grounds are solid.

Keywords Branching time theory • Thin red line • Metaphysics of the thin red line

There seems to be a minimal core that every theory wishing to accommodate the intuition that the future is open must contain: a denial of *physical determinism* (i.e. the thesis that what future states the universe will be in is implied by what states it has been in) and a denial of *strong fatalism* (i.e. the thesis that, at every time, what will subsequently be the case is metaphysically necessary).[1] Those two requirements

[1] Hence, strong fatalism implies physical determinism, while the latter does not imply the former, thus being compatible with the world having been otherwise, assuming that the initial condition of the world could have been otherwise. Also, strong fatalism is intended as opposed to weak fatalism, according to which whatever I will do now will not affect what will be the case. Weak fatalism, instead, does not imply, nor is implied, by physical determinism.

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are often associated with the idea of an objective temporal flow and the non-reality of the future. However, at least certain ways to frame the 'openness' intuition do not rely on any of these. Branching time theory (BTT) is one such: it is compatible with the denial that time flow is objective and it is couched in a language with a (*prima facie*) commitment to an eternalist ontology. BTT, though, urges us to resist certain intuitions about the determinacy of future claims, which arguably do not lead either to physical determinism or to fatalism. Against BTT, supporters of the thin red line theory (TRL) argue that their position avoids determinism and fatalism, while also representing the fact that there is a future which is 'special' because it is the one that will be the case. But starting with Belnap and Green (1994), some have objected to the tenability of TRL, mainly on metaphysical grounds. In particular, they argue that 'positing a thin red line amounts to giving up objective indeterminism'[2] and that 'has unacceptable consequences, ranging from a mistreatment of actuality to an inability to talk coherently about what *would* have happened had what is *going* to happen not taken place'.[3] In this chapter, we wish to reframe the dispute, thus showing that TRL's metaphysical grounds are solid and that it does not imply strong fatalism or determinism.

Branching Time and Alternative Futures

BTT allows us to clearly distinguish between deterministic and indeterministic views of reality, but it does not force us to choose between the two. As its proponents make clear,[4] BTT is a theory about the topology of time in our world, that is, it tells us how moments of time are connected to each other with respect to their temporal order. Using a metaphor, BTT states that the temporal order of our world has the shape of a tree. With respect to each moment, there is a unique *trunk* of past moments and a multiplicity of future *branches*. More precisely, a tree-world is a structure $T^b = <E, <>$ such that E is a set of moments, $<$ is a partial order relation defined on couples of elements of E (i.e. $<$ is transitive and antisymmetric, and $<=$ is reflexive). The trunk is a chain of moments in linear order whose upper bound is a certain moment t (which intuitively we can think of as the present moment), while the branches are chains of moments, such that any chain stands in no temporal relation to any other chain, but all are future with respect to t. A postulate of *no-backward branching* warrants that branches of temporally incomparable moments are all and only to be found in the future of each given moment.[5] Therefore, moments are temporally comparable only if they are on the trunk or they belong to the

[2] MacFarlane (2003): 325.

[3] Belnap and Green (1994): 367.

[4] Prior (1967), Thomason (1970, 1984), Belnap (1992), and Belnap et al. (2001)

[5] Belnap et al. (2001): 140. The other postulates are *non-triviality* (the structure is not empty), *partial order* and *historical connection* (for every distinct t_1 and $t2$ there is a t_3 such that $t_1 > t_3$ and $t_2 > t_3$). In order to keep the discussion under more familiar terms, our characterization of branching time theory differs in some minor respects from the one offered in Belnap et al. (2001) and Thomason (1970, 1984).

same branch. All tree structures compose a class, **Σ**. Such a class represents how, at each moment, there are many alternative futures, while the past is settled. A chain of moments is a series such that, for any two distinct moments t_x and t_y belonging to the series, either $t_x < t_y$ or $t_y < t_x$. Finally, a *history* can be defined as a maximal chain of moments.

Since BTT is about *our world's* temporal structure, it construes moments as concrete entities. Moments are indeed spatially complete instantaneous events (Belnap et al. 2001: 139), that is, instantaneous events that encompass the whole universe, from a spatial perspective.[6] A tree structure can thus also be defined on a domain of instantaneous events that may be 'smaller' than whole moments, with the relation '<' holding between instantaneous events (e.g. $e_x < e_y$) and thus also between moments (e.g. $t_x < t_y$). Events smaller than moments (from now on simply 'events') can be part of moments (and of other 'bigger' events in general). Although the branching time theory does not need to fully specify the mereological relations between events and moments, there are two interesting constraints on the part-whole relation between the two, which should hold in any formalization of it. Firstly, a moment t is a spatially complete instantaneous event whose parts are all and only events *simultaneous* with each other. Secondly, no event is part of two distinct moments. (Incidentally, from these constraints follow that $e_x < e_y$ if and only if there are two moments t_x and t_y, such that e_x is part of t_x, e_y is part of t_y and $t_x < t_y$, as we may expect.)

The constraints are interesting within a branching time structure because they force us to distinguish between the relations of genuine simultaneity and cross-simultaneity between events. *Genuine simultaneity* is a temporal relation between events. If we graph the ordering relation '<' on the natural or the real (depending whether we deem time to be discrete or not, respectively) in order to define a temporal metric between events, the simultaneity relation will be the zero-distance relation '$<_0$'.[7] It follows that such a relation holds only for same-branch events (as do temporal relations in general). *Cross-simultaneity* is instead defined in terms of same temporal distance from a moment.[8] A moment is cross-simultaneous with another moment if and only if they are at the same temporal distance from the present. Given that branching occurs only with respect to the future, cross-simultaneity only holds between *distinct* moments if these moments are future. (An alternative would have been to define the relation only for moments in the future.) The relation of cross-simultaneity allows us to define the notion of *instant* as a maximal set of cross-simultaneous moments. Because in the past and the present there is no branching, past moments and the present are instants; future moments, instead, are

[6] Of course, in a relativistic setting, the division of space-time into moments is always relative to a system of coordinates. We will not consider here the further complications due to special and general relativity (for a formulation of BTT in a relativistic space-time, see Belnap 1992).

[7] Alternatively, we can define simultaneity between events in terms of identity of moments: two events are simultaneous if and only if they belong to the same moment. Here, neither we are interested in providing a detailed formalization of our account nor we deem necessary to discuss what notions should be taken as primitive, since nothing of what we claim depends on these tasks.

[8] We are not forced to have a metric on '>' to define cross-simultaneity; we only need a relation of *same temporal distance* from a moment. Of course, within a temporal metric, such a relation is trivially defined.

only 'partial-instants' because they are elements of instants. If all histories are isomorphic, the class of *instants* is a linear order.[9]

Completing the sketch of the theory, let us define also the relations of *same-branchness*[10] and *same-worldliness* between events. Events e_x and e_y are same-branch if and only if $e_x < e_y$ or $e_y < e_x$, that is, two events are on the same branch if and only if there is a temporal relation between them. Events e_x and e_y are same-worldly if and only if there is an event e_z such that $e_z < e_x$ and $e_z < e_y$, that is, two events are in the same world only if there is another event with which they are both in a temporal relation.[11] Notice that, as we have defined them, same-wordliness is an equivalence relation, while same-branchness is not even Euclidean (e_t can be on the same branch both of e_x and e_y, while e_x not being on the same branch of e_y). Indeed, each event on the trunk of a tree is on the same branch of any other event on any other branch, but of course, events on different branches do not stand in the relation of same-branchness to each other.

The branching structure of temporal relations has been sometimes invoked to back up the idea that the passage of time is objective or that the future is unreal. McCall, for instance, explicitly grounds the mind-independence reality of the passage on the mind-independence of the direction of the temporal relation,[12] and Prior seems to suggest, furthermore, that the indeterminacy captured by the branching structure is due to the unreality of the future.[13] However, most often, BTT is invoked to back up

[9] Note that we are not postulating isomorphism between histories and *then* define instants on such grounds. Our definition of instant holds even if there is not a complete order of instants.

[10] The reader should be alerted that what we call *same-branchness* most often goes by *same-historiness*. An analogous remark applies for *determinate/indeterminate at a branch* and *necessary/possible at a branch*, which would usually be called *determinate/indeterminate with respect to a history* and *necessary/possible with respect to a history*. We prefer the term 'branch' as we find it theoretically more neutral. In particular, and as we shall clarify later, the totality of the branches of a tree may not (and in most cases do not) represent the totality of the metaphysical possibilities at a time. Yet we find that speaking of the totality of histories may, although only implicitly, suggest the misguided reading.

[11] The postulate of *historical connection* (for every distinct t_1 and t_2, there is a t_3 such that $t_3 < t_1$ and $t_3 < t_2$) in Belnap et al. (2001) makes each moment trivially same-wordly with any other. This is a difference between their formulation and ours. Indeed, as it will be clear below, we aim at characterizing the structure also with respect to metaphysically possible alternative situations and not just with respect to our world.

[12] McCall (1984). The idea that indeterminist causality can be exploited to ground the 'arrow' of time, that is, not simply a temporal asymmetry between the two directions of the temporal relation but also a preferred direction as *the* direction of time dates back to Reichenbach (1956); see also Horwich (1987).

[13] Prior (1967). In what follows, we will speak as if future moments are real, as usually branching theorists do. If topological connection requires sameness of ontological status and there is at least one real moment on a tree (for instance, the present), then this follows (see note 20). However, what is relevant here is that (i) branching time is *compatible* with the thesis that future moments are ontologically on a par with the present and the past and (ii) branching time vindicates the intuition of openness *not* through an ontological difference between the past and the future (even granting there is any). Besides, we will often speak in terms of the present, along with past and future moments. These locutions – 'present', 'past' and 'future' – have to be taken informally, since nothing of what we claim hinges on endorsing some dynamic or tense-realist view.

the idea that the future is genuinely – objectively and ontologically – undetermined, which is a logically independent thesis both from the hypothesis that the future is unreal and the hypothesis that the passage of time is objective. BTT nicely spells out the intuition that the future is indeterminate by positing a difference in the topological structure of the future with respect to the past and present. BTT does not spell out the indeterminacy intuition by appealing to an objective flow of the present, since the fundamental temporal relation that it resorts to can be construed as the standard 'static' relation of the B-theorist; neither it spells out such intuition by bestowing upon the future a different ontological status than the past and the present, as all future events are connected to the present moment (and the past) and thus are part of the same world. This is something which is important to keep in mind, because BTT friends cannot resort to those further metaphysical theses in defending their position and arguing against the TRL alternative.

Here is the trick: although any future event is connected to the present, there may be no temporal connection between future events in a world (including our world); thus, unconnected future events stand on *alternative* branches; they are alternative futures. More precisely, at a moment *t*, an event e_x (on any branch) is *an alternative future with respect to an event* e_y if and only if both e_x and e_y lie ahead of *t*, they are at the same temporal distance from *t* and e_x is on a different branch than e_y. And at a moment *t*, e_x is *among the alternative futures of t* if and only if $t < e_x$ and there is some e_y such that it is not the case that $e_x < e_y$ or $e_y < e_x$.

What we call 'alternative future' is also named 'possible future' or, as Belnap and Green put it, an event 'in the future possibilities of' a moment.[14] However, we believe that this qualification is misleading. Granted, the two events e_x and e_y are both in the same world; if we take such world to be the actual world, then e_x and e_y are both actual, and since whatever is actual is also possible, e_x and e_y are indeed possible. Still, calling e_x and e_y 'possible futures' may lead one to think that they exist in different worlds and, perhaps, in different ways from what is actual. Yet they are alternative just in virtue of the fact that they are temporally non-related, while both being future with respect to a same present. Hence, we prefer to say that events on different branches are alternative futures. Distinct cross-simultaneous events form a subset of the set of alternative futures. It is important to bear in mind that there is no ontological difference between alternative futures and present and past moments – or at least that no such difference is of any relevance for BTT. As we shall clarify later, on BTT it is indeterminate what your future *will* be, although it is not indeterminate what your alternatives *are*.

Thus, BTT is not a theory of (metaphysical) possibility and necessity. Indeed, there may be more metaphysical possibilities for a present event at a certain world than those represented by the branches of the tree of that world. In other words, we are here assuming that trees within BTT are generated through a principle of humean (or quasi-humean) recombination.[15] Thus, even if we find (no) event of a

[14] Belnap et al. (2001): 140 and Belnap and Green (1994): 371.

[15] See, for example, Lewis (1986): 89.

certain kind on every alternative future of a moment *t*, it will not be the case that an event of that kind is necessarily (not) going to happen; in other words, what *has to be* the case according to a certain tree-world may not be what *necessarily* has to be the case.

This suggests a natural way to expand the theory from a single world-tree to a class of such, representing the class of the metaphysically possible worlds. Instead of having a world-tree only $T^{\flat} = <E, <>$, we have a structure $S = <E, \boldsymbol{T}^{\flat}>$, where $\boldsymbol{T}^{\flat}$ is a set of world-tree and E is the union of all E in each $T^{\flat}$. S is the space of metaphysically possible worlds, some of which may have a branching structure and some of them may partially overlap (by sharing the same events in the same order up to a certain moment). As we have shaped it, thus, BTT offers a clear model accounting for the intuition that the future is open by providing a class of worlds such that, for any world in that class, the future may be open in a different way, namely, with respect to different alternatives.

Such a formal apparatus leaves us rather free to represent different kinds of determination and possibility. Although many options are available, we will follow this idea: each world-tree represents the *physically possible* continuation of the world's history at each of its moments; a world-tree structure represents the metaphysically possible alternatives for a world (more on this later on).[16]

From Branching Time to the Thin Red Line

Now, some wish to plug into this model another intuition – that, while at a present time the future is typically open, at a future time what will be the case is going to be settled. This is the gist of TRL. Again, TRL is not a theory about possibility and necessity. It is supposed to spell out our intuitions that the future ahead of us is open, but it still makes sense to claim that we can say true or false things about the future even when contingent events are under the radar. For instance, if I believe on the ground of some present evidence that tomorrow it will be sunny, I am not thereby committed to believe that causation of meteorological phenomena is deterministic or that fatalism is true. TRL and branching time theories share the same tree-like topological structure of time, but the former adds a special entity: the thin red line (R) representing that special future which will be the case. In TRL, a tree-world is a structure $T = <E, <, R>$ such that $\forall e_1 e_2 \in E \cap R\, R(e_1 < e_2 \vee e_2 < e_1)$. Thus, R is a history like any other.[17]

[16] One may even add a relation of accessibility among world-tree structures, but we shall not delve into this detail here as it is not relevant to the present discussion.

[17] We will not take into account Belnap and Green alternative view, according to which the thin red line is not simply a history, but rather a function from moments to histories (intuitively, the thin red line of each moment). They introduce this alternative only to discuss a rather technical point but then show that the same problems hold for both versions (for a criticism of Belnap and Green's argument against TRL based on such technical point, see Øhrstrøm 2009). See Belnap and Green (1994): 379–381 and an even more articulated version in Belnap et al. (2001): 162–8.

Belnap et al. (2001) and Belnap and Green (1994) argue against TRL, retorting that it provides an answer to what they call *the assertion problem*, which is problematic for metaphysical reasons (they also lay down semantic arguments against it, but we will address them only indirectly here). The problem moves from the assumption that it is correct to assert only things that at least in principle can be evaluated with respect to the their context of utterance. Of course, this does not mean that the parameters required for the evaluation of the utterance of a sentence must be elements of the context: further 'auxiliary' parameters may be required as well. For instance, in standard semantics, quantified sentences require an 'auxiliary' arbitrary assignment of values to the variables to be evaluated. However, it seems plausible to require that we make an assertion only in case the following conditions are satisfied: either the sentence uttered is *closed by independence*, that is, the truth-value of the utterance does not vary by considering different auxiliary parameters, or the sentence uttered is *closed by context*, that is, the context provides a unique auxiliary parameter (or a unique set of them).[18] For instance, it makes sense to say 'For some x, x is a tea pot', because the variable x is bound, and the sentence does not vary its truth-value with respect to different assignment of values to the variables (the sentence is closed by independence). Similarly, it makes sense to say 'that is a tea pot' pointing to something, because the context provides the referent of 'that' (the sentence is closed by context), whereas it does *not* make sense to assert 'x is a tea pot', since such a sentence is neither closed by context nor by constancy: by uttering it, we are literally asserting nothing.

Now, a sentence such as 'tomorrow will rain' seems to be on a par with 'x is a tea pot'. With respect to auxiliary temporal parameters, which we can think of as the alternative branches that lie *ahead* the time of utterance, its truth-value may vary and thus it is not closed by independence, and if indeterminism is true, it does not seem to be closed under the context either. As Belnap has it (Belnap et al. 2001: 151), there are no facts of the matter fixing one history as *the* history of the context of utterance. Any utterance, as any event, is part of many histories that share the same past but have different future branches. In the context of utterance nothing – or at least nothing that can be read off from the physical conditions together with the physical laws – tells us at which branch we should evaluate the sentence. But then, why does uttering sentences of the form 'Will: p' seems to make sense nonetheless?

Certain philosophers have tried to articulate a defence of the idea that sentences of the form 'Will: p' are indeed closed by independence,[19] but a more attractive position seems to be abandoning the idea that future-tensed sentences are not closed by context. TRL gives precise content to this idea: the future branch that the context

[18] For a formal characterization of the 'auxiliary' parameters, see Belnap et al. (2001): 147. As for the terminology, we rely on Belnap et al. (2001) for 'closed by independence' (what is dubbed 'closed by constancy' in Belnap and Green 1994) and on Belnap and Green (1994) for 'closed by context' (what is dubbed 'closed by initialization' in Belnap et al. 2001).

[19] See McArthur (1974) and Burgess (1978).

of utterance unambiguously set apart for the evaluation of claims about the future is the thin red line. Belnap and Green seem to object to such a solution to the assertion problem mainly because they think it rests on ill-conceived metaphysical grounds.

> [TRL] involves commitments to facts that do not supervene upon any physical, chemical, biological or psychological states of affairs. The fact, if it is one, that at a given indeterministic moment m there is some history such that it is the one that will occur, is not a state of affairs that supervenes upon what is true of particles, tissues or organisms that exist at m. Those of us who do not postulate a Thin Red Line have no need of such a mysterious realm of facts. (Belnap and Green 1994: 380–81; see also Belnap et al. 2001: 168)

> [TRL] also has problem with actuality. […] For a world to be actual is for it to be the world we inhabit. For a history to be actual would be for it to be the history to which the moment we inhabit belongs. It is not, however, in general the case that the expression 'the history to which the moment we inhabit belongs' secures a referent, since uniqueness fails in the face of indeterminism. (Belnap and Green 1994: 380; see also Belnap et al. 2001: 164)

The problems outlined by Belnap and Green are mainly two: (a) TRL requires the possibility of unambiguously referring to our *actual* future, and (b) TRL requires the commitment to metaphysically suspect kind of facts. Now, if (a) were true, then it would follow that branches other than the thin red line are not real alternatives, but merely logical ones (see also the paper by Iacona this volume). Therefore, endorsing TRL would be tantamount to give up the indeterminist view of the future. The way out Belnap and Green suggest (actually, a trap) is to accept ungrounded present facts about the future and thus justify the charge of (b). However, it is not clear that (a) is justified in the first place, and in what follows, we will try to undermine this view. What we believe is that, once the metaphysics underlying Belnap and Green's claim is clarified, nothing is left to support (a) and then (b) but an ungrounded and stubborn intuition.[20]

De re Possible Futures

It is now time to dig into some of the specifics of BTT metaphysics, which will prepare the ground for the discussion of TRL. BTT is a palatable theoretical option because of the way it cashes out the intuition that the future is open. BTT allows us to claim that there is no preferred alternative among the future ones: they are all connected to the present and the past in the same way, and they are all on the same ontological footing. Such an intuition is especially strong in the case of *de re* propositions, where the openness of the future is expressed with respect to the future alternatives for a specific individual. How is this cashed out within the theory in more

[20] It should be clear that Belnap and Green's objection is not concerned with TRL's capacity to propose a solution for the assertion problem. Indeed, they are quite clear on TRL solving the problem, they just object to the solution. 'The […] far more prevalent response to the assertion problem is to hold that future-tensed sentences are closed by context. On this view, future-tensed sentences make reference to a particular history supplied by the context of use – The Thin Red Line. […W]e argue at length against this tempting evasion of the assertion problem.' (Belnap and Green 1994: 378.)

rigorous terms? By simply speaking of instants or moments, we cannot pin that down. However, some events are complex entities, whose constituents/participants are individuals, properties and relations. Thus, the structure of an event has typically the form $e_x = R(i_1 \ldots i_n)$ where $i_1 \ldots i_n$ stand for individuals and R is a n-ary relation.

Now, here is the situation. We have this individual i_t, which exists at a moment t, and we want to say that in the future there are a number of alternatives for it (or her or him). We express that by saying that there are branches in the future of t, containing incompatible events involving i_t. More precisely, there is an individual i_x that is a constituent/participant of an event e_x existing at a future branch b_1 at a moment t_x that *represents* a genuine alternative future for i_t – one among several of its (or her or his) genuine alternative futures. But here we encounter a first ontological issue. Clearly, the intuition is that i_x is the 'same' as i_t; yet this is just sloppy talk. Speaking in more rigorous ontological terms, we should ask the following: are i_t and i_x numerically identical, are they different parts of a same individual, and are they 'cross-temporal counterparts' within the same world or none of these?

This point has not been given close consideration in the literature. Yet, not all of the options may be open to BTT. For the time being, we shall make no assumption, as what we shall say will not depend on this. In the sequel, however, we will not assume that an individual i_f, representing an alternative future for an individual i_m existing at the present moment, is numerically identical to i_m. This assumption may raise further problems that we do not need to address here, and in what follows we will take the representing relations between individuals being analogous to the counterpart relation. One may be tempted to claim that individuals on the thin red line at future times are numerically identical with the individuals in the present that they represent, while individuals on branches other than the thin red line can be at best counterparts of present ones. We think that this temptation should be resisted, since it is not clear that it is compatible with the claim that the thin red line is ontologically and metaphysically on a par with the other branches. And we do not need to defend this problematic thesis in order to argue for the TRL.

We are now in a position to define the alternative futures for individual i_t. In a branching world W, at a moment t, an event e_x taking place on one of the branches is among the *alternative futures for individual* i_t if and only if:

(i) There is an event e_t that is part of t, such that i_t is a constituent of e_t;
(ii) There is an individual i_x which is a constituent of e_x and which *represents* i_t; and
(iii) e_x lies ahead of t. We can, hence, define the *class of all alternative futures for an individual* i_t as that class which includes all the events which are among the alternative futures for an individual i_t. Finally, in order to generate the desired picture, we can partition the class of all alternative futures in subclasses, such that any two events e_x and e_y in the same subclass are not alternative with respect to one another, while any two events e_x and e_y in different subclasses are alternative to one another.[21]

[21] Here we face another problem: the one cashing out a metric to establish whether a class of alternative futures are at the same distance from the present; we shall leave this on a side.

Formal Features of the Thin Red Line

Let us now focus on the main characteristics of the *thin red line*. Intuitively, this branch contains all the truth-makers for future-tensed sentences evaluated at the present. But what sets it apart from any other branch?

Here are a few options that should be ruled out:

(i) It cannot be a different ontological status of its moments to set apart the thin red line from the other branches because, as we have seen, all moments on each branch exist in the same way.

(ii) It cannot be the fact that the thin red line bears a different kind of temporal relation – call it *same-temporality* – to the present than other branches, because there is no such thing within TRL and it would not be easy to justify its introduction if not by claiming that it is an *ad hoc* move.

(iii) Perhaps the right candidate lies among the properties of the thin red line or of its moments. May it be same-worldliness? No; if 'same-worldliness' means 'to be part of the same tree', all events on the trunk and on any branch are same-worldly with the red line.

(iv) May it be actuality? No.[22] Same-worldliness with an actual event implies actuality. Therefore, the thin red line branch is as actual as any other branch.[23] An important consequence of this fact is that if we informally characterize the thin red line as 'what will actually be the case', this expression cannot mean 'the alternative future which is now distinguished by the property of *being actual*'. But of course, not all same-world events (moments) are same-branch events (moments). Yet,

(v) The distinguishing property is not even same-branchness. Indeed, if we evaluate it from the present perspective, past and present events are no less on the same branch with events on the thin red line than they are with events on any other branch.

[22] And, in this opinion, we diverge from Belnap and Green, who argue that TRL 'has troubles with actuality' because it supposes 'that there is one from among the histories flowing out of *m* [the present moment] that is the actual history' (Belnap and Green 1994: 381). We believe that Belnap and Green's understanding of TRL, here, rests on a mistake; there is no reason to maintain that the thin red line is singled out by the property of being actual.

[23] In particular, if there is at least an actual event in a world with a branching structure, then every event in that world is actual and thus every branch. This can be easily demonstrated. (I) Assume there is at least an actual event (intuitively, all present events, including the present instant, are actual). (II) Any same-world event of an actual event is actual. (III) All events (and, hence, moments) on the red line are same-worldly with past and present events (and moments) and with any event (and moment) on any other branch. (IV) Thus, if the events (and moments) in the red line are actual, so are events (and moments) on any other branch. Note that (III) follows from the definition of same-worldliness and (I) and (II) are very plausible constraints on actuality. Thus, the red line branch is as actual as any other branch, independently on how we construe actuality, insofar as (I) and (II) are satisfied.

And here is an answer that strikes us as feasible. The distinction cannot be captured from the 'point of view' of the present.[24] Therefore, we need to distinguish between attribution of same-branchness as assessed at a certain instant and attribution as assessed at a different instant. This requires us to make use of certain semantic distinctions between BTT and TRL – those that in our view are key to pin down the metaphysical edge between BTT and TRL. It should hence be clear that our aim is not to provide a full-blown semantic machinery, but to flash out a certain metaphysical picture. Thus, we shall not spell out the conditions of evaluation of utterances of sentences in a context (as, e.g. Belnap et al. 2001: 141–156 do); rather, we will suggest how to evaluate those propositions pointing at certain features of branching worlds within BTT and TRL. This will allow us to show that the metaphysical objections to TRL are ungrounded, since TRL (a) does not force us to struggle with the notion of actuality and (b) requires only unproblematic facts about the future. And if there are no *metaphysical* objections to TRL, then the assertion problem can be solved by claiming that future-tensed sentences are closed by the context. The semantic rule for evaluating a future-tensed sentence tells us to look at the thin red line as an auxiliary parameter for the evaluation, that is, *the* history of the context of utterance. Of course, being limited to the information that we find in the context of use (the present), we are not in a position to *know* which branch is the red line. But this epistemic impasse is not surprising for auxiliary parameters and should not be confused with a lack of matter of fact.

Now, something should be said regarding our propositions. First of all, they are truth-bearers. And since we want to talk both of BTT and TRL, we allow propositions to have also 'indeterminate' as a truth-value along with truth and falsity. Moreover, for simplicity, we will consider only propositions about (particular) event(s), for instance, the proposition that an event e_x *occurs at a certain moment* m (i.e. an event e_x is part of m) or *that event* e_x *is ahead of event* e_y (i.e. that e_y is part of a moment m_1 and e_x is part of a moment m_x such that $m_1 < m_2$). Since trees and branches are constructed out of moments, which in turn contain events as parts, this makes our job more straightforward.[25] We will also assume this further restriction in order to keep the discussion simple: if $e < e_x$ and $e < e_y$ and neither $e_x < e_y$ nor $e_y < e_x$, then $e_x \neq e_y$ (intuitively, no distinct future branches share some of their events).

We are now ready to consider what it is for certain propositions to be true or false with respect to a world, within BTT or TRL. Here – if we are right – we shall find some relevant distinction between the two theories. The simplest case we will consider is that of a proposition about the occurrence of an event at a certain moment, evaluated with respect to a branch. We will express it through a tenseless temporal operator and a singular term referring to an event. Intuitively, the temporal operator expresses the moment we are looking at when we attribute something to the event (e.g. its

[24] The point we make here can be phrased also within the semantic machinery developed in MacFarlane (2003, 2008).

[25] The main limitation is that we will not have general propositions about events, but this will not affect our point but in one minor respect.

occurring or being in a certain relation with other events). Such a case will be assessed in the same way both in BTT and TRL.

(Truth$_B$) The proposition that, at m, e_x occurs is true in a branch B if and only if e_x is part of m and m is an element of B.[26]

From this basic case, we now develop an account of tenseless operators that involve instants (and not simply moments) and evaluation with respect to tree (and not simply a branch). And, interestingly enough, this makes a difference with respect to whether we are operating in a BTT framework or a TRL. Thus,

(Truth-T_{BTT}) The proposition that at an instant t e_x occurs is true in a tree T, if and only if e_x is part of all moments that constitute t in T; it is false in case it is part of no moment that constitute t in T and is undetermined if it is part of only some of the moments that constitute t in T.

(Truth-T_{TRL}) The proposition that at an instant t e_x occurs is true in a tree T, if and only if (i) e_x is an element of the moment that constitute the thin red line of T at t; it is false otherwise.

It is easy to see that, in TRL, propositions of the form specified will always have classical truth-values (true or false), whereas in BTT, they can be true only if the model has no branch at all (the limiting case of linear time).[27] This may be thought to be a defect of our definition, but actually we cannot avoid this kind of ambiguity if we speak only of instants in a BTT model. The situation gets better if we relativize the *evaluation* of the proposition with respect to a moment, and we still get a different result than in TRL models. Intuitively, the moment of evaluation is the moment we are considering as present when we evaluate the attribution (while the attribution can be made at a different instant than the one at which the moment of evaluation lies).

(Truth-M$_{BTT}$) The proposition that at an instant t e_x occurs is true in a tree T at a moment m, if and only if either $e_x <= m$ or $m < e_x$ and e_x is part of all moments m_x that constitute t in T; it is false in case it is part of no moment m_x that constitute t in T and is undetermined if it is part of only some of the moments m_x that constitute t in T.

(Truth-M$_{TRL}$) The proposition that at an instant t e_x occurs is true in a tree T at a moment m, if and only if either $e_x <= m$ or $m < e_x$ and e_x is an element of the moment that constitute the thin red line of T at t; it is false otherwise.[28]

[26] For an alternative definition of truth at a branch (history), cfr. Thomason (1984).

[27] Given that we have assumed that no distinct branches share any of their events.

[28] The definition suffers from a problem with counterfactual evaluation, as pointed out in Belnap and Green (1994): 380. We shall not deal with this matter here. However, the ontology of possible worlds sketched in the next section below could be put at use to provide a semantic machinery apt to solve the problem.

According to the definition, in BTT, there is a difference between the case in which e_x lies in the past of the moment m we are considering for evaluation and the case in which e_x lies in its future. If e_x lies ahead of m, the situation is as before: we get an undetermined result insofar as we are not in the limiting case of linear time (unless e_x is on none of the branches and thus the proposition is false). But if e_x is in the past of m, then the situation is very similar to that in TRL: we always have a determined truth-value. In TRL, the situation is very similar to the previous one.

More complex cases (connectives and propositions about relations between events) are trickier to spell out, but we do not need to deal with them now, since we just want to give an idea of the semantic notions involved here. Let us then move to consider the cases that we regard as crucial, namely, those concerning attribution of same-branchness to couples of events. The idea is that the difference between BTT and TRL will show up when the instant of attribution and the moment of evaluation are not the same, but the former lies in the future of the latter. Firstly, consider the following claims, as evaluated with respect to a moment m:

1. At t_0, e_2 is on the same branch as e_m.
2. At t_0, e_1 is on the same branch as e_m.

Suppose that e_m is part of m and m is an element of t_0 and e_1 and e_2 are both ahead of e_m. In BTT, insofar as e_m is part of m and m is an element of t_0, both attributions come out true, since e_m is on the same branch with any other event it stands in a temporal relation to. But the same goes in the TRL model. Although we have a distinguished branch in such a model, when we *predicate* a relation of same-branchness between a present event and a future one, we are not in a position to distinguish the thin red line from any other branch, *if* the attribution is made with respect to the present too. Yet the situation changes when the attribution is made with respect to a future instant. Let us consider the following claims:

3. At t, e_2 is on the same branch as e_m.
4. At t, e_1 is on the same branch as e_m.

Suppose that e_m is an event that is part of m and e_1 and e_2 are both ahead of e_m and are parts of (distinct) moments that constitute t.

The instant t is thus future with respect to the moment m, and if we do not have a thin red line in our model, we cannot distinguish among the different moments that constitute t and are temporally connected to m. Therefore, in BTT, insofar as e_1 and e_2 are part of any moment constituting t, e_m is both on the same branch of e_1 and on the same branch of e_2 (although e_1 and e_2 are not on the same branch of each other – remember that same-branchness is not Euclidean – see Fig. 1). Thus, same-branchness attributions 1 and 2 are both true within BTT. The situation changes when we move to a TRL model. In this case, since the attribution is made with respect to an instant t that is future with respect to the time of evaluation, we have a way to tell the situation of e_2, which lies on the thin red line, from that of e_1 which does not. Remember that the evaluations of the attribution are sensitive to what

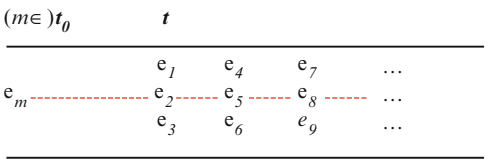

Fig. 1 Illustration of the predication of same-branchness between a present event and some future event, in a TRL model

events we find in the moment that constitutes the thin red line at the instant of attribution.

Here, then, we hit a genuine difference between the two theories.[29] It is not a difference in the very constituents of reality, but in the way our temporal model of reality allows us to assess, at the present time, what *will* be true. To put this into a single expression, we shall say that the exclusive relation among events on the thin red line is *fixed same-branchness*. For any events $e_1, \ldots, e_n$ on the thin red line, any instants t_1 and t_2, any tree T and any moment m on the thin red line, if it is true in T at m that

1. At t_1, $e_1, \ldots, e_n$ are on the same branch
   then, it is also true that in T at m,
2. At t_2, $e_1, \ldots, e_n$ are on the same branch.

Of course, this definition of the characteristic property of the thin red line entails that sentences about the future are closed by context, since it assume that it is possible to settle the truth-value of a sentence in a context with respect to a future point of evaluation 'already' at the time of the context. And this seems precisely what many-branch theories argue against. Belnap, for instance, claims that the context of use of a sentence does not provide enough parameters to determine the (classical) truth-value of it; in particular, it does not permit us to fix a unique history and thus a unique future branch:

> […] Unlike worlds, histories overlap, so that a single speech act will typically belong to many possible histories; and that is why the phrase '*the* history of the speech act' is impermissible. (Belnap et al. 2001: 152, see also Belnap and Green 1994: 378)

Thus, in our definition, the expression for the future moment would not pick up a parameter that can be used to settle the truth-value of what follows.

Yet notice, again, that we are not providing a semantics for tensed sentence here, but rather we are defining a property of a history (a maximal chain of moments) that, in our model of reality, distinguishes it from any other history at the same tree.

[29] It is noteworthy that the analysis does not depend on whether one adopts a tensed or a tenseless language. Indeed, 'e_1 will be on the same branch than e_2', when evaluated at t, is still F for TRL and *Ind* for BTT.

(Incidentally, that is why we speak of propositions as evaluated with respect to a time, and a world, rather than of utterance of sentences in a context – we consider all indexical completion from the context unproblematic with respect to *any* temporal parameter, whether future or past.) Remember that we are not assuming anything about any distinction between the past and the future, other than the topological asymmetry in the temporal relation, as in the very spirit of the standard formulation of BTT. Therefore, *any* moment in time is on the same footing as any other. There may thus be *semantic* reasons to deny that there are no matter of facts in the context of utterance concerning *the* future history to which a certain moment belong, but from a metaphysical point of view, we are legitimate to have a 'God's eye' view over the whole tree-world. The tree-world plus the thin red line is a model through which we aim at catching a certain picture of how reality is like.[30] From an epistemic point of view, we could never be in a situation of knowing what events will be on the red line (more realistically, we may know that certain events are more probable than others), but this does not thwart us from fleshing out a *metaphysical* notion. Hence, from *this* point of view – the God's eye – the notion of fixed same-branchness is well-defined and well behaving, and its use can be impinged by no *semantic* (or *epistemic*) argument.

This does not settle the issue in favour of the TRL once and for all, because there are still serious objections to it. In other words, the definition of the thin red line in term of fixed same- branchness is still a formal characterization of the model, which does not get us what we are after: a full-blooded metaphysical view. In particular, what is still unclear is what *makes it the case* that a certain branch is the thin red line, that is, that the relation among events on it is *fixed same-branchness*, and whether it is possible to answer this question while being coherent with other assumptions on the theory, such as the ontological indistinctness of the TRL with respect to other branches and in general the openness of the future. In the sequel, we will aim at acquiescing those further worries.

Branches, Possible Worlds and Determinacy

We are at this point ready to address questions regarding the different ways in which BTT and TRL express different forms of metaphysical possibility. Intuitively, each branch of a tree T represents a metaphysical possibility. But this should not be taken literally. As we stressed above, here we are not dealing with a usual notion of possibility: all T's branches are part of the same world and they exist in the same way. Here is, then, our first question: more exactly, what is the link between the branches of T and a standard (branchless) possible world?

[30] Even Belnap et al. (2001) clearly distinguish between the metaphysical picture and the semantic treatment of tensed sentences based on such picture.

The answer is quite straightforward. For each branch of a tree *T* and its 'trunk' (i.e. for each history), there is a branchless quasi-standard[31] possible world, which *maps* it. This is the world that contains exactly all and only the events on the trunk *and* the branch. To be more precise, a quasi-standard world (from now on, a world) is a structure $w = <E$, such that for any two events e_1 and e_2 included in *E*, either $e_1 > e_2$ or $e_2 > e_1$. Call *W* the class of all quasi-standard worlds.

Now, for any tree-world *T*, there corresponds a set of possible worlds *w*, which *maps T*. That is the set of worlds such that any branch of *T* is mapped by an element of *w*, and *w* contains only members that map a branch of *T*. Also, for any tree *T* containing a thin red line, there is an immediate correspondence between the thin red line and a world *W*. That is, to $T = <E, >, R >$ corresponds $w = <R$, Ð.

As we see it, the discussion surrounding BTT and TRL often rests on a confusion between three different kinds of necessity and determinacy. Having clarified the relation between standard possible worlds and trees in BTT and TRL, we are in a position to sort out these kinds, which we will put at use in the sequel:

(i) First, there is that notion of necessity corresponding to textbook possible-worlds semantics necessity, according to which *a proposition is necessary simpliciter when it is true in* w *for all the members of* W (the class of all worlds).

(ii) Second, there is necessity within a tree-world. Most trees do not contain all metaphysical possibilities, and yet there is a sense in which one could say that a certain proposition is necessary within that tree-world: this is the case when the proposition is true with respect to all the branches and the trunk. Thus, we say that *a proposition is necessary (with respect) to a tree-world T when it is true at every branch and the trunk in T or, alternatively, when it is true with respect to all worlds included in the set of worlds that maps T*. Coincidentally, this is what BTT theorists call *being determinate* of a proposition with respect to a tree.[32]

(iii) Finally, *a proposition is determined with respect to a branch when, at that branch, the proposition is either true or false*.

Clearly, necessity with respect to a tree and determinacy with respect to a branch are quite different from necessity simpliciter. Contingent claim, such as

3. Humphrey is elected president in 1968,

is not necessary in sense (i) even though they are determined with respect to a branch. Which is to say, at a quasi-standard world, (3) is determined, despite its

[31] We call such worlds 'quasi-standard' as they are defined in terms of their constituting events and the temporal relations between them, which of course is not the way they are defined in a textbook possible-worlds semantics.

[32] The notion of necessity with respect to a tree-world is defined formally; what does it boil down to on a more substantial level depends of course on how we construe the alternatives on the branches. If they are nomologic alternatives, then necessity with respect to a tree-world is physical necessity. An alternative is construing the branches as the metaphysical alternatives *at a time t*. We will thus have a notion of temporal necessity (parasitic on that of metaphysically possible at a time *t*) distinct both to physical necessity and necessity *simpliciter*.

being contingent. Note also that while BTT theorist speak of being *determinate* with respect to a tree, we speak of being *determined* with respect to a branch, in order to stress the fact that determinacy with respect to a branch is not a metaphysically loaded notion, while determinacy with respect to a tree is at least potentially so. For instance, if we construe the branches as metaphysical alternatives at a time, then a proposition is determinate at *t* if it is true on every branch of the tree, that is, if it is *metaphysically necessary with respect to a time t* (see note 28). And if we construe the branches as nomological alternative futures of *t*, then a proposition is determinate at *t* if it is true on every branch of the tree, that is, if it is *physically necessary with respect to a time t*. But independently on how we construe future alternatives, being determined with respect to one of these merely means possessing a 'traditional truth-value' (viz. true or false, but neither both, none of them nor some other) with respect to it.

Finally, (i)–(iii) are valid both in BTT and TRL. Within TRL, however, we can distinguish one more sense of determinacy – determinacy with respect to a tree, which can be defined as follows:

(iv) *A proposition is determined with respect to a tree T which contains a thin red line when, on the thin red line, that proposition is either fixedly true or fixedly false* (i.e. true or false with respect to each moment on the thin red line).[33]

Of course, that a proposition is determined with respect to a tree does not entail that it is necessary *simpliciter* nor that it is necessary at that tree (i.e. determinate with respect to that tree). For a proposition, being determined with respect to a tree (with a thin red line) is as metaphysically light as it is being determined with respect to a branch: it merely means possessing a traditional truth-value with respect to a (moment in) that tree.[34]

Brute Facts

In this section, we shall take stock of what we said so far and draw some conclusions regarding Belnap and Green's claim that TRL is – metaphysically speaking – ill-founded. First of all, does TRL compel to some form of determinism? We think it does not. On the one hand, TRL is compatible with the thesis that what future states the universe will be in is implied by what states it has been in; all you need to

[33] Although this sense of determinacy is not used in the rest of this chapter, it may come in handy when considering whether TRL can accommodate cases of backward causation. We believe that it can – contrary to Miller (2008, 2005) – although we shall not argue for this point here.

[34] The distinction that Von Wright (1984) makes between *truth* and *determinate truth* (see also Iacona this volume) corresponds to our distinction between *being determined with respect to a tree* and *being necessary (i.e. determinate) with respect to a tree*. According to Von Wright, a future-tensed proposition can be true without being determinately true, that is, it can be true at the present time without being true in *every* future alternative. This holds also in our picture.

do is to commit to interpreting all branches as mere representations of epistemic possibilities, while claiming that the thin red line also represents the only genuine possibility at that tree. (As we specified in the opening remarks, however, a determinist may hold that there are other trees where, because of different initial conditions, the thin red line lies on a branch other than the branch where it lies at the actual tree.) Yet, this is not to say that TRL entails determinism. Indeed, TRL is compatible with indeterminism too. After all, it maintains that true claims regarding the future do not need to be true with respect to every branch, that is, determinate with respect to that tree. But the relationship between TRL and determinism gets even more puzzling when we add that neither determinists nor indeterminists typically will invoke TRL to shape up their positions. You can have branches and still be a determinist, yet determinists do not need branches, as they can have a linear version of time. And while a branching time structure comes handy to many indeterminists, these would usually deny the existence of a thin red line.[35] Thus, you can have a thin red line and still be an indeterminist, but most indeterminists will not include thin red lines within their representations of temporal structures. Thus, TRL is somewhat puzzling: it is midway between determinism and indeterminism, being compatible with both and at the same time not a standard leeway to both. So, under which assumptions does TRL become an appealing position?

In our view, TRL is appealing to those who hold an *indeterminist view of natural laws* (plausibly along with a probabilistic conception of causation) *while at the same time not wanting to give up the idea that the future is not metaphysically distinct from the past and the present*. Given certain present conditions and a set of probabilistic natural laws applying to them, in most cases, there will be two or more alternative possible futures, each of which is assigned a certain probability of being the case. In this scenario, each branch represents one of the possible futures. However, the laws are compatible with the thesis that *only one* of the alternative possibilities will be the future: at present time, we have some genuine metaphysical alternatives, but we know that, at a future time, only one of them will be *the* future (of our world). Well, the thin red line helps sorting out all of this, as it clearly distinguishes between the evaluations of a proposition at present time from the evaluation that we can foresee it will receive at a future time.

But now the question arises: what makes it determined that only a certain future will hold, while many are genuinely possible at this time? In other words, what justifies us in positing the existence of the thin red line? It cannot be some metaphysical property of one of the branches that tell it apart from the other branches, because we said that all branches are actual and 'real' in the same way. Yet it cannot be the physical laws either, because otherwise TRL would not be compatible with indeterminism. Indeed, in the preferred reading, the branches stand for physically possible alternative futures, that is, those in such future states that are compatible with the present state, without being necessitated by it. Thus, indeterministic physical laws cannot ground a thin red line.

[35] An exception is McCall (1984).

Taking a different perspective, one could argue that, although physical laws do not logically entail the existence of a thin red line, they *motivate* TRL. Of course, such laws may induce to opposite upshots, but we find reasonable to ground TRL on them. Indeed, probabilistic theories force us to a particular conception of causality, which in turn requires (or at least is more 'tuned with') a branching view of time (space-time). According to the probabilistic conception, there may be (and often there are) more than one effect associated to a single cause. This is where the concept of indeterministic causation diverges from the deterministic one (and probably from the 'naïve' one too). However, the probabilistic conception does not diverge from the deterministic (and 'naïve') conception under another respect: no matter how many future effects are probabilistically associated with one cause, it will bring about only *one* effect. That is, probabilistic theories do not force us to maintain that one cause will follow more than one effect *in our world*.[36] And neither forces us to deny that it is now true (or false) that a certain future alternative will occur rather than another, insofar as this is not a consequence of the state of the universe up to the present plus the physical laws. For example, it is a matter of chance whether, at a future time *t*, an offspring *o* of individuals *a* and *b* will inherit *a*'s or *b*'s genetic make-up with respect to a specific *locus*. Still, it seems plausible to regard as true *now* that, at *t*, the locus will be filled with a specific make-up, and we could see this fact as implying (i) that, at present, there is more than one genuine alternative metaphysical possibility and (ii) that, at present, it is true that at a future time we will see the issue as settled, although at present we have no epistemic access as to how it is going to be settled. This is simply a consequence of the fact that our present spatiotemporal position is *not privileged* with respect to past or future ones. When described from a later temporal perspective, what looks as unsettled (given all, we can know of the past and the present) is indeed settled. The present truth of many future-tensed propositions is thus only a consequence of *what will occur*, which from a 'God's eye' point of view is as settled as what occurred. This is the intuition that the TRL wants to preserve and which is not at all in disparity with indeterminism: the future is not only as settled as the past; it is also as *contingently settled* as the past. Actually, thus, one could argue that indeterministic physical laws are best explained when we posit a thin red line.

Yet, of course, the issue is debatable. One man's reason is another man's *reductio*. One could rebut that the fact that physical laws are best explained when we posit a thin red line is a problem we should debug, not a virtue of the theory. Physical laws are merely compatible with a thin red line, and there is nothing in the world that can determine which among the possible histories *is* the thin red line. Hence, the postulation of a thin red line is at the end of the day groundless (Belnap et al. 2001: 169).

The last resort for a supporter of TRL is to go the hard way: the thin red line boils down to a *brute fact* about the world. Now, although brute facts may come off as metaphysically repugnant, they do not necessarily mean bad metaphysics and there

[36] Even if we accept a multiverse, in each single world one effect follows. See Lockwood (2005).

may be philosophers who are willing to accept an ungrounded thin red line.[37] After all, such facts do not seem to 'point' behind what is at the theorist's disposal – as Ted Sider has argued with respect to certain primitive properties – thereby ending up being scientifically unacceptable. We normally accept as a brute fact about the past that certain things rather than others have happened. If we ask 'what ground those facts?' *and* we are not determinist (or fatalist), all we can do is waive our hands in the air. But if the BTT theorist cannot be blamed for admitting brute facts concerning the past, then why should the TRL theorist be blamed for admitting brute facts concerning the whole of time? Any rationale for distinguishing the two cases seem to require that we resort to a difference between past and future that goes behind their different topological outline, which would be going behind the aims of BTT. In conclusion, the brute facts that seem at bottom to ground the thin red line are of a kind that *any* philosopher who is both eternalist and indeterminist is compelled (and usually willing) to accept. A BTT theorist who does not want to tangle with metaphysical differences between past and future should remember that she has little ground to accept such facts with respect to the past and present, but not with respect to the future. In an eternalist framework, the facts that ground the thin red line do not constitute a 'mysterious realm of facts'; indeed, what would be mysterious is a distinction between the past and the future of this sort.

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[37] See the paper by Iacona (this volume): 'Perhaps there is nothing in the structure of the world that determines a single possibility to be actual, yet this does not prevent that possibility from being actual' (p. 41).

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The Truth About the Past and the Future

Ned Markosian

Abstract This chapter is about The Truthmaker Problem for Presentism. I spell out a solution to the problem that involves appealing to indeterministic laws of nature and branching semantics for past- and future-tensed sentences. Then I discuss a potential glitch for this solution, and propose a way to get around that glitch. Finally, I consider some likely objections to the view offered here, as well as replies to those objections.

Introduction

This chapter is about The Truthmaker Problem for Presentism. Presentism is a version of The A-Theory of Time, according to which putative temporal properties such as *pastness, presentness*, and *futurity* (as well as their metric variants: *being-two-days-past, being-one-hour-future*, etc.) are genuine and unanalyzable properties whose exemplifications by times, events, and things is an objective, mind-independent feature of the world.[1] But according to Presentism, it is not merely that these putative properties are real. It is also that they have great ontological significance. For Presentism is the view that the only objects that exist at any given time are objects that are present at that time. That is, according to Presentism, the correct ontology of the world is subject to change over time, and is such that it never contains any object that lacks the property of being present. Thus, Socrates used to be included in the correct ontology, and you did not – but now you are in and Socrates is out.[2]

[1] For more on The A-Theory and its rival, The B-Theory, see Prior, *Past, Present and Future* and Markosian, "How Fast Does Time Pass?"

[2] For more on Presentism, see Markosian, "A Defense of Presentism."

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The Truthmaker Problem for Presentism begins with the popular idea that *truths* must have *truthmakers* – things or facts or whatever that make them true. This idea is then combined with the intuitive thought that there are lots of truths about the past and the future. For example, it seems clear that it is true now that there were once dinosaurs roaming the planet, and that there will one day be human outposts on Mars. The problem is that there do not seem to be enough truthmakers in the Presentist's ontology for all of these truths about the past and the future.[3]

In what follows, I will offer a "branching time" solution to this problem that strikes me as a very natural and simple one, even though it has not yet been defended in the literature. I will also discuss a potential glitch for this natural solution, and I'll try to show how the glitch can be fixed. Finally, I will discuss several objections to the solution that I am offering.

Presentism and Its Rivals

Even though Presentism is a version of The A-Theory of Time, it is possible to capture the dispute between Presentists and their rivals in a way that does not presuppose The A-Theory. All we need is a way to distinguish between objects that are present at a time (the way you are present right now) and objects that are not present at a time (the way Socrates is not present right now). But talk of an object's being present at a time need not be understood in terms of the A-Theorist's controversial property *presentness*. There is an alternative, B-Theory-friendly way to frame the issue, in terms of the two-place relation, *located at*, that an object or event can stand in to a time. Instead of saying that you now have the property of being present while Socrates does not, the B-Theorist can say that you are located at the current time, while Socrates is located only at certain earlier times. And since the relevant two-place relation, *located at*, is one that everyone (A-Theorists, B-Theorists, Presentists, and opponents of Presentism) should believe in, we can formulate Presentism and its main rivals in terms of this relation, in the following neutral way.

Presentism: What exists is liable to change over time. For any time, *t*, the objects that exist at *t* are all and only the objects that are located at *t*.

Eternalism: What exists does not change over time. The objects that exist at any time, *t*, include all the objects that are located at *t*, all the objects that are located at any time earlier than *t*, and all the objects that are located at any time later than *t*.

The Growing Block Theory: What exists is liable to change over time. For any time, *t*, the objects that exist at *t* are all and only the objects that are located either at *t* or at any time earlier than *t*.

[3] The Truthmaker Problem for Presentism is discussed (although not always by that name) by various writers. See, for example, Bigelow, "Presentism and Properties"; Sider, *Four-Dimensionalism*, pp. 35–42; and Keller, "Presentism and Truthmaking."

According to the Presentist, *temporal location* and *existence* are necessarily tied together. On this view, it is never the case that an object exists at a time without being located at that time.

The Eternalist, on the other hand, holds that temporal location and existence are not necessarily tied together. It is quite possible, according to Eternalism, for an object to exist at a time even though it is not located at that time, just as it is possible for an object to exist at a place without being located at that place. For the Eternalist, the correct ontology does not change from one time to the next, just as it does not change from spatial location to another.

Meanwhile, the proponent of The Growing Block Theory maintains that temporal location and existence are tied together, in a very specific way. In order to exist at a time, *t*, an object must be located either at *t* or at some time earlier than *t*. So according to this theory, the correct ontology does change over time, but always by addition, never by subtraction.

The Truthmaker Problem

So much for our formulations of Presentism and its main rivals. I now turn to a characterization of The Truthmaker Problem for Presentism. (The problem is primarily a problem for Presentism, although there is a version of it that applies to The Growing Block Theory. In order to keep the discussion here a bit more streamlined, however, I will focus only on the problem as it applies to Presentism.) The Truthmaker Problem concerns an apparent conflict between Presentism and a deservedly popular idea about the connection between what is true and what exists. One way to capture this idea is in terms of *supervenience*. We could say, for example, that *truth supervenes on being*, in the sense that any two worlds that differ with respect to what is true must also differ with respect to what exists (or else with respect to the pattern of instantiations of universals by what exists).[4]

Another way to capture the popular idea about the connection between what is true and what exists is in terms of the need for *truthmakers* for every truth, where truthmakers are the things[5] that make the relevant sentence or proposition true.[6] For example, if it is true that my shirt is blue, then the truthmakers for this truth include my shirt, the property of blueness, and (perhaps) the fact that the shirt is blue (that is, the shirt's instantiation of blueness). Here is one way to formulate such a principle.

[4] See, for example, Lewis, "Truthmaking and Difference-Making."

[5] Or perhaps the stuff.

[6] See, for example, Cameron, "Truthmakers."

The Truthmaker Principle: For every truth, p, there exist some things, x_1-x_n, such that p is true in virtue of the existence and arrangement of x_1-x_n.[7]

A side note on the metaphysics of truth: I happen to prefer to think about truth and truthmakers in terms of *propositions* (the things that are true) and *facts* (the instantiations of universals that are the truthmakers for true propositions). But in this chapter, I will leave that metaphysical background aside and instead talk in a neutral way about sentences and their truthmakers, without specifying what exactly those truthmakers must be like. But note that if pressed, I would spell out talk about truths and their truthmakers in terms of my preferred background metaphysics of propositions and facts.

It should be clear that there is at least an apparent conflict between Presentism and The Truthmaker Principle. To see why, consider the following sentences, both of which it would be natural to characterize as true right now.[8]

(1) There used to be dinosaurs.
(2) In 1,000 years, there will be human outposts on Mars.

The Eternalist can say that (1) is made true by the existence of some past dinosaurs. That is, the Eternalist can say that the currently correct ontology contains some dinosaurs, which are not located at the present time but are located at certain earlier times, and that these past dinosaurs are the truthmakers for the current truth of the proposition expressed by (1). Likewise, the Eternalist can say that (2) is made true by the existence of some future Martian outposts. That is, the Eternalist can say that the currently correct ontology contains some Martian outposts, which are not located at the present time but are located at certain later times, and that these future settlements are the truthmakers for the current truth of (2). But the Presentist cannot say anything like these things, because according to Presentism, the currently correct ontology contains neither past dinosaurs nor future Martian outposts.

Before we try to solve this problem, we should note that there is an important distinction between The Truthmaker Problem and another difficulty for Presentism, namely, The Problem of Singular Propositions About Non-present Objects. The latter problem concerns such sentences as 'Socrates was wise', which on the face of it express "singular propositions" about non-present objects – objects that do not appear in the Presentist's ontology.[9] I won't say anything else here about the latter problem (although I do attempt to solve it in the paper cited in the previous footnote), except to note that, since The Truthmaker Problem is meant to be a separate problem for the Presentist, we should consider it to be a problem that can be characterized in terms of purely general propositions.

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[7] I have included the word 'things' in this formulation of The Truthmaker Principle for stylistic reasons, but for a version of the principle that is neutral between a thing ontology and a stuff ontology, we could simply delete that word, while allowing our quantifiers to range over both things and stuffs.

[8] These examples are from Sider, *Four-Dimensionalism*.

[9] For more on The Problem of Singular Propositions About Non-present Objects, see Markosian, "A Defense of Presentism."

A Quasi-Deterministic Solution to The Truthmaker Problem

Let's start by considering some "easy" truths about the past and the future, which I believe can point the way toward a general solution to our problem. Here are some examples of what appear to be no-brainers.

(3) Five seconds ago, the moon was more than a mile from the earth.
(4) Five seconds from now, the moon will be more than a mile from the earth.

Notice, by the way, that there is no problem with the subjects of the relevant propositions not existing. For the moon, the earth, and the relation *more than a mile from* are all entities that exist right now. So let's assume that the relevant propositions exist and are in fact true right now. But what could *make* such propositions true, according to the Presentist?

I think it is very plausible to say that the truthmakers for both of these propositions include (i) the earth, (ii) the moon, (iii) their current arrangement, and (iv) the laws of nature governing these things. For the laws of nature are presumably deterministic enough to ensure that it is a consequence of those laws, together with the current arrangement of things, that the moon *was* over a mile from the earth 5 minutes ago; and, likewise, the laws of nature are presumably deterministic enough to ensure that it is a consequence of those laws of nature, together with the current arrangement of things, that the moon *will be* over a mile from the earth 5 minutes into the future. (We will shortly consider the possibility that the laws of nature and the current arrangement do *not* entail either that the moon was over a mile away from the earth 5 minutes ago or that the moon will be over a mile away from the earth 5 minutes from now.) Thus, on the assumption that the laws of nature are sufficiently deterministic in the relevant ways, it seems that there are enough things in the Presentist's ontology to serve as truthmakers for these easy truths.

But now suppose that similar remarks apply to our earlier examples:

(1) There used to be dinosaurs.
(2) In 1,000 years, there will be human outposts on Mars.

That is, suppose that the laws of nature are deterministic enough to entail (in conjunction with the current arrangement of things) that there used to be dinosaurs, and also that there will be human outposts on Mars in 1,000 years. Then there will be adequate truthmakers in the Presentist's ontology to make (1) and (2) both true right now. Moreover, on the supposition that the laws of nature are not sufficiently deterministic, in the relevant sense, then I think we should say that those sentences are false right now.[10]

[10] For similar proposals, at least with respect to future-tensed sentences, see Peirce, *Collected Papers of C.S. Peirce*, 5.459 and 6.368; Lukasiewicz, "On Determinism;" Prior, *Past, Present and Future*, Ch. VII; and Thomason, "Indeterminist Times and Truth-value Gaps."

This is the short version of my proposed solution to The Truthmaker Problem. If things now are such that it is a deterministic matter that there will be Martian outposts in 1,000 years, then I say let (2) be true now. Otherwise, I say, let (2) be false now. And similarly with sentences like (1). In this way, the truth about the past and the future will be determined by the way present things are right now, in accordance with Presentism and The Truthmaker Principle.

The long version of my solution involves giving a semantics for the account of the truth about the past and the future that I am proposing. In order to see how the relevant semantics will work, we first need to consider the standard semantics for tensed sentences. In order to do that, we'll assume the "tensed" conception of semantics, according to which the bearers of truth and falsity are to be assigned truth values at times, and also according to which the past and future tenses are ineliminable features of language.[11] (I take both components of this tensed conception of semantics to be required for Presentists and indeed for anyone who endorses The A-Theory of Time.)

In order to keep things simple, let's take sentences to be the bearers of truth and falsity, and let's deal only with general (as opposed to singular) sentences. Let's also assume that for every time, t, and every present-tensed, general sentence, ϕ, either ϕ is true at t or else ϕ is false at t. Whether ϕ is true or false at t will of course depend on the present-tensed facts at t. (Let *present-tensed facts* be facts involving only the intrinsic properties of, and relations among, present objects.)

We'll also need to have some tense operators in our language – sentential operators that correspond to 'it has been the case that', 'it will be the case that', and their metric variants. Here are some of the standard tense operators.

$P\phi$ = it has been the case that ϕ
$F\phi$ = it will be the case that ϕ
$P_n\phi$ = it has been the case n time units ago that ϕ
$F_n\phi$ = it will be the case in n time units that ϕ

What I have described so far is a system of tense logic of the type developed by the father of tense logic, Arthur Prior.[12] One crucial element of any model in the traditional semantics for such a system is a line consisting of points that represent moments of time. For each such point, p, and for each present-tensed sentence, ϕ, ϕ is assigned a truth value at p. Then the truth values of tensed sentences, like $F\phi$ and $F_3\phi$, are determined by truth conditions like the following.

$F\phi$ is true at p iff ϕ is true at some point to the right of p.
$F_3\phi$ is true at p iff ϕ is true at the point three units to the right of p.

[11] For a more detailed exposition of the tensed conception of semantics, see Markosian, "How Fast Does Time Pass?"

[12] See, for example, Prior, *Past, Present and Future*.

Fig. 1

Now we are in a position to appreciate the problem for the Presentist with the standard semantics for a system of tense logic. Let 'm' stand for the present-tensed sentence 'there are human outposts on Mars'. And let us assume that 'there are human outposts on Mars' is false right now but will be true in 1,000 years. Finally, consider a model that contains the line segment in Fig. 1 (with p_0 representing the present time).

On the standard semantics for tensed sentences, if '$F_{1,000}$ m' is true at p_0, as it is in our model, then this will be in virtue of the fact that 'm' is true at p_{1000}, the point 1,000 units to the right of p_0. But of course it is clear that if, in our model, 'm' is true at p_{1000}, then this is the case in virtue of Martian outposts that exist 1,000 years from now. In short, if sentence (2) is true right now, then, according to the standard semantics for tense logic, its truth is "grounded" by the existence of future Martian outposts. And it is equally clear that this is a problem for Presentists since we don't have any future Martian outposts in our ontology.

My proposed solution is to say that if (2) is true right now, then that is in virtue of the way present objects are right now. Here is a crucial assumption behind my solution:

Crucial Assumption: The totality of present-tensed facts at any given time is sufficient to determine a unique set of laws of nature that govern the world.

No doubt making this assumption will have some bearing on what we can and cannot say about the nature of the laws of nature. Personally, I like the so-called "Armstrong-Dretske-Tooley" account, according to which laws of nature are special relations among universals.[13] I think that this view of the laws will be one of the ones that is consistent with my proposed solution to the Truthmaker Problem. But if it is not, then I am willing to go looking elsewhere for an account of the laws of nature. In any case, we should note that my proposal comes with some commitments.

Now, either the laws of nature are deterministic or else they are not. If the laws are deterministic, then the line segment in Fig. 1 corresponds to the way things are in the actual world, and the current present-tensed facts are sufficient to determine that '$F_{1,000}$ m' is true (since in that case the present-tensed facts entail that there is only one nomically possible way things could be in 1,000 years).

Suppose on the other hand that the laws of nature are indeterministic. Then there are three further possibilities: either (a) every nomically possible future is such that it involves Martian outposts in 1,000 years, (b) some nomically possible futures

[13] See Armstrong, *What is a Law of Nature?*; Dretske, "Laws of Nature;" and Tooley, "The Nature of Laws."

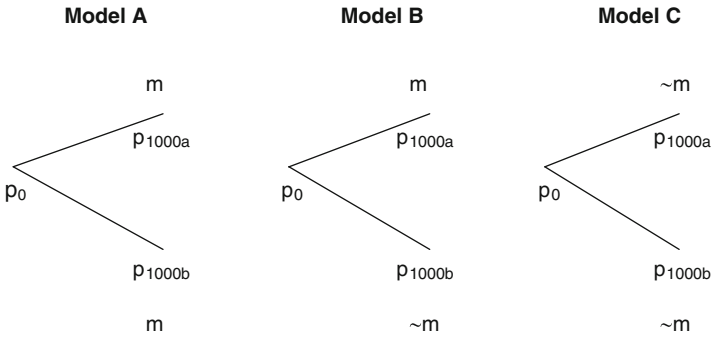


Fig. 2

involve Martian outposts in 1,000 years and some don't, or (c) every nomically possible future is such that it involves no Martian outposts in 1,000 years. These three possibilities can be captured by the simplified models in Fig. 2.

My proposal is that in Model A, '$F_{1,000}$m' should be true at p_0 since the totality of present-tensed facts at that point entails that every nomically possible future is such that there are Martian outposts 1,000 years after p_0. I also propose that in Model B, 'F_{1000}m' should be false at p_0 since it is not the case that the totality of present-tensed facts at that point entails that every nomically possible future is such that there are Martian outposts 1,000 years after p_0. (Note that an alternative way to go there would be to say that '$F_{1,000}$m' is neither true nor false at p_0. Personally, I prefer to say that "false" just means *not true*, rather than allowing truth-value gaps. But it should be clear that there is also available a truth-value-gap version of the proposal I am making.[14]) And finally, I propose that in Model C, 'F_{1000}m' should be false at p_0 (and in fact 'F_{1000}~m' should be true at p_0) since the totality of present-tensed facts at that point entails that every nomically possible future is such that it is not the case that there are Martian outposts 1,000 years after p_0.

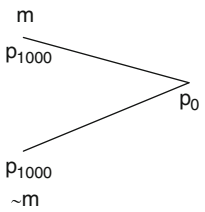
Notice that on my proposal, the possibility of indeterminism with respect to the past will force us to allow models with line segments that branch in the direction of the past as well as the future, as illustrated by Fig. 3.[15]

This may be taken by some to be a bad consequence of my proposal, but it is actually a consequence that I embrace. For on my view, if some sentence about the past is true, then it must be true in virtue of the way things are now. And I don't know what else besides current facts, including the laws of nature, could make such a sentence true now.

[14] For examples of such proposals, see Prior, *Past, Present and Future*, Ch. VII, and Thomason, "Indeterminist Time and Truth-value Gaps."

[15] For more on indeterminism with respect to the past and the idea of an open past, see Lukasiewicz, "On Determinism;" and Markosian, "The Open Past."

Fig. 3



A Potential Glitch

There are various objections to such a proposal, several of which I will discuss shortly. But first I want to talk about a certain potential glitch for the proposal. Consider a model that contains the line segment (with truth values for the present-tensed sentence ϕ) in Fig. 4.

The way I have so far characterized my proposal suggests that it should involve the following truth conditions.

$P_1\phi$ is true at p iff ϕ is true at every point one unit to the left of p.
$F_1\phi$ is true at p iff ϕ is true at every point one unit to the right of p.

But these truth conditions yield the result that in a model containing the above line segment, $P_1F_1\phi$ is false at p_{2b}, even though ϕ itself is true at that point. (The reason why $P_1F_1\phi$ will be false at p_{2b} is that not every point one unit left of p_{2b} is such that $F_1\phi$ is true at it. (In fact, neither one of the two points one unit left of p_{2b} has this feature.)) In other words, according to these truth conditions, even though ϕ is true at p_{2b}, it is not true at that point that it was the case one time unit ago that it will be the case one time unit hence that ϕ.

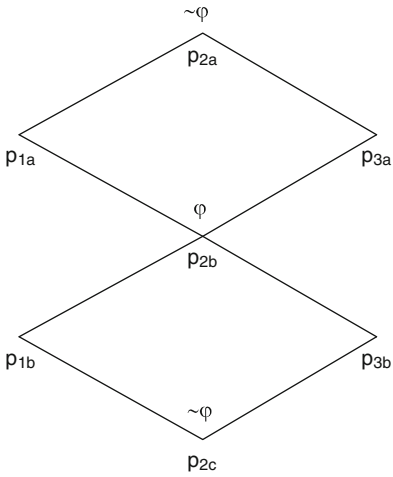
This strikes me as a very bad result. For even if we restrict our attention at p_{2b} to things that are present at that point, we will still find things in virtue of which $P_1F_1\phi$ should be true at that point, namely, whatever it is in virtue of which ϕ is true at that point.

A Solution

Luckily, there is a way to solve this problem. The solution involves giving truth conditions for tensed sentences that avoid this bad result. And the key to doing so is to give truth conditions for tensed sentences that incorporate the notion of a *route* through the line segment in any model.

Intuitively, a route is a possible course of history that is represented by a single, non-branching line that passes through the (possibly) branching line of the model, and that never "doubles back" on itself. So, for example, in the model represented by Fig. 4 below, there are exactly four routes that pass through point p_{2b}: (i) one that

Fig. 4



includes the points p_{1a}, p_{2b}, and p_{3a}; (ii) one that includes the points p_{1a}, p_{2b}, and p_{3b}; (iii) one that includes the points p_{1b}, p_{2b}, and p_{3a}; and (iv) one that includes the points p_{1b}, p_{2b}, and p_{3b}.

Then the idea will be that in working out the truth conditions for a tensed sentence at a point, we will take into account only those points that are on routes that pass through the first point (the point of evaluation). Moreover, if we are dealing with multiple tense operators, as in sentences like $P_1F_1\phi$, so that we have to move first backward and then forward along the line segment in our model, then we must be sure always to move forward on the same route we took to go back, and similarly always to move backward on the same route we took to go forward. The best way to ensure this is to introduce the notion of *truth on a route*.

Truth on a route can be defined in terms of regular truth for present-tensed sentences, as follows. (Recall that we are assuming that for each present-tensed sentence, ϕ, and each point, p, either ϕ is true at p or else ϕ is false at p. (Actually, what we assumed earlier was that for each time, t, and present-tensed sentence, ϕ, either ϕ is true at t or else ϕ is false at t. But now that we are dealing with branching line segments, the natural way to capture the same idea is to say that each present-tensed sentence has a truth value at each point.))

For any present-tensed sentence, ϕ, route, r, and point, p, such that p is on r, ϕ is *true-on-r* at p = df ϕ is true at p.

Then *truth on a route* can be defined for past- and future-tensed sentences in terms of *truth on a route* for present-tensed sentences. Here are some examples of how these definitions will go.

For any future-tensed sentence, $F\phi$, route, r, and point, p, such that p is on r, $F\phi$ is *true-on-r* at p = df ϕ is *true-on-r* at some point on r that is to the right of p.

For any future-tensed sentence, $F_1\phi$, route, r, and point, p, such that p is on r, $F_1\phi$ is *true-on-r* at p = df ϕ is *true-on-r* at the point on r one unit to the right of p.

Finally, we can make use of the notion of truth on a route in order to give truth conditions like the following for tensed sentences.

$F_1\phi$ is true at p iff for every route, r, through p, $F_1\phi$ is *true-on-r* at p.
$P\phi$ is true at p iff for every route, r, through p, $P\phi$ is *true-on-r* at p.

In fact, if we wanted to be super-efficient, we could give just one generic truth condition for all the tense operators:

For any tense operator, T, sentence, ϕ, and point, p, $T\phi$ is true at p iff for every route, r, through p, $T\phi$ is *true-on-r* at p.

These truth conditions will avoid the bad result mentioned above. That is, they will ensure that if ϕ is true at a point, p, then $P_1F_1\phi$ will also be true at that point. In fact, happily, these truth conditions will guarantee that for any sentence, ϕ, point, p, and number, n, if ϕ is true at p, then both $P_nF_n\phi$ and $F_nP_n\phi$ will also be true at p. (And similarly with various other, multiply tensed sentences of the relevant kind.)

Objections

There are at least three main objections that are likely to be raised against this proposal. The first objection has to do with the possibility of wildly indeterministic laws of nature.[16] Suppose, the objection goes, the laws of nature governing our world are wildly indeterministic with respect to the past. Suppose, in particular, that it is a consequence of quantum physics that there is a certain nonzero probability that all of the current particles in the universe sprang into existence, from nothing, a mere 5 minutes ago. Then on the proposal I am making, it is not true that you and I and the rest of the universe existed 5 minutes ago. Nor is it true that 5 minutes ago you were reading a paper on Presentism. But, it will be objected, these consequences sound absurd.

My reply to this objection is that I don't think the relevant consequences are so absurd. For I think Presentism is true, and I endorse the above principle about truth requiring truthmakers. So I don't see how there could be truths about the past that are not grounded in the way present things are. Put another way: If there were the kind of truths that the objector wants here, then they would be ungrounded truths, hanging in midair with nothing to support them. And that would be spooky. So I think the upshot is that if it turns out that the laws of nature are wildly indeterministic in the relevant way, then we do (and should) have a paucity of truths about the past.

[16] I am grateful to Peter Forrest for pressing this objection during a presentation of an earlier version of this material.

It is worth noting, however, that my earlier choice of bivalence over other alternatives is especially relevant here. Perhaps some people will find it much more palatable to invoke *degrees of truth* between 0 and 1, which will allow us to say, for example, that it is true to degree .99 that all the current particles (or at least many of them) have existed for more than 5 minutes. Similarly, this approach will allow us to say that it is true to degree .99 that you were reading a paper on Presentism 5 minutes ago, even in the imagined scenario.

The second objection that is likely to be raised against my proposal concerns what is sometimes called the "relevance constraint" on truthmakers, according to which the truthmaker(s) for a sentence must be whatever it is that the sentence is about.[17] Take for instance our first example:

(1) There used to be dinosaurs.

According to the objection, if (1) is true, then it must be made true by past dinosaurs, and not by present-day objects and current laws of nature.

My response to this objection is in two parts. Here is the first part. Sentence (1) is a past-tensed sentence with an existential quantifier inside the scope of a tense operator. So the sentence has this form:

(1a) It has been the case that there is an x such that x is a dinosaur.[18]

But notice that, grammatically speaking, the subject of (1a) is 'it.' (1a) says that *it* has been a certain way (namely, such that there are dinosaurs). And what is the referent of 'it' in this sentence? I don't think it is a bunch of past dinosaurs. I think it is *the world*.

Compare (1a) with this sentence:

(5) It's possible that there is a purple cow.

Most of us will want to say that (5) is true. But what are its truthmakers? There are two main views about the metaphysics of modality that are relevant here. The majority view (by, as it happens, an overwhelming majority) among contemporary metaphysicians is Modal Actualism, according to which (roughly) only actual objects exist, and talk of mere possibilia is to be understood in terms of such abstract objects as possible worlds (normally construed as maximal, consistent propositions) or qualitative properties.[19] On this view, the subject of a sentence like (5) is the actual world (together with its contents), and the truthmakers for this sentence are various actual objects, but never any non-actual objects.

The other main view about the metaphysics of modality is Modal Realism, according to which non-actual objects, like my numerous possible sisters, are just

[17] See, for example, Smith, "Truthmaker Realism;" and Merricks, *Truth and Ontology* (esp. p. 29). I am grateful to Andrea Borghini and Giuliano Torrengo for raising this objection.

[18] Or better still: (1b) It has been the case that there is an x and there is a y such that x and y are dinosaurs.

[19] See, for example, Plantinga, *The Nature of Necessity*.

as real as actual objects, like my four actual brothers.[20] On this view, the subject of (5) is the domain of all possible worlds, and the truthmakers for (5) are very real, albeit non-actual, purple cows.

Now, should we think that the Modal Actualist is in trouble because her view violates the relevance constraint on truthmakers, insofar as the truthmakers for (5) do not include any purple cows? I think the answer is clearly *No*. Unless the minority position – Modal Realism – is correct, we should be happy to say that the subject of (5) is 'it,' which refers to *the world*, and that it is the world and its contents that make (5) true. Meanwhile, as has often been emphasized,[21] Presentism is analogous to Modal Actualism, while its main rival, Eternalism, is analogous to Modal Realism. Given these facts, I think it is extremely natural and plausible for the Presentist to say that the truthmakers for (1) and (1a) are the present world and its contents (rather than any past dinosaurs), as suggested above.

I mentioned earlier that my response to the relevance-constraint objection came in two parts. The second part is simpler and shorter than the first part. It consists merely of the observation that if my opponent is going to insist that the truthmakers for (1) and (1a) must be whatever it is that those sentences are about, and also that the sentences in question are about non-present dinosaurs, and if I am going to go along with these claims, then, well, I'm not a very good proponent of my position. In short, the relevance-constraint objection to my solution to The Truthmaker Problem for Presentism ought not to convince anyone who is already committed to Presentism, since it requires a combination of claims that no self-respecting Presentist should accept.

The third main objection that is likely to be raised against my proposed solution to The Truthmaker Problem concerns a consequence of the semantics I have offered for tensed sentences that I went to a lot of trouble to secure, namely, that if ϕ is true at some point, then $P_1F_1\phi$ is also true at that point. The objection could be made by someone giving the following speech.[22]

> Okay, you have convinced me that the only way a future-tensed sentence like 'It will be the case in one day that it is raining' could be true at a time is if it is a deterministic matter at that time that it will be raining in one day. So suppose that things are in fact indeterministic enough on Tuesday to ensure that this future-tensed sentence is not true, on your view. That is, suppose that on Tuesday, the following day's weather is still "up in the air." So far so good. But then suppose that Wednesday rolls around, and sure enough it rains. Then on your view, the sentence 'It was the case one day ago that it will be the case one day hence that it is raining' is true on Wednesday. But that seems to go against the intuition that you originally appealed to, according to which it was not true on Tuesday that it was going to be the case that it is raining on Wednesday. It's as if Wednesday's rain has all of a sudden washed away the previous day's indeterminism!

Here is my reply. We must distinguish between two similar but importantly different things that could be said on Wednesday. The first is "It was the case one day ago that it will be the case one day hence that it is raining." This is an object-language

[20] See, for example, Lewis, *On the Plurality of Worlds*.

[21] See, for example, Markosian, "A Defense of Presentism."

[22] I am grateful to Ted Sider for raising this objection in conversation.

utterance with iterated tense operators, and it is true on Wednesday in the imagined scenario, according to the semantics I am proposing for tensed sentences. And the reason this sentence is true on Wednesday, despite the fact that things were still up in the air on Tuesday, is that Wednesday's falling rain is truthmaker enough to make it true.

Meanwhile, the second thing that could be said on Wednesday is "The sentence 'It will be the case in one day that it is raining' was not true yesterday." This is a meta-language utterance concerning the truth value of a particular tensed sentence on Tuesday, and it is also true. And the reason this meta-language sentence is true on Wednesday, despite the concurrent truth of the object-language sentence mentioned in the previous paragraph, is that on Wednesday, things are such that it was not a deterministic matter one day earlier that it would be raining.

Because these two things that can both be said on Wednesday are different claims, in different languages, concerning different topics, the truth of the latter claim (the meta-language one) does not undermine the truth of the former claim (the object-language one).[23] Wednesday's rain guarantees the truth of the claim that it was going to rain, but it does not thereby wash away the previous day's indeterminism. All is well.

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[23] It is worth noting, however, that in making this reply to the objection, I am committing myself to a rejection of the principle that if $P_1F_1\phi$ is true at a point, *p*, then $F_1\phi$ must also be true at every point one unit to the left of *p*. But the rejection of such "disquotation-like" principles was already built into the semantics for tensed sentences being offered here.

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Non-proxy Reductions of Eternalist Discourse

Fabrice Correia

Abstract Eternalists believe that there are past things and future things which are not present. In contrast, presentists hold that only present objects exist. In this chapter, I discuss presentist reductions of eternalist discourse which do not involve quantification over proxies—i.e. presentistically acceptable surrogates for merely past and merely future entities.

Introduction

Say that an object is *merely past* if it is past but not present, i.e. if it was present but is not so anymore, and that an object is *merely future* if it is future but not present, i.e. if it will be present but is not yet so.[1] *Presentists* hold that everything—absolutely everything—is present, i.e. that there are no merely past or future objects. *Eternalists* deny it; they hold that there are objects which are merely past and others which are merely future.[2] They are willing to claim, for instance, that there are things which

[1] There is an issue about how, in the present context, the notion of being present is to be understood. My own take on the issue involves a tensed notion of existence, and runs simply as follows: for an object to be present is for it to exist. I will have that account in mind, but accepting other accounts would not affect the points made in this chapter. Notice that I will assume that all the views discussed in this chapter agree that there are present things.

[2] Eternalism is not the only alternative to presentism. The so-called *growing block theorists*, for instance, agree with the eternalists that there are merely past objects but deny that there are merely future ones. The growing block theory is quite unpopular, and other alternatives to presentism and eternalism are implausible. Although my focus in this chapter will exclusively be on the divide between presentists and eternalists, it will be somewhat obvious how the discussion could be extended to other views on temporal ontology.

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were born in year 1800 which are no longer present and that there are things which will be born in year 2100 but which are not yet present. What are presentists to make of such claims?

Of course, *qua* presentists, they must say that these claims, *literally understood*, are false. Yet, pre-theoretically, we would naturally take them—at any rate, some of them—to be true. Leaving aside the fact that the use of 'there are things' to quantify over inhabitants of this world which are capable of having a birth may sound odd to the layman, this is arguably the case of the two examples just given. Some presentists may simply ignore that pre-theoretic attitude. But some will hold that the claims in question—at any rate, some of them—are in fact true, although they have to be understood in some nonliteral way. These presentists face the task of 'reducing' talk of merely past and future objects, i.e. of proposing appropriate translations or paraphrases of the relevant quantified claims which can be taken to be true on the background assumption that presentism holds.

Such paraphrases can be of two sorts. Using Kit Fine's (2005) terminology, they can be *proxy* or *non-proxy*. Proxy paraphrasing translates alleged quantification over non-present things into quantification over presentistically acceptable proxies or surrogates—*Ersatzen*, as David Lewis calls them. Non-proxy paraphrasing translates the target claims but without invoking proxies. Many objections have been raised against the viability of actualist proxy reduction of talk of mere possibilia,[3] and many of them carry over the possibility of proxy reduction of the non-present which concerns us here. I find these objections serious, and accordingly I think presentists who want to reduce eternalist discourse should seriously consider non-proxy reduction.

Some studies (Fine 1985, 2005; Forbes 1989; Correia 2007) have been (at least partly) dedicated to non-proxy reduction of possibilist discourse. Three methods of paraphrase can be found there, the *Peacockean*, the *Vlachian*, and the *Finean* methods, as I will call them. In contrast, the literature on non-proxy reduction of eternalist discourse is quasi nonexistent (the only publication on the topic I know of is Correia 2009). In some cases (see sections "Linear Time: The Peacockean and the Vlachian Methods" and "Linear Time: The Finean Method" below), the three methods of translation just mentioned can be applied to the case of eternalist discourse in a relatively straightforward way, whereas in some other cases (see section "Branching Time"), some nonobvious modifications are required. This chapter is a discussion of these methods in the temporal context and of a new method I call the *metric* method, which, unlike the others, is not applicable to the case of possibilist discourse.

I take the metric method to be of great interest, because, as I will argue, it escapes certain difficulties met by the other three methods. However, this chapter is not a wholehearted defence of that method against the others, for, as I will stress, unlike the latter methods, the metric method does not deliver what we want given certain (debatable, but nevertheless not implausible) assumptions about eternalist

[3] See Fine (2005) for a recent example.

quantification and the logic of tense. The aim of this chapter is rather to discuss the scope and relative merits of various techniques of non-proxy paraphrasing which can be used in the present context and indirectly to advertise such techniques—which I think is worth doing since, strangely enough, the three techniques already used and discussed in the literature are widely ignored by the philosophers who work on the philosophy of time or modality.[4]

The scope of such a study is bound to be limited. Let me here mention three limitations of this chapter.

1. The primary targets of non-proxy reduction are sentences of a language, e.g. English, which can reasonably be taken to be true by eternalists and which entail the existence of something which is not present. As we shall see, the adequacy of a method of paraphrase is highly sensitive to the class of sentences it is applied to. Any study of the present kind must focus on restricted classes of sentences (which should nevertheless be expressively rich enough to be of interest). I will assume that the target of presentist reduction is certain interpreted first-order tense-logical formal languages, leaving aside many other languages, e.g. languages with further tense-logical operators and higher-order languages.
2. I will assume that the tense logic for the languages to be considered, be it the logic accepted by eternalists or the one endorsed by presentists, can be characterized by some standard Kripke-style semantics.[5] This is an assumption I take to be fairly weak, and in any case, it is one that many, in both camps, are happy to accept.
3. The adequacy of a method of paraphrase may turn on which conception of the structure of time in the relevant Kripke models is countenanced. I will only take into consideration two such conceptions: the conception of time as linear and the conception of time as branching towards the future but linear towards the past. This is a limitation, but not a very drastic one since many philosophers endorse one or the other. And, in any case, it will be somewhat obvious how the discussion would go if certain other conceptions were taken into account.

The plan of the chapter is as follows. In section “Adequate Translations”, I elaborate on what I take adequate presentist translations of possibilist talk to be. In section “The Target Language, Its Semantics and the Corresponding Logics”, I present the language I take to be the target of the presentist translations, as well as semantic and logical material relative to that language. In the three sections that follow, I discuss the four methods of translation under the assumption that the logic for the target language is determined by linear models. And finally in section “Branching Time”, I discuss these same methods under the alternative assumption that the logic of that language is determined by branching time models.

[4] Sider (2006) provides a striking recent example.

[5] On Kripke-style semantics for tensed languages one may consult, e.g. Burgess (2002) and Hodkinson and Reynolds (2006).

Adequate Translations

I will take the target of reduction of eternalist discourse to be the quantified tense-logical language L defined in the next section, and I will take it that the task of the presentists I am interested in here is to provide adequate non-proxy translations of the sentences of L into some language, L itself or another language, which we may call the *home language*.

There are several eternalist views as to what the correct logic for L is, and likewise there is potential disagreement amongst presentists about the logic of a candidate home language. The home languages of the translation functions to be discussed below are all extensions of L, and they exploit the tense-logical operators and the existential quantifier. Accordingly, there is no reason to expect that a translation function will be adequate whatever the eternalist view on the logic for L and the presentist view on the logic of the home language.

I will take the following as a constraint on adequacy:

Logicality constraint. Given an eternalist view about the logic for L and a presentist view about the logic for a language L', for a translation function from L into L' to be adequate, the following condition should hold: for every sentence ϕ of L, ϕ is deemed to be logically true according to the eternalist view iff ϕ's translation is deemed logically true according to the presentist view.

This constraint is quite strong, and some might take them to be too demanding. I do not want to discuss this point here. As we will see, however, the methods of translation to be discussed fare rather well with respect to the constraint.

The fulfilment of the logicality constraint is certainly not sufficient for adequacy. The point of reducing eternalist discourse is to 'approximate' talk of merely past and future objects in terms acceptable to presentists. An adequate translation function should be such that what, according to the eternalist, the quantifier performs in a given sentence ϕ is 'mimicked' by syntactic elements in ϕ's translation: what our presentist aims at is defining pseudo-quantifiers over merely past and merely future objects. It is hard to come by with a rigorous characterization of that aspect of adequacy, and I have none to offer here. Yet hopefully what has been said will be enough for present purposes.

The Target Language, Its Semantics and the Corresponding Logics

I take the target of presentist non-proxy reduction to be an interpreted first-order tense-logical language L, with primitive truth-functional connectives $\neg$ (negation) and $\vee$ (disjunction), primitive quantifier $\exists$ (absolutely unrestricted existential quantification), and primitive tense-logical operators P (for 'sometimes in the past'), F (for 'sometimes in the future') and N (for the non-redundant 'now'[6]).

[6] See Prior (2003).

We assume that L's vocabulary comprises the identity predicate $=$, as well as the predicate Pres for presentness (and the predicates I will use in examples of sentences of L).[7]

Conjunction ($\wedge$), material implication ($\supset$), material equivalence ($\equiv$), and absolutely unrestricted universal quantification ($\forall$) are defined in a standard way in terms of the chosen primitive vocabulary. H (for 'always in the past'), G (for 'always in the future'), A (for 'always') and S (for 'sometimes') are defined as follows:

- $H\phi := \neg P\neg\phi$.
- $G\phi := \neg F\neg\phi$.
- $A\phi := H\phi \wedge \phi \wedge G\phi$.
- $S\phi := \neg A\neg\phi$.

Standard notational conventions will be followed throughout, and standard syntactical notions will be assumed to be known.

We define a *frame* as a tuple $\langle T, <\rangle$, where

- T (times) is a non-empty set
- $<$ (temporal precedence) an asymmetric, transitive relation on T

A *model* for L is then defined as a tuple $\langle \pi, T, <, D, I\rangle$, where

- $\langle T, <\rangle$ is a frame
- π (the present time) a member of T
- D (domain) a function taking each $t \in T$ into a set D_t (the domain of t), such that $\bigcup_{t \in T} D_t \neq \varnothing$
- I (interpretation) a function which takes each n-place predicate and member of T into a set of n-tuples of members of $\bigcup_{t \in T} D_t$, with the condition that (1) $I(=, t)$ is always the set of all $\langle d, d\rangle$ such that $d \in \bigcup_{t \in T} D_t$, and (2) $I(\text{Pres}, t)$ is D_t for all $t \in T$

Relative to a model, an *assignment* (to the variables) is a function which takes every variable of L into a member of the union of all the time domains of that model. If ρ is such a function, x a variable of L and d an element of the union of all the time domains of the model, $\rho^{x \to d}$ is ρ itself if $\rho(x) = d$, and the assignment just like ρ except that it assigns d to x otherwise.

Up to section "Branching Time", I will focus on eternalists and presentist positions which assume that the logic for L is a logic characterized by Kripke models whose temporal precedence relation is linear. I here present the corresponding semantics, leaving the alternative conception of the logic as characterized by models whose precedence relation is branching for section "Branching Time".

We define a *linear frame* as a frame $\langle T, <\rangle$ such that

- For all $t, t' \in T$, either $t < t'$, or $t = t'$, or $t' < t$.

A *linear model* for L is a model $\langle \pi, T, <, D, I\rangle$ where $\langle T, <\rangle$ is a linear frame.

[7] For the sake of simplicity, L's vocabulary is supposed not to comprise individual constants.

Given the divide on temporal ontology which is the focus of this chapter, we need to define two notions of truth in a linear model, an eternalist notion (*e-truth*) and a presentist notion (*p-truth*). *e*-truth at a time $t \in T$ in a linear model $M = \langle \pi, T, <, D, I \rangle$ relative to assignment ρ is defined recursively as follows:

1. $M, \rho, t \models^e \varphi(x_1 \ldots x_n)$ iff $\langle \rho(x_1), \ldots, \rho(x_n) \rangle \in I(\varphi, t)$.
2. $M, \rho, t \models^e \neg\phi$ iff $M, \rho, t \not\models^e \phi$.
3. $M, \rho, t \models^e \phi \vee \psi$ iff $M, \rho, t \models^e \phi$ or $M, \rho, t \models^e \psi$.
4. $M, \rho, t \models^e \exists x \phi$ iff for some $d \in \bigcup_{t \in T} D_t$, $M, \rho^{x \to d}, t \models^e \phi$.
5. $M, \rho, t \models^e P\phi$ iff for some $t' \in T$ such that $t' < t$, $M, \rho, t' \models^e \phi$.
6. $M, \rho, t \models^e F\phi$ iff for some $t' \in T$ such that $t < t'$, $M, \rho, t' \models^e \phi$.
7. $M, \rho, t \models^e N\phi$ iff $M, \rho, \pi \models^e \phi$.

p-truth at *t* in *M* relative to ρ is defined in just the same way, except that the truth clause for the quantifier is replaced by

4′. $M, \rho, t \models^p \exists x \phi$ iff for some $d \in D_t$, $M, \rho^{x \to d}, t \models^p \phi$.

A sentence—i.e. a closed formula—of *L* is said to be *e*-true (*p*-true) in linear model *M* iff it is *e*-true (*p*-true) at the present time of the model (relative to any assignment we like).

So far for the basic semantic apparatus. Where $\mathfrak{M}$ is a class of models, we shall call the set of all sentences of *L* which are *e*-true in all members of $\mathfrak{M}$ *the logic e-determined by* $\mathfrak{M}$, and the set of those which are *p*-true in all members of $\mathfrak{M}$ *the logic p-determined by* $\mathfrak{M}$. Throughout the next three sections, I will focus on eternalists who take the logic for *L* to be the logic *e*-determined by so me class of linear models and presentists who take it to be the logic *p*-determined by some such class of models.[8]

Linear Time: The Peacockean and the Vlachian Methods

Eternalists claim that there are objects which are past but not present, i.e. that

1. $\exists x(P\text{Pres}(x) \wedge \neg\text{Pres}(x))$.

[8] *e*-truth in a model *M* need not depart from *p*-truth in *M*: the two notions are coextensive if the time domains of *M* are all the same. If that condition on *M* is satisfied, I shall say that *M* is *flat*. An eternalist cannot hold the view that the logic for *L* is the logic *e*-determined by some class of models which are all flat. For the sentence $\forall x\text{Pres}(x)$, which is deemed false by eternalists, is *e*-true in any flat model and so belongs to the logic *e*-determined by any class of such models. A presentist can in principle take the logic for *L* to be the logic *e*-determined by some class of flat models, but the resulting view is problematic. For the sentence $\forall xA\text{Pres}(x)$ is *p*-true in any flat model and thus belongs to the logic *p*-determined by any class of such models. Yet the view that this sentence is true is very implausible: surely, I was not yet present a 100 years ago, and I will not be present anymore a 100 years hence. (The presentist view I deem problematic is a temporal version of the 'new actualist' position defended by Linsky and Zalta (1994), which I find equally problematic.) It will accordingly be (tacitly) assumed that the classes of linear models at stake here comprise at least some non-flat models, and the same will go for the classes of branching models presented in section "Branching Time".

There is a natural suggestion for a paraphrase which a presentist may put forward, which does not use expressive resources foreign to *L* itself. The idea is to translate (1) into

2. $P\,\exists x N\,\neg\mathrm{Pres}(x)$,

i.e. 'there was something (present) which now is not present'. For the presentist, the complex expression $P\exists x$ acts like a quantifier over past objects, and *N* forces the predication to be evaluated at the time at which (2) as a whole is evaluated.

The foregoing considerations suggest a general translation procedure which runs as follows:

Take ϕ in *L*.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by $S\exists xN\psi$.

For the presentist, in a formula of type $S\exists xN\phi$ the expression $S\exists x$ acts like a quantifier over past, present and future objects, and *N* forces ϕ to be evaluated at the time at which $S\exists xN\phi$ as a whole is evaluated.

The proposed translation scheme is simple and elegant, but it is very easy to see that it does not deliver adequate results in all cases (which is why I did not give it a name). For take the sentence

3. $P\exists x(x \text{ is walking on the moon} \wedge N(x \text{ is not walking on the Moon}))$.

Granted that Neil Armstrong was walking on the moon sometimes in 1969 and is not doing it now, everyone—eternalists and presentists alike—must take (3) to be true. Arguably, a presentist should then be able to take its translation to be true. But by the proposed translation scheme, (3) translates into

4. $PS\exists xN(x \text{ is walking on the Moon} \wedge N(x \text{ is not walking on the Moon}))$,

and on any reasonable tense logic, (4) cannot be true. For on any such logic, (4) is indeed equivalent to

5. $PS\exists xN(x \text{ is walking on the Moon} \wedge x \text{ is not walking on the Moon})$,

and (5) is a claim to the effect that sometimes in the past, either there was even more in the past, or there was then, or there would be, something such that now, a certain contradiction about that thing is true.

The problem, informally speaking, is that when (4) is evaluated at the present time, *N* points to that time, whereas in order for the translation to be correct it would have to 'follow' the temporal shift induced by the occurrence of *P*.

One way of getting things right invokes the temporal analogues of the indexing device introduced in Peacocke (1978) for the modal and the actuality operators and discussed in Forbes (1989, p. 87ff) and Correia (2007) in the context of non-proxy reduction of possibilist discourse. The idea is to index the tense-logical operators *P*, *F* and *N*, say by means of the numerals '1', '2', …, and to interpret an occurrence of the indexed presentness operator N_i as 'following' the temporal shift induced by the occurrence of P_i or F_i under certain syntactic conditions.

Let us be more precise. Languages containing these indexed operators can be given a Kripke-style model theory akin to the model theory for L presented above. In order to define a translation function for sentences of L, only one index is actually needed. Let then L^P be the language resulting from L by adding the operators P_1, F_1 and N_1. A linear model for L^P is simply a linear model of the sort at work in the semantics for L. The notion of truth for L^P is not just a notion of truth at a time of evaluation in a linear model relative to an assignment to the variables. An extra parameter—a second time, which we may call the *stored time*—is involved, which is acted upon by P_1 and F_1. As in the case of L, two notions of truth, one for eternalists and one for presentists, can be defined, but here we concentrate on the latter notion since L^P is to be used as the language into which the translation is to be carried out. Using '$M, \rho, u, t \models^p \phi$' for '$\phi$ is p-true at time of evaluation t given stored time u in linear model M relative to assignment ρ', the truth clauses for the indexed operators run as follows (T is M's set of times and $<$ its precedence relation):

- $M, \rho, u, t \models^p P_1\phi$ iff for some $t' \in T$ such that $t' < t$, $M, \rho, t', t' \models^p \phi$.
- $M, \rho, u, t \models^p F_1\phi$ iff for some $t' \in T$ such that $t < t'$, $M, \rho, t', t' \models^p \phi$.
- $M, \rho, u, t \models^p N_1\phi$ iff $M, \rho, u, u \models^p \phi$.

The other truth clauses are like those of the definition of p-truth for L. A sentence of ϕ of L^P is then said to be *p-true* in a linear model M whose present time is π iff ϕ is true at time of evaluation π given stored time π in M (relative to any assignment we like).

Thus, the effect of P_1 and F_1 is twofold: (1) they shift the time of evaluation, in the same way as P and F, respectively, and, (2) unlike what happens with P and F, this shift is 'recorded' in the stored time position. What N_1 does is simply make the stored time the time of evaluation. Given this behaviour of the indexed operators, the following translation procedure suggests itself:

The Peacockean translation procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of applying the following procedure to each occurrence o of a sub-formula of type $\exists x\psi$ in ϕ:
   (a) If o is not within the scope of an occurrence of P or F, replace o by $S\exists xN\psi$.
   (b) If o is within the scope of an occurrence of P or F, replace o by $S\exists xN_1\psi$ and replace the occurrence of P or F which immediately governs o by its indexed counterpart (if this has not yet been done).[9]

[9] The reason for the bracketed qualification stems from the fact that more than one occurrence of a quantifier may be immediately governed by a tense-logical operator. Thus consider the formula $FP\exists x\exists y\phi$. Applying the procedure to $\exists x$ yields $FP_1S\exists xN_1\exists y\phi$. Since P has already been replaced by P_1, applying the procedure to $\exists y$ consists only in replacing $\exists y\phi$ by $S\exists yN_1\phi$, which yields $FP_1S\exists xN_1S\exists yN_1\phi$.

(An occurrence o' of P or F immediately governs an occurrence o of $\exists x\psi$ iff o is within the scope of o', and there is no occurrence o'' of P or F such that o is within the scope of o'' and o'' within the scope of o'.)

The proposed translation scheme eschews the kind of difficulty met by the previous one. By the new scheme, (3) translates into

(4′) $P_1 S \exists x N_1$(x is walking on the Moon $\wedge N \neg$(x is walking on the Moon)),

which is certainly not problematic in the way (4) was. N_1 is bound by P_1, while N is not: it points to the time at which (4′) as a whole is evaluated.

It can be shown that

Proposition 1. *Given any linear model M and sentence ϕ of L, ϕ is e-true in M iff ϕ's Peacockean translation is p-true in M.*

As a result, given any class of linear models $\mathfrak{M}$, and any sentence ϕ of L, ϕ belongs to the logic e-determined by $\mathfrak{M}$ iff ϕ's translation belongs to the logic p-determined by $\mathfrak{M}$. Therefore, the proposed translation function satisfies the logicality constraint on adequacy, granted an eternalist view of the logic for L as the logic e-determined by some class of linear models and a presentist view of the logic for L^P as the logic p-determined by the same class.

Before going further, let me present an alternative method—the *Vlachian* method, as I called it—which is in some important respects similar to the Peacockean method.

The new method makes use of two operators $\uparrow$ and $\downarrow$ introduced in Vlach (1973)[10] to formalize certain sentences containing the expressions 'once' and 'then' in their temporal senses and is the temporal counterpart of the method discussed in Forbes (1989, pp. 27ff) and Correia (2007) in the context of the reduction of possibilist discourse.[11] Both $\uparrow$ and $\downarrow$ are unary sentential operators and can be given a bi-dimensional semantics exactly like the one presented above for the Peacockean indexed operators but with the following truth clauses for Vlach's operators:

- $M, \rho, u, t \models^p \uparrow\phi$ iff $M, \rho, t, t \models^p \phi$.
- $M, \rho, u, t \models^p \downarrow\phi$ iff $M, \rho, u, u \models^p \phi$.

Thus, the effect of $\uparrow$ is to store the time of evaluation and that of $\downarrow$ is to make the stored time the time of evaluation.

It is clear from the proposed semantics for the Peacockean and the Vlachian operators that the former are definable in terms of the latter together with P and F: P_1 is definable as $P\uparrow$, F_1 as $F\uparrow$ and N_1 simply as $\downarrow$. Therefore, the Peacockean translation scheme immediately yields an equivalent translation scheme from L to the language L^V obtained from L by adding $\uparrow$ and $\downarrow$. But there is a simpler translation scheme from L to L^V, and it is that scheme I dubbed Vlachian. It is defined by the following procedure:

[10] Vlach uses instead K and R, respectively.

[11] Fine (1977) mainly deals with (proxy) reduction of possibilist languages which are extensional, i.e. which do not contain modal operators but rather quantifiers intended to range over merely possible worlds, but he nevertheless mentions the Vlachian method of reduction of modal languages on page 144.

The Vlachian Translation Procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by $\uparrow S\exists x\downarrow\psi$.

The scheme is indeed simpler, because here we do not have to treat occurrences of type $\exists x$ in a different manner according to whether or not they are within the scope of an occurrence of P or F. Notice that the Vlachian scheme is syntactically different from the Peacockean scheme, but these two schemes are equivalent from the point of view of the formal semantics, in the sense that for every sentence ϕ of L and every linear model M, ϕ's Vlachian translation is p-true in M iff ϕ's Peacockean translation is. Consequently,

Proposition 2. *Given any linear model M and sentence ϕ of L, ϕ is e-true in M iff ϕ's Vlachian translation is p-true in M,*

and as a consequence, the Vlachian translation function also satisfies the logicality constraint on adequacy given an eternalist view of the logic for L as the logic e-determined by some class of linear models and a presentist view of the logic for L^V as the logic p-determined by the same class.

Both the Peacockean and the Vlachian methods of translation appear to be promising. Yet, one might argue, presentists who want to use these methods face a serious difficulty. The argument for the case of the Peacockean method runs as follows[12]:

All we have so far by way of an explanation of the meaning of the sentences of the Peacockean language L^P is the model-theoretic characterization presented above. But that model-theory is a purely formal theory, where the 'times' it invokes are entities whose nature is not specified, the 'temporal precedence' relations are relations between such entities satisfying certain formal constraints and the domains of the various 'times' are sets of objects whose nature is again left open. This formal model-theory can at best characterize certain logical features of the sentences of L^P, but this is certainly not sufficient to tell us what the *truth-conditions* for these sentences are. Unless truth-conditions are given, the use of the indexed operators is illegitimate.

An eternalist can in an obvious way exploit the proposed model-theory in order to give truth-conditions for the sentences of L^P. He can tell us (i) that there is a special linear model M whose 'times' are just the real times, whose 'present time' is the real present time, whose 'temporal precedence' relation is the real earlier-later relation, whose 'time-domains' are the sets of objects existing at the corresponding real times, and finally whose interpretation function is 'faithful to reality', i.e. assigns to each predicate Π of L^P and time t the extension which Π has in fact at t, and (ii) that for a sentence of L^P to be true is for it to be true at the present time in M.

[12] This is a variant on a temporal analogue of an objection to Forbes' use of the Peacockean method for the purpose of reducing possibilist discourse in his (1989), an objection which is presented by Forbes himself (pp. 90ff) and made again in Melia (1992). The objection is against the view that a modalist can use the Peacockean method for the purpose in question, where a modalist holds that our modal concepts are not to be analysed in terms of quantification over possible worlds.

It is evident that a presentist cannot go the same way. For presentists believe that there is only one time, the present time, and consequently, from their own perspective no sentence of type $P\phi$ or $F\phi$ is true at the present time in the model defined in point (i) above, and so, were they to accept point (ii), they would be committed to the view that no sentence of that sort is true. That view is extreme, and it can be assumed that it is not one a presentist would be willing to endorse. Presentists thus face the challenge of providing us with an alternative semantic story, and it is hard to see which story this could be.

The argument for the case of the Vlachian method is exactly similar.

I take these arguments to have a great strength provided that it is assumed, as the arguments do assume, that truth conditions for the Peacockean or the Vlachian operators must be provided in order for them to acquire a meaning. Yet this assumption is questionable. One possible line of response is that the operators are not artificial devices whose meaning needs to be established; they merely help regiment an unproblematic linguistic phenomenon of which competent English speakers have a pre-theoretic understanding. Consider the following sentence, taken as an example by Vlach himself (1973, p. 2):

6. Jones was once going to cite everyone then driving too fast.

This sentence clearly differs in meaning from the following other sentence:

7. Jones was once going to cite everyone now driving too fast.

The response I have in mind runs as follows.[13] At any time of evaluation for (7), 'now' in (7) points to what is happening at that time. In contrast, in (6) 'then' is bound by 'was' (or 'was once') in a semantically relevant way. Where $D(x)$ is short for 'x drives too fast' and $C(j,x)$ for 'Jones cites x', (7) can be formalized using the rigid presentness operator as follows:

$$PF\forall x(ND(x)\supset C(j,x)).$$

As for (6), it can be formalized by

8. $P_1F\forall x(N_1D(x)\supset C(j,x))$

using the Peacockean operators, and by

9. $P\uparrow F\forall x(\downarrow D(x)\supset C(j,x))$

using Vlach's operators. Since (6) is clearly meaningful, both (8) and (9), which simply regiment (6), are also meaningful. More generally, since the Peacockean and the Vlachian operators are nothing but devices used to represent in formalized languages the kind of binding phenomenon at work in (6), the sentences of L^P and L^V are meaningful, and their meaningfulness stems from the meaningfulness of their counterparts in plain English.

This response leaves untouched the question of how one could formulate a proper semantics for 'once' and 'then' without invoking an ontology of past, present and

[13] This is the kind of response Forbes (1989, 1992) gives to the objection alluded to in footnote 12.

future times. Some will insist that this cannot be done, and accordingly that the use of the temporal 'once' and 'then' does commit one to quantification over times other than the present time. I disagree, but I will leave the issue at this point here. Yet at the end of the next section, I present a way of interpreting the Peacockean and the Vlachian operators I find particularly attractive.

Linear Time: The Finean Method

Fine (1985, 2005), drawing on the pioneering work of Arthur Prior, proposed a very nice alternative to the previous methods of paraphrase (in the modal case, but here I just focus on a variant of its temporal counterpart).[14] A crucial presupposition of the method is that presentists have no problem with the existence of times: they reject merely past and merely future objects, but they are happy to accept the existence of one time, viz. the present time. The Finean translation function takes the sentences of L into sentences of language L^T, which is L enriched with special variables for times τ, τ', τ'', ...[15] The presentist formal semantics for L^T is just like the presentist semantics for L but with the following extra conditions: (1) each time domain D_t of a model contains t, and no time distinct from t belongs to D_t, and (2) given any model M, an assignment assigns times of M to the temporal variables. I shall call linear models which satisfy condition (1) *temporalized*.

The Finean translation scheme is best presented via a détour. The Finean takes it that the locution

It is true at time τ that ϕ,

or 'at τ, ϕ', for short, can be defined as

$A(\mathrm{Pres}(\tau) \supset \phi)$

(or alternatively, as $S(\mathrm{Pres}(\tau) \wedge \phi)$). Let then '$\mathfrak{n}$' be a (temporally) rigid name for the present time. If the Finean is right, then given that 'Now, …' is equivalent to 'at $\mathfrak{n}$, …', $N\phi$ can be defined as $A(\mathrm{Pres}(\mathfrak{n}) \supset \phi)$. A translation procedure akin to the first one we met in the previous section, but from L to L^T enriched with $\mathfrak{n}$, is accordingly available:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x \psi$ in ϕ by $S\exists x A(\mathrm{Pres}(\mathfrak{n}) \supset \psi)$.[16]

[14] To be accurate, in these two papers the target languages are, like the languages (Fine 1977) mainly focuses on, extensional languages (see footnote 11 above). The method of translation presented in Fine (1985, 2005) already appears in Fine (1977), but in a different form: instead of quantification over worlds, Fine (1977) follows Prior and exploits quantification over world propositions, which go proxy for possible worlds (see in particular the end of p. 144).

[15] Instead of variables for times, one could add a predicate for times and express quantification over times by means of standard quantification restricted to the objects which satisfy that predicate.

[16] Of course, given the definability of 'now', a better translation procedure would be from L to L^T minus N enriched with $\mathfrak{n}$ and would translate N itself.

Of course, the resulting translation function is as problematic as its mate, for similar reasons.

The Finean fix is somewhat straightforward: instead of using a rigid designator for the present time, use a non-rigid definite description for it, namely, 'the present time', and give it wide scope. More precisely, the suggestion is that the second clause of the translation scheme should be (here I am using a bastard notation):

Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by 'the present time τ is such that $S\exists xA(\text{Pres}(\tau) \supset \psi)$'.

Assuming that there is always only one present time,

$$\text{the present time } \tau \text{ is such that } S\exists xA(\text{Pres}(\tau) \supset \psi)$$

is equivalent to $\exists\tau(\text{Pres}(\tau) \wedge S\exists xA(\text{Pres}(\tau) \supset \psi))$, and since for presentists being present and being in the range of the existential quantifier are always equivalent, the latter is equivalent to $\exists\tau S\exists xA(\text{Pres}(\tau) \supset \psi)$. The Finean translation scheme can thus be defined by means of the following procedure:

The Finean Translation Procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by $\exists\tau S\exists xA(\text{Pres}(\tau) \supset \psi)$ (τ any variable for times).[17]

The way pseudo eternalist quantification is achieved is more complicated than in the case of the previous two translation schemes, but a great advantage of the Finean method of translation is that it is untouched by the objection levelled at the other schemes I discussed in the last section. For the vocabulary involved in translating is just part of the unproblematic vocabulary of L plus quantifiers over times, and, again, there is nothing to stop a presentist to use such quantifiers as long as he respects his view that everything is present.

The Finean translation function is *almost* logically as good as the Peacockean and the Vlachian scheme. Remember that the semantics for L^T involves exclusively *temporalized* models. An eternalist need not consider the logic for L to be *e*-determined by a class of models of that sort,[18] and accordingly there is no hope that we can establish that the logicality constraint can be fulfilled by the Finean function starting from any eternalist conception of that logic. We need to focus on conceptions of the logic for L as *e*-determined by some class of temporalized models—more accurately, given the background assumption at work at the moment, by some class of temporalized linear models. In fact, it can be established that

[17] This is a translation scheme from L to L^T, but of course it could be turned into a more elegant translation scheme from L to L^T minus N enriched with $\mathfrak{n}$ (see previous footnote). But for the sake of simplicity I leave things as they stand.

[18] An eternalist may be a nihilist or a monist about times. See below.

Proposition 3. *Given any temporalized linear model M and sentence ϕ of L, ϕ is e-true in M iff ϕ's Finean translation is p-true in M.*

Consequently, the Finean translation function satisfies the logicality constraint given an eternalist view of the logic for L as the logic *e*-determined by some class of temporalized linear models and a presentist view of the logic for L^T as the logic *p*-determined by the same class.

So far so good. The Finean method of translation is nice, but it presupposes a certain view about the ontology of time which may be rejected by some presentists, and hence is not available no matter what once presentism is taken for granted. The logics for L^T *p*-determined by classes of temporalized linear models all validate

(E) $A\exists\tau(\tau=\tau)$,

which we can read 'There is always a time', and all instances of

(P) $A\forall\tau(\phi\supset A(\mathrm{Pres}(\tau)\supset\phi))$.[19]

That (E) and all instances of (P) should be accepted is in fact a necessary condition for the Finean method to be adequate. This is obvious for (E). As to (P), remember that the starting point of the Finean story was to define the locution 'at τ, …' as $A(\mathrm{Pres}(\tau)\supset\ldots)$. The requirement that all instances of (P) should be accepted is a direct consequence, given that definition, of the requirement that the following principle should itself be accepted:

Always, for every object x, if x is a time and so and so is the case, then at x, so and so is the case.

And that *this* should be accepted by a presentist is obvious, since presentists believe that 'for every object x' and 'for every present object x' are always equivalent.

Now, the view that presentists should accept (E) and all instances of (P) as true is objectionable. Presentism is compatible with two (mutually incompatible) views about the ontology of time which have some plausibility, *nihilism* and *monism*, and endorsing either view is incompatible with accepting the conjunction of (E) and of all the instances of (P).

The nihilist claims that there is no time at all, not even a present time, and so rejects (E). It is not too difficult to appreciate that a presentist can be a nihilist. A presentist whose ontology makes room only for elementary particles and events involving such particles, for instance, is arguably a nihilist. A presentist may indeed countenance an ontology which is so poor that nothing in that ontology could even remotely deserve to be called 'the present time'.[20]

The monist, in contrast, holds that always there is a unique time. He indeed endorses the stronger view that the present time—call it again '$\mathfrak{n}$'—is such that

[19] Compare Fine (2005, p. 226).

[20] Notice that it is natural for a nihilist to endorse the view that there never was and never will be any time (what would be so special about present ontology, as opposed to past or future ontology, in respect to the existence of times?), and in so doing he would take all instances of (P) to be trivially true.

there never was, and there never will be, any time distinct from it. For him, 24 h hence will be different from now insofar as what will be then true at $\mathfrak{n}$ is different from what is presently true at $\mathfrak{n}$, not insofar as there will then be a time distinct from $\mathfrak{n}$ at which different propositions (or other truth-bearers) will be true. A monist cannot accept all instances of (P)—in fact, there are infinitely many instances he must reject. Suppose ϕ is true but only temporarily so: either it was false sometimes in the past or it will be false sometimes in the future. It is easy to see that monism is incompatible with the truth of the corresponding instance of (P). For suppose the instance is true. Then $\phi \supset A(\text{Pres}(\mathfrak{n}) \supset \phi)$ is true as well, and given the truth of ϕ, $A(\text{Pres}(\mathfrak{n}) \supset \phi)$ is true. By monism, there is always a unique time, and that time is identical with $\mathfrak{n}$, so that $A\text{Pres}(\mathfrak{n})$ is true. It follows that $A\phi$ is true, in contradiction with the assumption that ϕ is only temporarily true.

Thus the Finean method of translation cannot be used by a nihilist or a monist. A presentist who wants to use that method must be a *pluralist*, i.e. he should endorse, like the monist, the view that always there is a unique time, plus the following view:

(Pl) Always, for every time τ, the following holds: (always in the past, for every time τ', $\tau \neq \tau'$) and (always in the future, for every time τ', $\tau \neq \tau'$).

(Pl) is indeed validated on any view according to which the logic for L^T is the logic *p*-determined by some class of temporalized linear models. For a pluralist, the monistic way of accounting for the difference between now and 24 h hence is all wrong; 24 h hence will be different from now because there will then be a time distinct from $\mathfrak{n}$ at which different propositions (or other truth-bearers) will be true.[21]

Digression: Interpreting the Peacockean and the Vlachian Operators

Fine (1977, p. 144) suggests that the modal Vlachian operators are definable in terms of quantification over world propositions and the necessity operator. Fine's definition can straightforwardly be turned into a definition in terms of (actualist) quantification over worlds and the necessity operator, and this definition has a straightforward temporal counterpart for Vlach's temporal operators. Given the definability of the Peacockean operators in terms of Vlach's, the Finean definition straightforwardly yields a definition of the former. In what follows, I focus on Vlach's operators, but it will be clear how the case of the Peacockean operators should be dealt with.

[21] The nihilism/monism/pluralism distinction is also relevant to eternalism, although in this case, the characterization of monism as well as that of pluralism should be slightly modified. Both the monist eternalist and the pluralist eternalist hold that always, there is a unique *present* time. And while the monist holds in addition that there never was, and there never will be, any time distinct from $\mathfrak{n}$, the pluralist accepts the result of modifying (Pl) by replacing all occurrences of 'for every time' by 'for every *present* time'.

In a nutshell, the Finean idea is to define ↑… as $\exists\tau$… and ↓… as $A(\text{Pres}(\tau) \supset \ldots)$. In order to be more precise, some definitions are needed. Say that in a formula of L^V, an occurrence o of ↑ *binds* an occurrence o' of ↓ iff (a) o' is within the scope of o, and (b) there is no occurrence o'' of ↑ within the scope of o and having o' within its scope. Let us then say that a formula of L^V is *nice* iff in that formula, every occurrence of ↑ binds some occurrence of ↓ and every occurrence of ↓ is bound by some occurrence of ↑. Given the role played by Vlach's operators, formulas of L^V which are not nice are deviant and hence can be ignored.

The Finean suggestion is that Vlach's operators can be defined in L^T via the following translation procedure:

Take ϕ nice in L^V.

1. If ϕ contains no occurrence of Vlach's operators, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\uparrow\psi$ in ϕ by $\exists\tau\psi$, where ψ results from ψ by replacing each sub-formula of type $\downarrow\chi$ where the occurrence of ↓ is bound by the indicated occurrence of ↑ by $A(\text{Pres}(\tau) \supset \chi)$ (τ any variable for times).

It can be shown that for every nice sentence ϕ of L^V and any temporalized linear model M, ϕ is p-true in M iff it's translation under that scheme is p-true in M. Notice that the translations of the formulas of L via the Vlachian scheme are nice, and that combining the Vlachian scheme with the translation procedure just described yields the Finean scheme.

The Finean definition can be seen as a special take on an interpretation of Vlach's operators in terms of the notion of truth at a time, which I find particularly attractive, on which ↑… is to be understood as 'there is a time such that …' (or 'the present time is such that …') and ↓… as 'at that time, …': the definition can be seen as resting on that interpretation plus a special view as to how 'at that time, …' is to be understood. I like this interpretation, but I am not so happy with the Finean take on expressions of type 'at that time, …', because its adequacy turns on which tense logic is taken for granted. I would prefer to regard 'at time τ, …' as a primitive. Be it as it may, the availability of both the Finean interpretation and the one which takes 'at time τ, …' to be primitive turns on which conception of the ontology of time is countenanced—these interpretations are incompatible with nihilism and monism, they require pluralism—and this may be taken to speak against them.

Linear Time: The Metric Method

All the methods of translation presented so far have their drawbacks. The Finean method is not neutral regarding the ontology of time since it requires pluralism. Both the Peacockean and the Vlachian methods make use of linguistic devices which raise doubts: the complaint is that these devices need to be given a proper semantics, and it is hard to see how this can be done without appealing to times

other than the present time—which is of course something presentists cannot do. In response to this worry I pointed to two ways of interpreting the Vlachian operators, and so indirectly the Peacockean operators, but I stressed that they too require pluralism to hold and hence are not ontologically neutral. Can we do better?

We can. Philosophers of time often use and discuss tense-logical operators, and most of the time the operators used or discussed are the so-called 'Priorean operators' 'sometimes in the past' and 'sometimes in the future' (and those definable in terms of these operators and truth-functional connectives). Yet, as Prior himself taught us, there is a wide variety of tense-logical operators, differing in various ways, in particular in their logical properties. Among the operators which have been largely neglected since Prior first discussed them in some details in his (1957, Chap. II) are the so-called 'metric operators', and it is these operators that what I called the *metric* method of translation invoke.

The Priorean operators allow us to talk about what happened in the past and the future, but not about what happened or will happen *a certain amount of time* in the past or in the future. The metric operators do. A metric operator is associated with a unit for measuring temporal intervals, e.g. the second or the day, and it takes a name for a number and a sentence to make a sentence. Choosing the day as unit, the metric operators are two, '— days in the past, …' and '— days in the future, …'. Which numbers (e.g. the positive natural numbers, the positive rationals or the positive reals) one allows to be designated by what fills in the '—' slot in a metric operator depends on one's take on the logic of these operators. Obviously, the Priorean operators are definable in terms of their metric mates: 'sometimes in the past' can be defined as 'some number of days in the past' and 'sometimes in the future' as 'some number of days in the future'.

Each of the methods of translation we met so far interprets the eternalist's 'there are objects x' by means of 'sometimes, there are objects x' and has its own way of cancelling the temporal shift induced by 'sometimes'. The shifts induced by the Priorean operators, and hence by 'sometimes', are of unspecified length. In contrast, the metric operators induce shifts of definite length, towards the past or towards the future, and accordingly they provide a nice way of inducing and subsequently cancelling shifts. The basic idea of the metric method of translation should be straightforward: understand the eternalist's 'there are past objects such that …' as 'for some n, n days in the past, there were (then present) objects such that, n days in the future, …', and in a similar way, understand the eternalist's 'there are future objects such that …' as 'for some n, n days in the future, there will be (then present) objects such that, n days in the past, …'.

We can take the home language L^M of the metric reduction to be L enriched with variables for numbers n, n', n'', …, and for each such variable n, a pair of operators P_n (for 'n days in the past') and F_n (for 'n days in the future').[22] The metric translation procedure can then be specified as follows:

[22] Given the definability of the Priorean operators in terms of the metric operators, the home language could be taken to be L^M minus P and F, but in order to keep things simple I leave things as they stand.

The Metric Translation Procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ by $(\exists nP_n\exists xF_n\psi)\vee(\exists x\psi)\vee(\exists nF_n\exists xP_n\psi)$ (n any numerical variable).

The semantics for L^M is slightly more complicated than the semantics for the other languages we already met, due to the need to interpret the numerical variables. It can be described as follows[23]:

A subset N of $\mathbb{R}^+$ (the set of all non-negative reals) is said to be *closed* if $0\in N$ and for all $\mu,\nu\in N$, $\mu+\nu\in N$. Where $F=\langle T,<\rangle$ is a linear frame, a *measure* on F is a tuple $\langle N,d\rangle$, where $N\subseteq\mathbb{R}^+$ is closed and d is a total function from T^2 to N, such that:

- $d(t,u)=0$ iff $t=u$.
- $d(t,u)=d(u,t)$.
- $d(t,u)+d(u,v)\geq d(t,v)$.
- If $t<u$ and $u<v$, then $d(t,u)+d(u,v)=d(t,v)$.
- For all $t\in T$ and $\mu\in N$ distinct from 0, there is a $u\in T$ such that $u<t$ and $d(t,u)=\mu$, and there is a $v\in T$ such that $t<v$ and $d(t,v)=\mu$.

A *measurable linear frame* is a linear frame on which there exist measures, and a *measurable linear model* a linear model whose frame is measurable. An *m-linear frame* is a tuple $\langle T,<,N,d\rangle$, where $\langle T,<\rangle$ is a measurable linear frame and $\langle N,d\rangle$ a measure on it. And finally, an *m-linear model* is a tuple $\langle\pi,T,<,N,d,D,I\rangle$, where $\langle\pi,T,<,D,I\rangle$ is a linear model and $\langle T,<,N,d\rangle$ an *m*-linear frame.

Let $\langle\pi,T,<,N,d,D,I\rangle$ be an *m*-linear model. Given the intended interpretation of the subscripted *P*s and *F*s, we require the assignments to assign members of N distinct from 0 to the numerical variables. The truth predicate $\models^p$ for L^M is then defined in the same way as for L, with the following truth clauses for the indexed operators:

- $M,\rho,t\models^pP_n\phi$ if for some $t'\in T$ such that $t'<t$ and $d(t,t')=\rho(n)$, $M,\rho,t'\models^p\phi$.
- $M,\rho,t\models^pF_n\phi$ if for some $t'\in T$ such that $t<t'$ and $d(t,t')=\rho(n)$, $M,\rho,t'\models^p\phi$.

p-truth in an *m*-linear model is defined as before by reference to its present time.

One can show that

Proposition 4. *Given any measurable linear model M, any measure on its underlying frame and any sentence ϕ of L, ϕ is e-true in M iff ϕ's metric translation is p-true in M endowed with that measure.*

Where $\mathfrak{M}$ is any class of measurable linear models, say that a class $\mathfrak{M}*$ of *m*-linear models is *based on* $\mathfrak{M}$ iff $\mathfrak{M}*$ is obtained from $\mathfrak{M}$ by endowing each

[23] For the sake of simplicity the way I present the semantics is not completely general. For a more general treatment, see Hajnicz (1991). The adequacy result mentioned below still holds on the more general approach.

model it contains with some measure on that model. Then for any class $\mathfrak{M}$ of measurable linear models and any class $\mathfrak{M}*$ of *m*-linear models based on it, for every sentence ϕ of *L*, ϕ belongs to the logic *e*-determined by $\mathfrak{M}$ iff ϕ's metric translation belongs to the logic *p*-determined by $\mathfrak{M}*$. The metric translation function thus satisfies the logicality constraint, granted an eternalist view of the logic for *L* as the logic *e*-determined by some class of measurable linear models and a presentist view of the logic for L^p as the logic *p*-determined by a class of *m*-linear models based on it.

The metric method of translation is of great interest, since it altogether eschews the problems met by the three other methods previously discussed. True, it relies on the assumption that the metric operators make sense and on certain associated eternalist and presentist views about their logic, which, from the point of view of the formal semantics presented above, amount to the view that models for the languages involved should be measurable. Yet this assumption does not appear to be very substantial. The fact that this formal semantics involves models which informally represent past, present and future times at various temporal distances from one another is no more problematic than the fact that the presentistic formal semantics for language *L* presented in section "The Target Language, Its Semantics and the Corresponding Logics" involves models which informally represent past, present and future times: these are *formal* semantics whose role is to characterize logical validity, and one is not supposed to take seriously what their models informally represent.

It might be argued, though, that the metric method does not fare well in one respect when compared to the other methods: unlike those methods, it relies on quantification over numbers, which is ontologically costly. But this argument is very weak. First, notice that quantification over numbers is not, unlike quantification over past and future times, per se problematic for a presentist. There is nothing to prevent a presentist, e.g. to endorse a Platonist view about numbers and take them to always exist or even to tenselessly exist. Secondly, and more importantly, number talk—especially of the rudimentary sort needed to make sense of the metric operators—appears to be unavoidable, e.g. in empirical science, but also in ordinary activities, and so *if* such talk could be shown to be intelligible only if an ontology of numbers were countenanced, then the argument would be straightforwardly undermined. Finally, whether the intelligibility of number talk—again, especially of the rudimentary sort in question—*does* require an ontology of numbers is of course a question open to philosophical debate.

Branching Time

So far we have focused on eternalists and presentists who take the logic for *L* to be determined by some class of linear models. Let us now turn to conceptions of that logic as determined by some class of backward linear and forward branching

models. As the reader may have already noticed, this alternative conception will make an important difference at various junctures. Given the background provided by the previous sections, I will omit certain points of detail.

Basic Notions

We define a *branching frame* as a tuple $\langle T, < \rangle$, where

- T (times) is a non-empty set.
- $<$ (temporal precedence) an asymmetric, transitive relation on T, which has the following extra properties:
  - It is backward linear: for any t, t' and t'' in T such that both $t<t''$ and $t'<t''$, either $t<t'$ or $t=t'$ or $t'<t$.
  - It is connected: for any t and t' in T such that $t \neq t'$, either $t<t'$ or $t'<t$ or for some t'' in T, both $t''<t$ and $t''<t'$.[24]

A branching frame is by definition backward linear, but it need not be forward branching: linear frames are all branching according to the definition. Given the views of interest to us in this section, the classes of models relevant for characterizing the logics put forward by these views will comprise at least some, maybe only, models based on branching frames which genuinely branch towards the future.

Where $\langle T, < \rangle$ is a branching frame, a *history* relative to that frame is a non-empty set $h \subseteq T$ such that

- For any t and t' in h, either $t<t'$ or $t=t'$ or $t'<t$.
- For any t in h and t' in T, if either $t<t'$ or $t'<t$, then $t' \in h$.

Notice that by the connectedness of $<$, any two histories overlap. Let $<_h$ be the restriction of $<$ to history h. Then by the first condition in the definition of a history, $\langle h, <_h \rangle$ is a linear frame.

A *measure function* on branching frame $\langle T, < \rangle$ is a function μ which takes each history h of the frame into a measure $\mu_h = \langle N_h, d_h \rangle$ on $\langle h, <_h \rangle$, such that

- For all histories h and h' and all times t and t', if both $t \in h \cap h'$ and $t' \in h \cap h'$, then $d_h(t,t') = d_h(t,t')$.

This condition is imposed in order to ensure that the distance between two times does not depend on which history comprising these times is considered. A *measurable branching frame* is a branching frame on which there exists a measure function. Finally, an *m-branching frame* is a tuple $\langle T, <, \mu \rangle$, where $\langle T, < \rangle$ is a measurable branching frame and μ a measure function on it.

[24] This condition ensures e.g. that a branching frame cannot be composed of two nonoverlapping trees.

Simple Semantics

There is a simple branching semantics for L which looks a lot like its linear counterpart. A *branching model* for L is a model for that language whose underlying frame is required to be branching rather than linear. p-truth is defined exactly like it was defined in the linear case. The case of eternalist truth is not so straightforward.

One can distinguish between two eternalist views on (absolutely unrestricted) existential quantification, a *strong* and a *weak* one. Say that a time t in a branching model is *accessible* from a time t' of that model iff either $t = t'$ or t is before or after t' relative to the temporal precedence relation of the model. On the strong view about existential quantification, the range of the quantifier at any time in a model is the same, and it is the union of all time domains. On the weak view, the range of the quantifier at a time t is limited to the union of the domains of the times accessible from t, and this typically changes from one time to another.[25] We thus distinguish two eternalist notions of truth, *se-truth* and *we-truth*. *se*-truth is defined exactly like *e*-truth, and *we*-truth as well except for the truth clause for existential quantification, which has to be modified in order to conform to the weak conception. The remaining semantic notions are defined as before.

The branching models for L^P and L^V are just the branching models for L, and p-truth for these languages is defined in the same way as for L, but by going two dimensional. The notion of a *temporalized branching model* is defined in the obvious way, and L^T is now interpreted by means of these models in the same way as before. Finally, the models for L^M are the *m-branching models*, i.e. models of type $\langle \pi, T, <, \mu, D, I \rangle$, where $\langle \pi, T, <, D, I \rangle$ is a model and $\langle T, <, \mu \rangle$ is an m-branching frame, and the rest of the semantics goes the same way as before.

The Peacockean, the Vlachian and the Finean translation schemes still fare well given a weak eternalist view on existential quantification. In fact,

Proposition 5. *Given any branching model M and any sentence ϕ of L, ϕ is we-true in M iff ϕ's Peacockean translation is p-true in M,*

Proposition 6. *Given any branching model M and any sentence ϕ of L, ϕ is we-true in M iff ϕ's Vlachian translation is p-true in M,*

and

Proposition 7. *Given any temporalized branching model M and any sentence ϕ of L, ϕ is we-true in M iff ϕ's Finean translation is p-true in M.*

In contrast, the metric scheme is inadequate. This can be seen from the fact that $\exists n P_n \exists x F_n$, which is supposed to mimic quantification over past objects, induces problematic temporal shifts. Take for instance a monadic predicate Π of L distinct from = and Pres. Then the sentence $\exists x \Pi(x)$ is *we*-true in a branching model iff

[25] The distinction between the strong and the weak views on quantification can also be drawn in the modal case: on the strong view, the range of a quantifier at a world w is the union of all world domains, and on the weak view, it is the union of the domains of the worlds accessible from w. Forbes (1989, p. 29) advocates a weak conception in that context.

$\exists x N\Pi(x)$ is. In contrast, $\exists nP_n \exists xF_n \Pi(x)$ can be *p*-true in an *m*-branching model without $\exists nP_n \exists xN\Pi(x)$ being true in that model. No modification of the scheme can lead to something acceptable. The best that can be done is to mimic quantification over future objects by means of $\exists nF_n \exists xP_n$.

None of the four translation schemes is adequate if a strong eternalist view on existential quantification is assumed. The problem, in the case of the Peacockean and the Vlachian schemes, is that at a time *t* in a model *M*, $S\exists x$ acts like an existential quantifier over the union of the domains of all times of *M accessible from t*, whereas what is needed is an expression which acts like an existential quantifier over the union of *all* time domains. A correct result is obtained if we replace *S* in the Peacockean and the Vlachian translation procedures by *SS*: it can be shown that

Proposition 8. *Given any branching model M and any sentence* ϕ *of L,* ϕ *is se-true in M iff* ϕ*'s modified Peacockean translation is p-true in M*

and that

Proposition 9. *Given any branching model M and any sentence* ϕ *of L,* ϕ *is se-true in M iff* ϕ*'s modified Vlachian translation is p-true in M.*

The Finean scheme faces the same problem on the strong eternalist view, and the translation scheme should also be modified by replacing *S* by *SS*. This is not yet enough, though. The rendering of 'at τ, …' as $A(\text{Pres}(\tau) \supset \ldots)$ is no longer adequate, because where *M* is a temporalized branching model and ρ an assignment which takes τ into a time *t* of the model, all sentences of type $A(\text{Pres}(\tau) \supset \phi)$ are vacuously true at any time *t′* which is not accessible from *t*. An adequate rendering of 'at τ, …' is as $AA(\text{Pres}(\tau) \supset \ldots)$. These modifications are sufficient to ensure that the version of Proposition 7 for the strong eternalist view holds:

Proposition 10. *Given any temporalized branching model M and any sentence* ϕ *of L,* ϕ *is se-true in M iff* ϕ*'s modified Finean translation is p-true in M.*

The metric scheme is still bad on the strong view, for the same reason as before, and there is no way to fix the problem.

Alternative Semantics

On the simple branching semantics, truth is relative to times only, rather than to pairs comprising a history and a time of that history. Alternative semantics, e.g. the semantics presented in Prior (2002, pp. 126–127 and p. 132) and the standard supervaluational semantics as put forward in Thomason (1970) do relativize truth to such pairs. In this section, I will not discuss in details adequacy results for the various methods of translation we met once such alternative semantics are adopted. I will rather focus on the notion of truth at a history-time pair, which is common to all these semantics, and put forward some considerations which should be enough to see how things go.

In the simple semantics, the original nonmetric translation schemes achieve pseudo *weak* eternalist quantification by means of the expression $S\exists x$. Now consider a model, a history h relative to the underlying frame and a time t in this history. Relative to $\langle h,t\rangle$, P acts like an existential quantifier over the times earlier than t, and F like an existential quantifier over the times later than t *in history* h.[26] As a consequence, when a formula of type $S\exists x\phi$ is evaluated at $\langle h,t\rangle$, $S\exists x$ reaches only all past, present and future objects of h: the future objects of alternative histories which are not in the domain of a time in h (if any) are left aside. In order to remedy this problem, we need a way of shifting histories.

This can be done by using a historical possibility operator $\Diamond$ which, semantically, acts like a quantifier over histories containing the time of evaluation: a formula of type $\Diamond\phi$ is p-true at $\langle h,t\rangle$ relative to an assignment ρ in a model M (given stored time u if the language is Peacockean or Vlachian) iff for some history h' such that $t\in h'$, ϕ is true at $\langle h',t\rangle$ relative to ρ in M (given stored time u). Define $\overline{S}\phi$ as $P\phi\vee\phi\vee\Diamond F\phi$. The idea is to use $\overline{S}\exists x$ instead of $S\exists x$. But then we need a way to cancel the shifts in histories induced by the possibility operator.

Consider first the Vlachian method. The natural thing to do here is to invoke modal Vlachian operators $\Uparrow$ and $\Downarrow$, and go for the following procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by $\Uparrow\uparrow\overline{S}\exists x\Downarrow\downarrow\psi$.

As for the Finean method, the natural idea is to invoke variables for histories in addition to variables for times, plus an actuality predicate Act—the modal counterpart of Pres—and adopt the following procedure ($\Box$ is defined as $\neg\Diamond\neg$):

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of replacing each sub-formula of type $\exists x\psi$ in ϕ by $\exists\eta\exists\tau\overline{S}\exists xA\Box(\mathrm{Act}(\eta)\wedge\mathrm{Pres}(\tau)\supset\psi)$ (η any variable for histories and τ any variable for times).

Finally, the natural thing to do on the Peacockean side is to invoke an actuality operator @—the modal counterpart of N—and go for the following procedure:

Take ϕ in L.

1. If ϕ contains no occurrence of $\exists$, then ϕ's translation is ϕ.
2. Otherwise, ϕ's translation is the result of applying the following procedure to each occurrence o of a sub-formula of type $\exists x\psi$ in ϕ:
   (a) If o is not within the scope of an occurrence of P or F, replace o by $\overline{S}\exists xN\psi$.
   (b) If o is within the scope of an occurrence of P or F, replace o by $\overline{S}\exists xN_1\psi$ and replace the occurrence of P or F which immediately governs o by its indexed counterpart (if this has not yet been done).

[26] The qualification is useless in the case of P, since the times earlier than t are bound to be in h.

Of course, in each case, the semantics should be modified in order to handle the new modal vocabulary. The details are somewhat obvious up to a certain point, but there are some subtleties.

The modified Peacockean language contains the actuality operator @, and accordingly its semantics will have to endow each model with a distinguished actual history comprising the present time of the model—a 'thin red line', as Belnap and Green (1994) would call it. In addition, the adequacy of the proposed translation scheme requires that *p*-truth in a branching model be defined by reference to the present time and the actual history of the model.

In contrast, the semantics for the modified Vlachian and the modified Finean languages can, but need not endow the models with distinguished histories. If they do, then can define *p*-truth in the same way as in the semantics for the modified Peacockean language. Alternatively, an option which does not require the introduction of actual histories is to go supervaluationist: define *p*-truth in a model as *p*-truth relative to the present time of the model whatever the history which comprises it. Another such option is to define *p*-truth in a model as *p*-truth relative to every history-time pair $\langle h,t\rangle$ such that $t \in h$. (The latter notion of truth is actually a notion of logical validity.)

In the simple branching semantics, the modified nonmetric translation schemes achieve pseudo *strong* eternalist quantification by means of $SS\exists x$. When a formula of type $SS\exists x\phi$ is evaluated at a history-time pair $\langle h,t\rangle$, $SS\exists x$ reaches only all past, present and future objects of *h*: $SS\exists x$ is indeed equivalent to $S\exists x$. A possibility operator $\Diamond$ can be invoked again. The idea is now to use $S\overline{S}\exists x$ instead of $SS\exists x$, and then to appropriately introduce mechanisms to cancel historical shifts. The Vlachian and the Peacockean translation procedures described above should be modified simply by replacing $\overline{S}$ by $S\overline{S}$. As to the Finean procedure, $\overline{S}$ should also be replaced by $S\overline{S}$, and in addition, $A\Box$ should be replaced by $A\Box A$. The previous considerations on *p*-truth in a model still apply here.

Interestingly, the metric method fares well on the new branching semantics in the case of weak eternalist quantification. One can adequately translate $\exists x\phi$ into

$$\exists nP_n\exists xF_n\phi \vee \exists x\phi \vee \Diamond\exists nF_n\exists xP_n\phi.$$

When that sentence is evaluated at a history-time pair $\langle h,t\rangle$, $\exists nP_n\exists x$ acts like a quantifier over all the objects of the domains of the times preceding *t*, and given that the history is fixed, F_n appropriately cancels the temporal shift induced by $\exists nP_n$; and in addition, $\Diamond\exists nF_n\exists x$ acts like a quantifier over all the objects of the domains of the times following *t*, and given that the relevant frames are backward linear, P_n appropriately cancels the historico-temporal shift induced by $\Diamond\exists nF_n$. In contrast, the method is not effective in the case of strong eternalist quantification.

A few remarks before concluding this section.

The complaints levelled against the use of Vlach's operators or the temporal Peacockean operators by presentists discussed in section "Linear Time: The Peacockean

and the Vlachian Methods" have counterparts which concern the use of the modal mates of these operators. It will be said that these modal operators cannot be understood if not in terms of quantification over merely possible histories. But notice here that if the claim is taken for granted, then the problem is for *actualists* and does not concern those presentists (if any) which are possibilist. In any case, actualist presentists can avail themselves of a line of response akin to the one put forward in section "Linear Time: The Peacockean and the Vlachian Methods": the Vlachian and the Peacockean operators are devices which formalize binding phenomena between locutions expressing historical possibility or necessity and 'actually' in one of its uses.[27] And of course, the interpretations of the temporal Vlachian and Peacockean operators presented in section "Linear Time: The Finean Method" have counterparts for the corresponding modal operators.

The distinction between nihilism, monism and pluralism put forward in section "Linear Time: The Finean Method" has a modal counterpart: the modal nihilist claims that there is no history; the modal monist holds that, (1) necessarily, there is just one history and (2) the actual history is such that, necessarily, every history is identical to it; and finally the modal pluralist accepts (1) and denies (2). Clearly, the interpretation of the Vlachian and Peacockean operators just alluded to requires modal pluralism, and the Finean translation procedure put forward in this section is available only to presentists which are pluralists in both the temporal and the modal sense. In contrast, of course, the last metric procedure introduced in this section does not require any particular take on these issues.

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[27] This is the point made by Forbes (see footnote 13)—although he does not have *historical* modality in mind.

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