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對時間之宇宙成長理論的辯護

A Defense of the Growing Block Theory of Time

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A Defense of the Growing Block Theory of Time

本論文係林益政君（學號 R06124011）在國立臺灣大學哲學系完成之碩士學位論文，於民國 108 年 7 月 19 日承下列考試委員審查通過及口試及格，特此證明

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In memory of Yung-Shiang Liao

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摘要

在本論文中我為時間之宇宙成長理論辯護，這個理論宣稱只有過去以及現在的東西存在，而時間的流逝是倚靠新的時空切片加入到現在的宇宙中來表現。文獻上有很多攻擊時間之宇宙成長理論的論證，本論文聚焦處理時間旅行問題以及知識論的問題，這兩個攻擊有一個共同點在於他們都認為時間之宇宙成長理論在存有學的預設上是有缺陷的，所以不會是表徵世界最好的理論之一，而我將引入二維時間的概念幫助我回答以上兩個問題。

在第一章，我會用結合二維時間和時間之宇宙成長理論來說明在這樣的世界裡，時間如何流逝？時間為何流逝？時間在哪裡流逝？以及，時間留得多快。在第二章，我將回應在時間旅行的討論中攻擊時間之宇宙成長理論最嚴重的問題，像是葛雷的沒有出發地問題（1999）、斯拉特的未來照片問題（2005），以及瓦薩曼（2018）的不確定性問題。我宣稱如果將原本的時間之宇宙成長理論加上第二維的時間，所有的問題都會自動瓦解。但是，不是所有的哲學家都接受二維時間。瓦薩曼（2018）提出了 A-model 來解決時間旅行問題但卻不需要承認二維時間的存在，不過我不認為這個理論會在沒有二維時間的狀況下是成功的，因為沒有二維時間 A-model 就會產生矛盾。在第三章，我將處理來自知識論的問題，這個問題認為沒有人可以在 A 理論的世界觀中知道自己正存在於現在。但我認為如果我們合併卡麥隆（2015）的可靠論以及布洛德（1923）的生成概念，那麼我們就可以在 A 理論的世界觀中知道自己正存在於現在。在第一部分我會為卡麥隆回應來自米勒（2017, 2018）的攻擊，第二部分我會說明我的這個合併作法如何使得時間之宇宙成長理論免於知識論的攻擊，也就是說只要滿足我提出的「生成條件」，那麼信念形成機制就會是可靠的且信念也會是安全的。我的結論是：因為這些對時間之宇宙成長理論的攻擊都失效，所以時間之宇宙成長理論成功守住她在分析時間哲學領域中的地位。

關鍵字:
時間哲學、二維時間、A 理論、時間之宇宙成長理論、時間旅行、時間流逝、時間的知識論問題

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ABSTRACT

This dissertation is a defense of the growing block view of time (GBT). The basic idea of GBT is that past and present entities exist, and the passage of time is in virtue of the addition of new slices. Moreover, ontologically speaking, the present moment in GBT holds a privileged status: the present is represented by the edge of reality, i.e., it is the latest slice of the block. GBT was ignored from the time it was first introduced into the philosophy of time by C.D. Broad (1923), until Michael Tooley (1997) finally brought it back to the battlefield. However, GBT still did not receive the treatment it deserves in the metaphysics of time. It encountered several objections, and since no one provided good responses to them, some philosophers began to refer to GBT as *the most infamous theory of time*. Within these objections, I think the epistemic problem and the problems from time travel are the most fatal to GBT, but that these can also be overcome.

In my thesis, I aim to respond to these fatal objections and argue that GBT is one of the best theories for describing reality. In Chapter One, before I respond to these problems, I introduce the notion of *hypertime* and combine it with GBT to form a new version of GBT called hypergrowing block theory (HGBT). I posit that this new version of GBT overcomes all fatal objections. There are two motivations to accept hypertime: one is the passage of time, while the other concerns time travel. I illustrate how an HGBTer answers the problem of the passage of time in the second half of Chapter One. In Chapter Two, I explain how to time travel in the GBT (HGBT) view of the world. There are two versions of HGBT; I choose one of them to show how HGBT dismisses problems that arise from time travel. After these two chapters, I hope that philosophers will be convinced by my support of hypertime. In the last chapter, I tackle the epistemic problem from David Braddon-Mitchell (2004). I firstly argue that Ross Cameron's theory of knowledge (2015) is successful by addressing the criticism from Kristie Miller (2017, 2018). Moreover, I add the A-Entrance principle to strengthen Cameron's theory. This combination not only makes the belief-forming process reliable, but it also makes beliefs from the process safe. Consequently, GBT is no longer subject to the epistemic problem. In short, I successfully respond to fatal objections to GBT, so that GBT can preserve its rightful place on the stage of the philosophy of time.

Key Words:
Philosophy of Time; Hypertime; A-theory; Growing Block View of Time; Time Travel; The Passage of Time; The Epistemic Problem

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INTRODUCTION

What is time? Human beings use the notion of time daily but we do not exactly know what it is. Since ancient Greek, philosophers have dealt with the problem of time. In that era, they tend to discuss time and change together. Heraclitus, Plato and Aristotle think that time is derived from changes or motions, and there are changes in reality so time exists. However, in the same period, Parmenides and Zeno deny the reality of change thereby denying the reality of time. Although these discussions are in the ancient time, their spirit is preserved in the contemporary debate of the philosophy of time. Nowadays, philosophers of time are still working on this problem. But does this mean that the philosophy of time does not progress? I think this conclusion is too quick because in ancient Greek, their idea about time is rudimentary. In history, philosophers kept pondering what time is and the answers philosophers gave were more and more fine-grained. In the seventeenth century, Isaac Newton provided a more detailed theory about space and time: absolute space and absolute time. His theory persisted until the early twentieth century. Albert Einstein in his miracle year published several breakthrough essays on spacetime which superseded the Newtonian spacetime system and greatly advanced our knowledge about time (or spacetime). [1]

In the early twentieth century, after the miracle year, J. M. E. McTaggart (1908) published an important work, "The Unreality of Time", on the philosophy of time. Although his conclusion denies the reality of time, this work is the base of the contemporary discussion of time. In McTaggart's work, there are two types of temporal series: *A-series* and *B-series*. He uses these two series to develop an appealing argument against the reality of time. From then on McTaggart's distinction has dominated

[1] There is a great introduction to history of the philosophy of time, please see Adrian Bardon's *A Brief History of the Philosophy of time* (2013).

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discussion of time among analytic philosophers. On the one hand, philosophers who think A-series correctly describes reality form the camp of A-theory. On the other hand, scholars who accept that B-series is the only fundamental way to describe reality become B-theorists.[2] A- and B-theory are two main camps in the philosophy of time and their debates are still fiercely right now.

Now, I want to characterize the difference between A- and B- theory. The first difference between A-theory and B-theory is that they use different *terms* to describe time; in A-theory I call them *A-term*, and in B-theory I call them *B-term*. (In the following thesis, whenever I describe something that belongs to A-theory I will use "A-" as prefix for A-theory and "B-" for B-theory.) A-term includes such words "past", "present" and "future", and B-term includes relations "earlier than", "later than" and "simultaneously". The essential difference here is that a proposition containing an A-term may be true at one time and be false at another time, but the truth-value of a proposition involving B-term does not change, i.e., if B-proposition is true, then it is true at all time. For example, an A-term proposition <Taipei is raining now> may be true in a moment but be false in another moment. On the contrary, a proposition involving B-term <The February 28 incident took (tenseless) place 17 years later than the Musha incident> is always true.[3] However, some people would argue that the debate on using A-term or B-term to describe the world is a verbal debate. Certainly, in the appearance, philosophers seem to debate about what terms we should use, but I think the deep problem is that does A-term or B-term reveal the nature of the world? That is,

[2] For limited space, I do not immerse myself in McTaggart's paradox. If one is interested in this paradox, please see McTaggart (1908), C. D. Broad (1938), Hugh Mellor (1998), E. J. Lowe (2002), Kit Fine (2005) and Rögnvaldur Ingthorsson (2016).

[3] In discussing the B-proposition, there is a concern should be mentioned. In considering the value of a proposition, there are some people who live earlier than that event do not consider this proposition as true. E. J. Lowe (2002) offers a distinction between *what is true* and *what is known to be true* to dispel this concern. He claims that our ignorance does not influence the relation between two events, that is, even if one does not know event A is earlier than event B, even A is still earlier than event B. Our knowledge does not shape *what there is*.

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does reality contain A-facts? Or, is reality merely constituted by B-facts? I consider these question are substantive; thus, philosophers should treat it seriously.

In our ordinary language, our utterances usually express an A-proposition, but hardline B-theorists cannot accept this since, in B-theorists' view of the world, the truth-value of a proposition does not change. So, facing this, they translate an A-proposition to the a B-proposition. There are two ways for them to translate a proposition: the date analysis and the token analysis. According to the date analysis, the tense in the proposition should be translated to a particular time: for example, <Taipei is raining now> is translated to <Taipei is raining on May 4, 2019>. Once the translation is done, the time in the proposition only refers to a certain time in the block, so its truth-value would not be altered. On the other hand, according to the token analysis, the truth-value is given when the utterance is made. That is, the truth-value of a sentence "Taipei is raining now" is self-referential; it refers to the time this token is made and the truth-value of it depends on whether there is truthmaker at that time or not. In these two types of analysis (translation), "is" is not tense but tenseless. The "is" in the proposition or sentence do not represent the present tense, rather, it is only used to claim the truth or illustrate the connection between the object and the property.

However, A. N. Prior (1959) provides an objection "Thank Goodness That's Over" to B-theorists who do not take tense seriously or scholars who think the method of translation can solve the problem. Richard Gale (1962), in addition, criticizes B-theorists' translation approach is not viable because it is impossible to translate A-proposition to B- proposition without losing any meaning. Because of these, B-theorists gradually abandon their stubborn position and try to accept tense in their theory: this new tent is called *NEW* B-theory. Nowadays, there are more and more B-theorists to

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accept tense in their theory. Dean Zimmerman (2005) claims that it becomes more difficult than the old time to distinguish A-theory from B-theory because some B-theorists takes tense seriously; Kit Fine (2005) in his book *Modality and Tense* also claims that there is no obstacle for B-theorists to take tense in their world. For instance, the most famous B-theorist taking tense seriously is Hugh Mellor (1998). Thus, the usual formulation is not adequate for us to make a distinction, so we should find a new way to distinguish A- and B-theory.

For me, the fundamental difference between A-theory and B-theory about reality is not what terms they use but the passage of time. The passage of time is the most obvious notion that A-theorists accept while B-theorists strongly oppose. In A-theory, the passage of time is the nature of time and this feature cannot be translated into any B-theory's words for B-theorists to capture since they deny that time passes genuinely (or fundamentally). There are four main theories in A-theory: Growing Block theory, Moving Spotlight theory (MST), Presentism and Branching Time model (BT). All of them think that there are tensed facts in reality and time passes genuinely. On the other side, B-theory is not divided into different theories, rather, there is only the new and old version of B-theory. Even if some B-theorists take tense seriously, all of them reject to accept that the passage of time is part of reality. Most of them think that the passage of time only exists in human's experience.[4]

I believe that A-theory is true especially GBT. There are several reasons in favor of A-theory and the most essential one is that it captures the pre-theoretical intuition of human beings. We intuitively think that the time I am typing this sentence (or you are reading this sentence) is now. Moreover, we think time flows and the passage of time

[4] See Huw Price (2009), L.A. Paul (2010), Barry Dainton (2011), Simon Prosser (2016).

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is real rather than only an illusion in human beings' experience. The time you read this sentence is now and the time you read this sentence is also now. There is no contraction here since when you read the latter sentence, the time you read the former sentence is not now anymore because time passes. This is one of the main reasons to advocate an A-theory.

As I said above, there are four main theories in A-theory. The difference between A-theories is ultimately about their ontology. Presentism is the view that only present objects exist and the passage of time is represented by that there are changes in what exists over time. MST accepts an eternalist view of the world (past, present and future things exist), but she argues that past, present and future is fundamentally different. The present slice is privileged because it is shined by the spotlight; slices have been shined called past slices and have not yet been shined called future slices. The passage of time that the MSTer characterizes is by the moving spotlight. Branching Time model is the view that time extends into the past like a line while extends into the future as branches. The passage of time is characterized by the fallen of branches, i.e., when the now moves to one of the branch and other branches fall. (There are many ways to characterize a branching time model and this way is from Storrs McCall (1996)) Lastly, GBT only accepts the present and past objects in reality and the passage of time is in virtue of the addition of new slices.[5]

[5] Advocator of Presentism, please see Ned Markosian (2004), Craig Bourne (2006), Dean Zimmerman (2011) and David Ingram and Jonathan Tallant (2018). Recently defenders of MST are Bradford Skow (2009), Meghan Sullivan (2012) and Ross Cameron (2015). The most famous defender of Branching time model is Storrs McCall (1996). Defenders of GBT are C. D. Broad (1923), Michael Tooley (1997), Peter Forrest (2004) and Fabrice Correia and Sven Rosenkranz (2018).

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0.1 Motivations of GBT

What are my motivations to defend GBT rather than other A-theories? There are three motivations I concern: the passage of time, the truthmaker and the open future view. The first reason is why I choose the A-theory and I have addressed above. For the second reason, in our intuition or the metaphysical concern, past propositions have truth-values because they exist such as <Socrates was wise>. We intuitively think this proposition is true in virtue of a state of affair "Socrates being wise" as a truthmaker. I want to preserve this intuition in my theory, so I rule out Presentism as my candidate. For the third reason, I want to preserve the open future view in my theory, i.e., there is no fact making any future tensed propositions true now; therefore, I rule out MST. (I will state this part clearly in section 0.1.4.) Therefore, there is only GBT left.

In the following sections, I will introduce GBT's four essential notions: *the objective now*, *coming into being*, *the open future* and *the passage of time*. I will illustrate the first three notions in this chapter and the fourth notion in the next chapter.

0.1.1 The Objective Now

Are there objective differences between past, present, and future? This is a good question to distinguish A-theory from B-theory. A-theorist reckons that there is ontologically different between past, present, and future, while B-theorists deny this distinction. For further inquiry, in the group of A-theory, since all of them endorse the difference, what does the ground of this difference? Each A-theory has their ways to characterize the difference by singling out the objective now.

For the GBT, the present is the edge of Reality. But there are two edges of Reality, the first slice and the latest slice. Which one is the present slice? The latest slice is the

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present slice. The way to distinguish the first and the latest slice is by the relation events in that slice bear. Events in the latest slice only stand in the relation "later than" or "simultaneously" because they are located in the latest slice and there is no event later than them. Moreover, a MSTer says that the objective now slice is illuminated by the moving spotlight and Sider (2011, p. 259) says "the event is shined by the spotlight possess the property of presentness." In addition, a presentist claims that only present slice exists and that is the way the present being privileged. Lastly, branching time theory argues that the present moment is privileged in that it is the edge of the branch and non-branch time. (The future directed is branching.)

Now, we know how the A-theory privileges the present, but A-theorist wants to say more. A-theorist wants to say the present is objective. This is because the present moment is not relative to any frame of reference, that is, it is an absolute moment in the A-theorists' view of the world. There is a more intuitive way to grasp this idea. Suppose that it is now 3 p.m. in Taipei, Taiwan and 2 a.m. in Boston, United States. I call my friend, Yu, who lives in Boston. During the phone, we use the word "now" to refer to the time we are chatting. But, the time on his watch is different from the time my watch shows. Whose time is referred to by the term "now"? The answer A-theorist gives is "neither". This is because a clock or a watch is a thing to represent a human's time or local time rather than physical or global time. There must be a global time that fixes each agent at the same time-slice or we cannot interact with each other immediately. Since we can interact with each other, then we must share the same fact that we are located in the same slice. What we use the term "now" refers to the objective now slice. If Yu and I are not located in the same slice, then we cannot interact with each other immediately just like I cannot now dial the number to W.V. Quine.

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But, the term “now” in this example is ambiguous. There are two ways in using the term “now”; the indexical use of now and the non-indexical use of now. When one uses the indexical now, the reference of the term “now” is sensitive to the context of utterance. During the phone, when I utter “it is now 3 p.m. in Taiwan”, what the time the term “now” refers to is the time that this sentence is uttered. The term “now” specifies which time is present not by explicitly stating a date, but by the time the utterance is made. Thus, the reference of the term “now” in the indexical way of use is determined by the time the sentence is uttered. However, in A-theorists’ view of the world, there is not only the indexical use of now but also the non-indexical use of “now”. When one uses the “now” in the non-indexical way, the reference depends neither on the context of utterance nor on the time the sentence is made. The reference always refers to the objective now slice. When I utter “it is now 3 p.m. in Taiwan”, what the time the term “now” A-theorists want to refer to in an A-theorists’ view of the world is the objective now slice rather than only the slice that the sentence is made.

In addition, what is the role the objective now plays in the GBT view of the world? As I said above, it is the edge of Reality and there is no slice later than the objective now slice. That is to say, an event located in the objective now slice does not possess the relation “earlier than” to anything. Given these, we can understand how events are arranged to be a sequence in the block. Suppose that, there are two events: “Yu is eating pasta” and “Yu is watching YouTube.” We do not know which one is earlier and which one is later than the other. The objective now can give us the answer. At a moment, the block contains the event “Yu is eating pasta” but the other one is not involved in the block. As time passes, the event “Yu is watching YouTube” is involved in the block. Therefore, we can know that the event of eating pasta is earlier than the event of

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watching YouTube since there is at least a moment that the block only contains the event of eating pasta and does not have the other one.

However, there is an objection to the notion of the objective now. The Special Theory of Relativity argues that there is no absolute simultaneity in the world, and the temporal sequence depends on a reference of the framework. Given different references of the framework, there are different temporal sequences between events. From the perspective of reference X, event A is simultaneous with the event B, but from the perspective of reference Y, event A is earlier than the event B. If it was true, and all A-theories posit the objective present, then all A-theories are put into danger. But the story has not ended. There are many articles in literature arguing that A-theory is not subject to this objection. For example, regarding GBT, Peter Forrest (2008) whose idea originated from Richard Swinburne (1983) offers a viable way-out for GBT. Thus, the Special Theory of Relativity does not sentence the A-theory death.

0.1.2 Change

Speaking of the issue of time, it is hard to not discuss the issue of change. As I said above, since ancient Greece, philosophers have tended to tie the issue of time with the issue of change. Nowadays, B-theorist posits a static view of time encompassing all events in the block so there is no such "genuine" change in the block.[6] However, for A-theory, *change* is an essential feature. In A-theorists' view of the world, time is dynamic, which captures the notion of change. Bradford Skow (2012, p. 227) claims "change is

[6] Some B-theorists try their best to characterize *change* in their theory because human beings experience a *change* in each moment such as a rolling-ball on the desk. Since we experience the change, some of them claim that *change* only exists in our experience and the notion of the specious present can explain how we experience *change*.

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the engine that pushes the NOW into the future." (Pushing the NOW into the future is a metaphor for the passage of time.)

How does a GBTer characterize change? Before C. D. Broad (1923, pp. 68-69) discusses the issue of change, he firstly distinguishes *events* and *things*: things are what we think of an ordinary object such as an apple or a table, while an event is like a meeting, a game, and so on. Things can undergo a change and events do too. But they change in different ways: things change *in time* and events change *of time*.[7] There are three kinds of change that Broad (1923, pp. 70-71) characterizes in a GBT view of the world: change *in time*, change *of time* and *coming into being*. The first and the second are an ordinary concept of change that we use daily. When things undergo change, meaning that they have different properties at a different time such as a green apple changes to a red one: an apple changes *in time*. On the other hand, an event undergoes change not *in time* but *of time*: it changes from present to past; for example, an event "Yu is eating pasta" is now happening, but it will change *of time* to be a past event as time passes. (An event can *only* undergo a change *of time* and an object can *only* undergo a change *in time*; this is an important difference between things and events.) Note that, these kinds of change do not deprive anything from objects or events. Change happens because new slices are added to the block. The event changes from present to the past, it does not lose some weird property "presentness", rather, it gains new relation "earlier than". For example, the event "Yu is eating pasta" changes from present to past because it gains a new relation "earlier than" to other events. Therefore, an event is a past event, according to GBT, it stands in an "earlier than" relation to other events. So, past events or objects are no less real than things in the objective now slice, according

[7] Similar works can be seen in A. N. Prior's (1968) paper and Hugh Mellor's (1998) book; moreover, both of them are connected this distinction to the issue of change although Prior is an A-theorist while Mellor is a B-theorist.

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to Broad. But this idea is abandoned by Broad's successors such as Robert M. Adams (1986), and Peter Forrest (2004, 2006). They consider that entities change when they no longer are located in the objective now slice and this change does cause them to lose something.[8] I will not subscribe to this idea since this approach pays too much price; for example, the McTaggart Paradox will be summoned and GBT would be more like her rival "Presentism".[9]

The third kind of change, *coming into being*, claims that before objects or events come into being, they are not part of Reality: they do not exist in the block.[10] This notion is essential in the GBT view of the world in that the growth of block implies that things come into being. If there was no this kind of change, then the block cannot grow. In addition, *change in time* and *change of time* entails the notion of *coming into being*. An object or an event can change, they must exist in the block and this existence entails that they have undergone *coming into being*. Before a thing comes into being, it does not exist, so it cannot undergo a change *in time* or *of time*. This kind of change, however, is objected by eternalists since they claim that all events exist in the block, there is no room for the notion of *coming into being*. On the one hand, I do not anticipate that B-theorists accept this idea since this is a pure notion of the A-theory. On the other, the MSTer can accept the notion of *coming into being* in the context of time-travel. (I will elaborate on this idea in chapter two.) Therefore, the whole picture is that once an event has *come into existence*, it can undergo a change *in time* or *of time*. For example, the event "Yu is eating pasta at t_1" *comes into being* representing that at t_0 the event does

[8] Timothy Williamson, although he is not a GBTer, also denies this idea. He (1999, p. 195) argues that "A past table is not a table that no longer exists; it is no longer a table."
[9] For the detailed discussion about the latter worry, please see Chris Heathwood's work (2005).
[10] The term "come into existence (or being)" is the same meaning as Broad's "becoming". To say something *becomes* is ungrammatical in English, so I replace it with another term with the same meaning.

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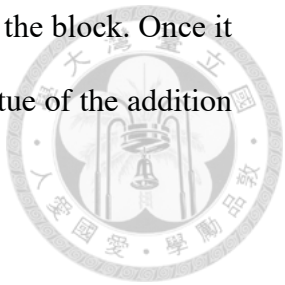
not exist, but at t_1 the event exists, and it always exists (tenseless) in the block. Once it exists (tenseless) in the block, it can undergo a change *of time* in virtue of the addition of new slices without losing anything.



According to these three kinds of change, Broad (1923, p. 73) introduces three kinds of judgement as the ideology to describe them: *existential judgement, characterizing judgement,* and *genetic judgement*. (All of them are equally fundamental and irreducible.) *Existential judgement* expresses the existence of a thing or an event— an apple *exists* or an event *exists*. *Characterizing judgement* is about properties of a thing— an apple *is red*. If there were only two judgements in ideology, it is not enough to capture the third kind of change— *coming into being*.[11] There is a particular moment that prior to it some event A doesn't exist, and after it, the event exists and forever exists. The only way to capture this special moment is to introduce the third judgement *genetic judgement*. The event *comes into existence*, which points to a particular time that the event begins to exist.

0.1.3 The A-Entrance Principle

After I explain the notion of the objective now and the notion of change, I want to point out that there is a close relationship between the objective now and coming into being.

[11] Perhaps Michael Tooley (1997) would deny my claim here. He only admits an existential judgement and a characterizing judgement in his ideology. In addition, he introduces a new notion *as of* to capture the actuality, that is, the growth of the block. Whenever he uses it, there must be a particular time followed the term: as of 1997. "As of 1997" means that when the block is young and the 1997-slice is the latest slice in the block. Thus, he could say: the theory of GBT is not actual as of 1900, but it is actual as of 1930. He thinks that this kind of expression can also capture the growth of the block. But, I don't agree with him because his terminology entails that the block is static in each moment, but in t2 reality will be more than t1 (t2 later than t1). Tooley's GBT fails to capture the moment that an event is coming into existence and our intuition of passage of time: we experience the things that are coming into existence. Without Broad's third predicate, it is hard to capture the picture of *coming into being*. In addition, the operator *as of* would generate a contradiction if time-travel is possible.

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The relationship between them is central in GBT. In the following essay, I will use this relationship in many places. Therefore, I should state clearly what it is.

The objective now is the edge of reality, and as I said above, there is no slice later than it. That is, events locating in the objective now slice do not stand in "earlier than" relation to other events. This entails that events in the objective now slice are the *latest* relative to the entire block. But these events are no longer *latest* when time passes. Other new events come into being and these new events are later than those old ones, so the old events are not new anymore. But how do these new events be added to the block? When time passes, time brings new slices and new events to exist, i.e., events are added to the block by coming into being. In this picture, we can see that when new events are coming into being, new events locate in the objective now slice.

However, if *coming into being* only happens at the objective now, then it is counterintuitive in that we intuitively think that past events have come into being. If *coming into being* only happens in the objective now slice, then Plato could not shave his beard in 388BC., Newton could not witness the fallen of the apple in the 16th century and Kant could not finish the first Critique in 1787. We have an intuition that all these events came into being at that time. I (follow Broad) do not deny that change can not take place in the past: there are two kinds of change, *change in time* and *change of time*, which are allowed to occur in the past. So, the beard could be shaved in 388BC, the apple could fall from the tree in the 16th century and the papers could be filled with ink in 1787. There is room for past changes but *coming into being* cannot happen in the past.

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This is weird at first glance because, in the picture of GBT, all events and objects have been coming into being. I do not deny this. What I reject is to say that the event of beard-shaved in 388BC is now coming into being. It is impossible that the event of beard-shaved in 388 BC is coming into being because it has existed in the block for a long time. The definition of *coming into being* is that prior to its existence, it does not exist in the block. The event in the past does not satisfy this definition, so we cannot say a change in the past is coming into being.

Now, I rule out that we can use the predicate *coming into being* on events or objects in the past, i.e., *coming into being* only happens at the objective now. I want to characterize this idea through a principle: the principle of *A-Entrance of Coming into Being*. (*henceforth* the A-Entrance principle) This principle is about the relationship between *the objective now* and *coming into being*.

> A-ENTRANCE OF COMING INTO BEING: An event or an object can come into being only by acquiring a location in the objective now slice.

I will use a metaphor to illustrate this principle. Suppose that the "Entrance" is the objective now slice, the block is a warehouse, and an event is a cargo that someone wants to push it into the warehouse. There is no other entrance that one can put cargo into the warehouse, so the only way to push it into the warehouse is through the entrance. Before the cargo is moved into the warehouse, it does not exist in the warehouse. Someone moves it at a velocity of a meter per second toward the entrance. A few moments later, the cargo finally approaches the door. As it is moved into the warehouse, the first region that the cargo occupies is the entrance. And then, at the same speed, it is successfully moved into the warehouse. So far, it is clear to see what I want to say.

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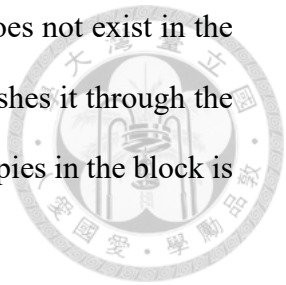
Let me reiterate this with GBT's terminology. An event (a cargo) does not exist in the block (a warehouse) before it is coming into existence (someone pushes it through the entrance). When it is coming into existence, the first location it occupies in the block is the objective now slice (the entrance).



However, although I ruled out the possibility for past events to come into being, it is possible that an event is coming into being, and it is not located at the objective now but the past. If this was possible, then my principle would be futile. Nevertheless, I think this situation is impossible because it generates a contradiction in the block. Suppose that there are two propositions <Yu is not watching YouTube at t_1> and <Yu is watching YouTube at t_1>. It is impossible for both of them to be true since these two propositions are mutually exclusive. When Yu is watching YouTube at t_1, he cannot not-watch YouTube at t_1. If a GBTer allows the past event to come into being, then she needs to explain away this contradiction. But I think there is no way out of this contradiction.

0.1.4 The Open Future

The future is open, which is the main motivation for me to defend GBT. Although Ross Cameron (2015, p. 174) argues that MST sits better with this idea than GBT, I do not buy his argument and in this section, I will spell out my reasons.

Before I spell out my reasons, I think I should state clearly what exactly the open future view is or what the open future view means. There are two approaches to capture this idea: the indeterminacy approach and no fact of the matter.[12] The indeterminacy approach that Ross Cameron (2015) argues is that it is indeterminate whether a

[12] This distinction is from Ross Cameron and Elizabeth Barnes (2009, 2011) and Ross Cameron (2015).

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proposition *p* is true or not, the relevant fact is unsettled which obtains, but it is determinate that *p* has a truth-value. For example, consider a proposition "there will be a sea battle tomorrow", the truth-value of it is indeterminate because which facts make it true or false are unsettled (but facts exist). When time passes, the facts will settle and the proposition will have a truth-value.

I disagree with Cameron's view on the ground that "unsettled" leaves room for the relevant facts to exist. Certainly, he does not deny those facts to exist; but if the facts exist, then why doesn't it make true the proposition? To be more specific, if the future does not branch and the ontology is eternalism, then why is the proposition still indeterminate? Truthmaking relation should be a tenseless relation rather than a tensed relation. That is, once the relata exist in the block, the truthmaker must make true the proposition and the relation between relata exist. So, Cameron cannot say the truth-value of the proposition is unsettled simply because the spotlight has not yet shined on the truthmakers. Cameron needs to introduce more ideology to explain why, but GBT can do better than the MST. GBT could say that there is no fact locating in the future (future facts), so the proposition is not made true or false by any fact: the truth of the proposition is indeterminate *simpliciter*.

Moreover, there is another reason why I do not choose MST. I reckon that the open future view is incompatible with eternalism because the open future view implies free will while eternalism does not. More specifically, if there are facts located in the future, then agents cannot do otherwise, and in this sense, the future for the agent is not open. For example, if there is a fact "I am watching YouTube at t_1" located in the future when now is t_0. The fact located in the future makes me cannot do otherwise at t_1. I have to watch YouTube at t_1. I cannot do otherwise at t_1, i.e., I cannot play badminton at t_1. If I

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cannot do otherwise or I cannot resist myself to do what the fact forces me to do, then I am not free. Thus, if there are facts located in the future, then agents do not have free will. However, a MSTer could respond that free will does not regard to future facts but only past facts. So, given the past facts, it is not determined that one cannot do otherwise, so one is still free. But I do not think this is freedom. I think we should *given all the facts in the block* to evaluate whether an agent is free or not rather than only considering past facts. If some facts make one cannot do otherwise at any moment in time, then this person is not free. Nevertheless, opponents could contend that in an A-theorist's view of the world, the reality is changing in each moment. When I persist to t_1, the fact might be changed, so I can do otherwise. This problem is the same if I endorse Hyper-Growing Block Theory (*henceforth HGBT*), so I deal with this problem in the next paragraph.

Lastly, I want to say more about the open future view and hypertime. (The discussion of hypertime will be stated in chapter one.) If there is hypertime in Reality and I want to preserve the open future view, then both the ordinary time and hypertime should not have future: the hypertemporal ontology will be "GBT+GBT". (Hypertime also possesses its ontology and the discussion is in section 1.1.1.) I, in the previous paragraph, said why I think that the open future view is incompatible with future facts. Then, the same reasons could be applied to hypertime: future facts rule out people's freedom. But opponents argue that the block is changing in each moment, that is, when I persist to t_1, facts are changed, so I can do otherwise. If this was correct, then both hypertime and ordinary time can have future facts. However, if there are facts located in the future, and one can cause new facts to rewrite them, then what is the matter about future facts? Why do philosophers posit them in reality? They do not possess any theoretical or practical use. So, according to Occam's Razor, we should eliminate them.

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Therefore, if I want to preserve the open future view, then GBT is the better candidate than its rival, MST.

0.2. The Roadmap of This Dissertation

In *Chapter One*, I will introduce the notion of hypertime and discuss some problems about the passage of time. Hypertime is a temporal dimension which is similar to our ordinary concept of time. But there is a tension here. If the ordinary time possesses ontology (A- or B-theory), then why does not hypertime have an ontology? This issue is ignored in the literature; thus, in section 1.1.1, I will discuss the ontology of hypertime and I called it hypertemporal ontology. I reckon that this is extremely important for philosophers who posit hypertime in their theory because different theories of hypertemporal ontology generate different difficulties and advantages. If one does not clearly state the ontology of hypertime, then how does one convince the public that her theory is not problematic? For this reason, I will do some exercises on hypertemporal ontology. In the second part of this chapter, I advance GBT to Hyper-Growing Block theory (HGBT). I think once a GBTer or an A-theorist accepts hypertime, then several problems are dissolved automatically. There are two main motivations to accept a hypertime model: one is about the passage of time and the other is about time travel. In this chapter, I advertise my first motivation. (The second motivation is at the next chapter.) I think postulate hypertime can coherently explain how time passes in A-theorists' view of the world. In addition, I will reply to four problems about the passage of time with hypertime.

In *Chapter Two*, I try to advertise the notion of hypertime in terms of time travel. I will illustrate how to time-travel in HGBT view of the world. One motivation to accept hypertime in the reality is to change the past. However, Ryan Wasserman (2018) does

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not think that changing the past needs to posit hypertime. He offers a theory called W-model to change the past genuinely without hypertime.[13] But I do not think his approach works without a hypertime model since it generates a contradiction. In addition, he also provides an approach for GBT to escape the indeterminacy problem, but I do not think this approach works without hypertime either. After these discussions, I will introduce two versions of HGBT: Peter van Inwagen's (2010) and Sara Bernstein's (2017). I do not think Bernstein's version is compatible with GBT and its disadvantages outweigh advantages, so I stand behind van Inwagen's version. In the last section, I will use van Inwagen's HGBT to respond to three problems against GBT: the indeterminacy problem, the future photo problem, and no destination problem. At the end of the first two chapters, I hope some people will be persuaded by me to accept hypertime.

In *Chapter Three*, I discuss a challenge from epistemology to GBT. All A-theories posit the objective now in their theory, but people in reality do not know whether they are at the objective now or not. This is counterintuitive in that we seem to *know* we are at now but there is no justification for us. If we cannot know whether we are at the objective now or not, then it is very weird for A-theorists to posit an unknowable thing in reality. There are several versions of the epistemic problem and I only focus on David Braddon-Mitchell's (2004) because his target is GBT. I think if the world is an A-theorists' view of the world, then we definitely can know we are at the objective now. I will adopt Ross Cameron's theory of epistemology (2015) to respond to this problem. But this strategy is objected by Kristie Miller (2017, 2018): she argues that the belief-forming process in Cameron's theory is not reliable because most beliefs of locating at the objective now that are generated by the belief-forming process are not true. Nevertheless, the real

[13] He in the book calls his theory A-model, but A-model is too misleading so I call it W-model in the following essay. ("W" stands for Wasserman.)

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disagreement here is not about the belief-forming process but how to evaluate whether the belief-forming process is reliable or not. I will present a way of diagnosing this disagreement, and give an example to say whose method is correct. I, moreover, will add a principle, the A-Entrance Principle, to strengthen Cameron's theory. Once this principle is added to his theory, it secures not only the reliability of the belief-forming process but also the safety of beliefs. Therefore, if Cameron's theory is correct, then, we, in the objective now slice, can know we are at the objective now.

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CHAPTER ONE:
Hypertime and The Passage of Time

In this chapter, I want to discuss the relation between hypertime and the passage of time. Since I accept the hypertime model, I utilize this and the next chapter to advertise and to clarify what the notion of hypertime is. I reckon that the hypertime plays a good role in explaining reality and helping A-theorists to dissolve several objections. In section 1.1, I will explain what hypertime is and develop a new perspective of temporal ontology—hypertemporal ontology. In the second half of this chapter, I will explain how time passes in a GBT view of the world in terms of hypertime. I will also reply to some problems with the passage of time with hypertime model.

1.1 What is Hypertime?

"What hypertime is" is a deep philosophical and physical problem. On the side of physics, Itzhak Bars, the professor at the Department of Physics and Astronomy at the University of Southern California, is the most famous physicist advocating the idea of *hypertime*. He does not call the second temporal dimension *hypertime*, rather, he only names his theory *Two-Time Physics* (2T-Physics).[1] On the side of philosophy, many philosophers discuss hypertime (or supertime) or multi-temporal dimensions in their works, although some of them do not accept it.[2] Nevertheless, hypertime is worth discussing because it is discussed by both physicists and philosophers.

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[1] For the summary of his theory, please see his personal website: http://physics.usc.edu/~bars/research.html#2T. After he developed his theory in 1995, he published "2T Standard Model" in 2006, and published a book *Extra Dimensions in Space and Time* in 2010. Physics is not the topic I dealt with in this essay, so I will not discuss it. The only reason I refer to these works is to show that hypertime is also discussed in the field of physics. The notion of hypertime is not a day-dream of philosophers.

[2] In the philosophical literature, the discussion of hypertime model is divided into two parts: the issue of the passage of time and the issue of time-travel. Here, I focus on the issue of the passage of time, and in the next chapter, I will discuss the issue of time-travel. For the discussion of the notion of hypertime and the passage of time, please see J. J. C. Smart (1949), Ned Markosian (1993), and Bradford Skow (2015). I will discuss these works in this chapter. For the discussion of the time travel,

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So, what is hypertime? Hypertime is a dimension which is distinct from time, but hypertime possesses some features that are similar to time. Bradford Skow (2012, p. 225) points out that "time provides a kind of perspective on the universe: relative to a different times, the universe can be a different state of the universe. Similarly, [hypertime] provides a perspective on *both* the universe and time. " For each moment of hypertime, the contents in the block are determined by the fact of the block at that hypertime moment; that is, the contents of the block at one hypertime moment need not constrain its contents at other hypertime moments. The whole picture is that the world is not three spatial dimensions plus one temporal dimension, rather, the world is three spatial dimensions plus two temporal dimensions. The following diagrams help us to grasp this idea (it is in a GBT view of the world):

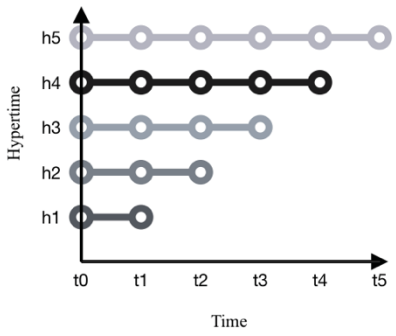

Figure 1.1 A GBT with Hypertime

The x-axis represents one dimension of time, which is a time that we ordinarily think time itself and the y-axis represents a second temporal dimension, which is hypertime. Each of the horizontal lines represents a block universe for each moment of hypertime. In virtue of the passage of time, the block grows relative to each moment in hypertime. In this world, the growth of the block can be understood as a temporal expansion along hypertime, i.e., hypertime passes in virtue of the addition of new blocks.

please see David Deutsch and Michael Lockwood (1994), Jack Meiland (1974), G. C. Goddu (2003), Peter van Inwagen (2010), Sara Bernstein (2017), and Andrew Law (2018).

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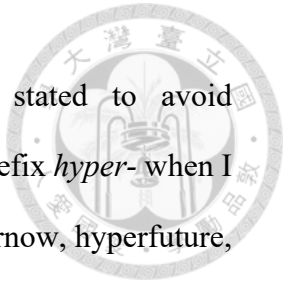

In addition, there is a hypertime language that should be stated to avoid misunderstanding. I follow Skow's (2015) terminology to add the prefix *hyper-* when I describe things in hypertime such as hypermoment, hyperpast, hypernow, hyperfuture, and so on. Moreover, there are three fundamental propositional operators in a hypertime model: HYPERWILL, HYPERNOW, and HYPERWAS. One can say, in HGBT view of the world, that both HYPERWAS[Yu is watching YouTube at t1] and HYPERNOW[Yu is not watching YouTube at t1] are true without contradiction. This is because these two propositions are true with respect to different hypermoments. Furthermore, it is inappropriate to say that h2 is later than h1 in that there is no earlier or later relation in hypertime dimension. It does not make sense that there is an event in 2000 at h2 that is later than the other event in 2018 at h1. There is no earlier or later relation between these two events. Since the block at h2 is not later than h1 but sometimes we need to say the block at h2 is later than the block at h1, so to avoid misunderstanding, I will use LATER THAN or EARLIER THAN to represent the relation between two hypermoments.

1.1.1 Hypertemporal Ontology

In the philosophy of time, many literature discuss temporal ontology. But if the ordinary time has an ontology, then does not the second temporal dimension, hypertime, also have its own ontology? I call theories of ontology of hypertime hypertemporal ontology. This idea is usually ignored by philosophers who endorse hypertime in their theory or who oppose hypertime. In the following part, I will firstly explain how many theories of hypertemporal ontology there are and draw some diagrams for them. I, furthermore, will introduce some philosophers who accept hypertime in their theory and point out what hypertemporal ontology their theories are. Even though some of them do not

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clearly state or formulate what it is, it is worth guessing which hypertemporal ontology their theories are close to. Also, I will point out what hypertemporal ontology that opponents attack. This exercise helps philosophers not only to understand more clearly what their theories' pros and cons are but also to successfully reply to opponents' objections.

What is the difference between temporal ontology and hypertemporal ontology? In *Introduction*, I introduced what temporal ontology is; for example, there are past, present, and future entities in eternalists' reality, while there are only present entities in Presentists' reality. Hypertemporal ontology says that there are two temporal dimensions in reality and each dimension has its own ontology from A- or B-theory. If A- or B- theory is true, then there are at least 25 theories of hypertemporal ontology. The following table shows all combinations of hypertemporal ontology.

	Presentism	MST	GBT	Branching Time (BT)	B-theory
Presentism	Presentism+ Presentism	MST+ Presentism	GBT+ Presentism	Branching Time+ Presentism	B-theory+ Presentism
MST	Presentism+ MST	MST+ MST	GBT+ MST	Branching Time+ MST	B-theory+ MST
GBT	Presentism+ GBT	MST+ GBT	GBT+ GBT	Branching Time+ GBT	B-theory+ GBT
Branching Time	Presentism+ BT	MST+ BT	GBT+ BT	BT+ BT	B-theory+ BT
B-theory	Presentism+ B-theory	MST+ B-theory	GBT+ B-theory	BT+ B-theory	B-Theory+ B-theory

Table 1.1 Hypertemporal Ontology

The rows represent the first-order time, the ordinary time, and the columns are the second-order time, hypertime. Take "MST+Presentism" as an example: MST is the ontology of hypertime and Presentism is the ontology of the ordinary time. However, some people say that not all of them are viable, some of them collapse to first-order temporal ontology. That is when the hypertemporal ontology is Presentism, all theories of temporal ontology collapse to their first-order temporal ontology. This is because in

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Presentism view of time, there are no past and future slices and the rest of things in hypertemporal dimension are the first order time. For instance, when I combine Presentism with GBT, the diagram is like Figure 1.2 and this is an ordinary view of GBT rather than "Presentism+GBT". Nevertheless, I think advocators of hypertime still want hypertime in their theory because one of the motivations to endorse hypertime is to genuinely change the past. That is, even though there is no hyperpast for them to compare the truth-value of the proposition for evaluating whether the past is changed or not in the context of time travel, they still can use hypertemporal operator to achieve the goal by saying that both of these two propositions HYPERWAS[I'm standing at t1] and HYPERNOW[I'm sitting at t1] are true.

Now, I present five diagrams of "GBT+*X*" and *X* is any theory in the first-order temporal ontology:

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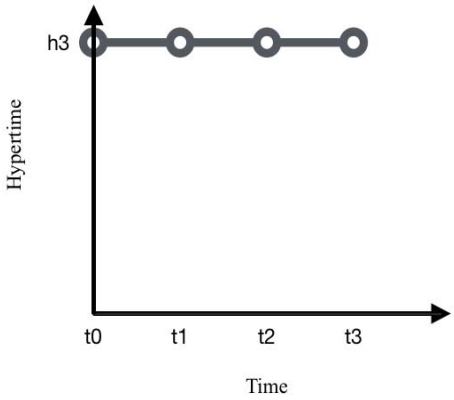

Figure 1.2 Presentism plus GBT

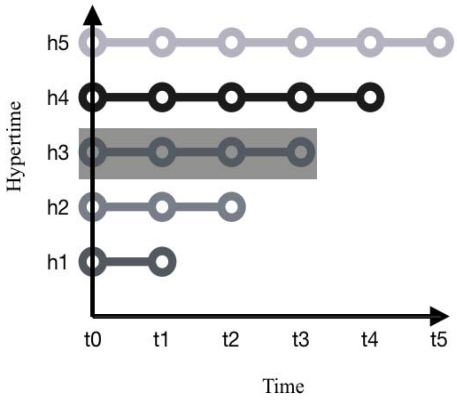

Figure 1.3 MST plus GBT

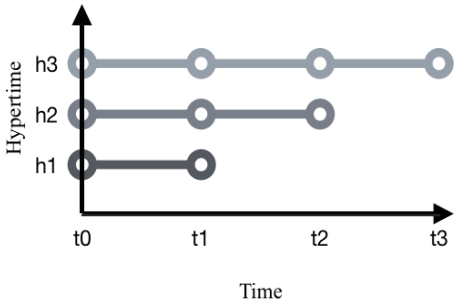

Figure 1.4 GBT plus GBT

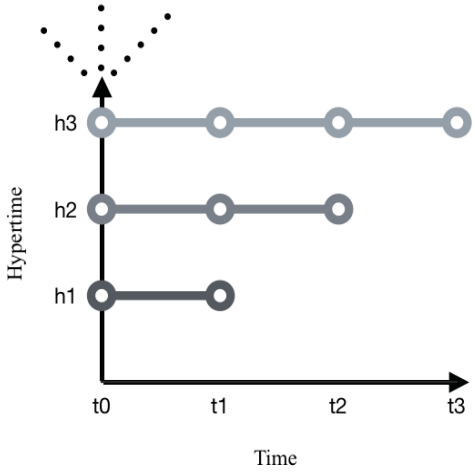

Figure 1.5 BT plus GBT

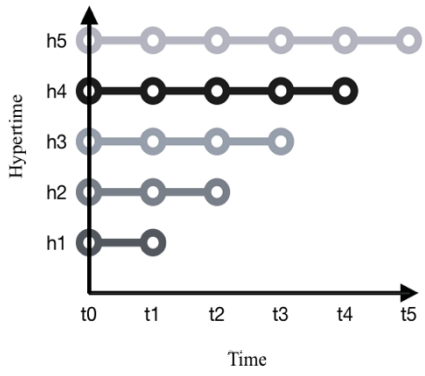

Figure 1.4 B-theory plus GBT

Suppose h3 is hypernow. Figure 1.2 is GBT plus Presentism: since Presentism does not commit the past and future slices (or I should say block), there is no block in hypertime except hypernow. The passage of time is that hypernow moves from h3 to h4 and the block grows to t4. Figure 1.3 is GBT plus MST; there are hyperpast, hypernow, and

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hyperfuture blocks in reality and hypernow in MST is where the spotlight is, so the spotlight (the gray area) shines the entire block.[3] The passage of time is represented by the spotlight moving from h3 to h4 to shine the next block; also, from h3 to h4, the block grows from t3 to t4. Figure 1.4 is GBT plus GBT, there are only hyperpast and hypernow blocks in reality and both of these two temporal dimensions grow and the growth of hypertime is in virtue of the addition of new blocks. Figure 1.5 is a little bit misleading in that hypertime is a Branching time model which is difficult to depict. Branching time model does not endorse future entities. She claims that they are unreal, so I use dot lines to represent them. When the objective now moves to h4, some branches fall and this is how time passes in this picture, according to McCall's BT. Figure 1.6 is GBT plus B-theory of time. All slices in reality exist but none of them are ontologically privileged since the hypertemporal ontology is a B-theorist's view of time, and there is no objective becoming in hypertime either. But there is still the objective now in first order time and the block still grows in virtue of the addition of new slices although blocks are static in each hypermoment.

Now, I will introduce five philosophers' theories involving hypertime, but most of them are not aware of different theories of hypertemporal ontology. In addition, opponents who are against the hypertime model also attack different kinds of hypertemporal ontology but they do not notice it either. So, in this part, I will help them to point out their hypertemporal ontology

In these five philosophers, three of them accept hypertime in their theory and their first order ontology is GBT: Jack Meiland (1974), Peter van Inwagen (2010), and Sara

[3] In fact, there are at least two ways to depict "GBT plus MST". One way is what I draw and the other way is that the spotlight only shines on one slice like the traditional MST, so the gray area would be a slice rather than a block.

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Bernstein (2017). Let us consider Peter van Inwagen's first. The main goal of his theory is to change the past without generating paradoxes when one time-travels to the past. (In this section, I will not discuss how the theory works and what problems they face. I will leave the discussion until the next chapter.) The following is textile evidence from van Inwagen which help us to figure out what his hypertemporal ontology is:

Peter van Inwagen:

> As hyper-time passed and the block grew a certain number of seconds longer, there came a point at which those human beings got back into the machine. […]
>
> Our model represents the growing block as having a ‘‘hyperhistory.’’ Normally it grows at a steady rate, but hyper-occasionally it instantly ‘‘shrinks’’ (loses a terminal segment) and then begins to grow again, and grow in a different way from the way it grew the previous hyper-time. The hyper-history of the block comprises all the episodes of normal growth and sudden ‘‘snappings-back’’ that have hyper-ever occurred. (2010, pp. 16-19)

The two quotations clearly state that the first order temporal ontology is GBT, but his hypertemporal ontology is not that clear. Some textile evidence could help us to guess what it is. In the first paragraph; he says that "hypertime passed", so we can rule out B-theory as his hypertemporal ontology. In the second paragraph, he uses the word "hyperhistory", i.e., there is hyperpast in hypertime, so we can rule out Presentism. Except for these, there is no further evidence for me to rule out other theories, so his hypertemporal theory is either BT, MST or GBT.

But I think Peter van Inwagen's ontology is "GBT+GBT or GBT+BT". These combinations are close to his motivation for endorsing an annihilation version of time travel. His motivation is *open future* and *changing the past*. The open future view is captured by GBT but if his theory was "GBT+MST", then this motivation vanishes.

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This is because there is hyperfuture in the hypertime and it implies that the future is not open: what will be done will be done, and no one can do otherwise. But he could say that given the past facts (even hyperpast facts) or given the fact that the future counterfactually depends on the present, agents still possess freedom. I do not think this reply escapes my challenge. Certainly, given the (hyper-)past facts, agents are not determined to do anything, but I think when one considers whether a theory's future is open or not, one cannot only evaluate past facts or present facts; rather, one should evaluate all facts in the block. If the situation is that given all facts in the block, an agent cannot do otherwise, then this agent is not free. Thus, this kind of theory cannot say its future is open. So, van Inwagen's options only leave BT and GBT, and this is the end of this exercise since there is no further evidence for me to tell what his hypertemporal ontology is.

On the other hand, Sara Bernstein (2017) also posits hypertime in her theory. Her motivation is also about time travel. She does not follow van Inwagen's approach, the annihilation version of time travel; rather, she establishes a new theory called Movable Present (MOP). (I will discuss what MOP is in section 2.2 in detail.) She wants to stay neutral in which first-order temporal ontology one adopts when one considers the possibility of time travel. She reckons that different first-order A-theories with the MOP are all possible. So, in this exercise, I will not discuss what her first-order ontology is. But it is difficult to figure out what her second order temporal ontology is since in different parts, she seems to presuppose different theories of second-order temporal ontology in the background. So, I will quote different paragraphs in her work to find out what her hypertemporal ontology is:

Sara Bernstein

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> [Presentism:] The Intelligence sees individual slices of existence successively pop into existence in hypertime. Temporal locations are repeated, but hypertemporal locations are hyperchronological. […] Since presentist MOP "resets" the objective present, its effect on the extant temporal manifold bears similarity to van Inwagian time travel with annihilation: the result of the time traveler's voyage is the removal of the extant times from existence, leaving events to regenerate differently the second time around. (2017, p. 87)

> [the GBT:] Growing block MOP requires that the time traveler regenerate a new block of reality that "saves over" the existing temporal manifold. Given the acceptance of hypertime, the idea is that there is a new block at every hypermoment. […] Here's how it works. Call Bianca's failure to attend Woodstock state W-, and Bianca's attendance at Woodstock state W+. The Intelligence sees the block in state W- at hypertime 1, Bianca's time travel at hypertime 2, and state W+ at hypertime 3. At hypertime 2, a new block is generated in place of the old one. The Intelligence sees the appearance of a new block hyperafter the existence of the hyperolder block that contains state W-: at hypertime 2, all of reality is replaced by a new, maximally determinant block. (2017, p. 88)

> [the MST:] The Intelligence views the location of the objective present in the following hyperchronological order: t1/ht1, t2/ht2, t3/ht3, t1/ht4, t2/ht5. […] As on the growing block model, moving spotlight MOP requires that the hyper- present block regenerate and replace the old block in hypertemporal succession. […] With the addition of time travel, the block is replaced by a new block and, presumably, a new spotlight: the spotlight shone on the time traveler. (2017, p. 89)

In the part of Presentism, she claims that the extant temporal manifold would be annihilated when time travel occurs, and the time machine will regenerate a new slice for the machine to occupy. The Intelligence sees slices successively pop into existence in hypertime and there is a thing called hyperchronology. This is enough to show that her second-order temporal ontology in this part perhaps is GBT because slices successively pop into existence and this is what a GBTer calls *coming into being.*

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On the GBT part, she mentions that the time machine possesses the ability of regeneration; also, the Intelligence sees that h1 to h3 exist. But when I time-travel at hypertime 2, my time machine regenerates a new block to replace the old one and this new block is also at hypertime 2. Put them together, it can be seen that there is hyperfuture and hyperpast in reality. So, the hypertemporal ontology cannot be B-theory because the hypertense is fundamental, it cannot be GBT and BT since there is hyperfuture, and it cannot be Presentism since there are hypermoments other than hyperpresent. Therefore, the only option left for her is MST.

On MST part, there is no enough evidence to show that what the second-order temporal ontology is. The story she tells is not enough to tell either. There are only two evidence available for us to rule out some theories: the hyperchronological order and the hyperpresent. If there is the hyperpresent, then either the hyperpresent is at the last position in the order, or the first position in the order, or in the middle position in the order. So, if it is in the first position then there is hyperfuture, and if it is in the middle position then there are both hyperpast and hyperfuture, and if it is in the last position then there is only hyperpast. Based on this diagnosis, we only have MST, GBT, and BT in hand. Since there is no further information for me to know which one is in her mind, there is no way to figure out what her hypertemporal ontology really is.

Moreover, in the literature of the philosophy of time travel, there is a famous 2-T approach about past-alteration which is offered by Jack Meiland (1974) and his main motivation is also to change the past without generating paradoxes:

Jack Meiland:

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The moments labeled t1 to t[6] on the diagonal line are present moments. The line P1–t1… represents the past when t1 is the present moment. That is, P1 is the past at (or with respect to) the present moment t1. Similarly, P2 is the past with respect to t2. The dotted vertical lines indicate the positions of moments in the past. For example, the intersection of P3 with vertical line Pt1 is the position of the moment t1 in the past with respect to t3. […] Consider the present moment t4 in Figure [2.7]. P4 is the past associated with t4. Now, suppose that t1 is the time of the Great Exhibition (1851, that is). So the point in Figure [2.7] labeled 'B' is the time of the Great Exhibition in t4's past. Suppose further that Harrison is not at B. But between t4 and t5, someone invents a time machine which Harrison enters at t5 and travels to the Great Exhibition. If time travel into the past takes no time (that is, is instantaneous), then Harrison will arrive at the point labeled 'A'. Thus, the proposition 'Harrison was not at the Great Exhibition' is true at t4 and false at t5. […] [M]y position is that the past itself is a continuant. Being a continuant, the past exists at different times and there- fore can be different at one time from what it is at another time. (1974, pp. 159-160)

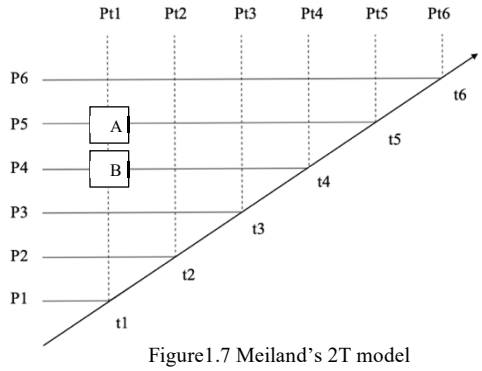

Figure1.7 Meiland's 2T model

Ryan Wasserman (2018, p. 97) claims that "although [Meiland] does not use the terms 'hypertime' or 'GBT' in [his] explanation, we can easily retell his story in our terms. In particular, we can take P1, P2, etc. to be various hypertimes, and we can take t1, t2, etc. to correspond to the leading edge of the block as it expands from one hypertime to the next." Thus, it is clear that Meiland's first-order temporal ontology is a GBT. What, then, is his second-order temporal ontology? There is no sufficient evidence in his story to tell us the answer. Since point B exists as of t5, I can infer that there is hyperpast. In

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addition to this, there is no extra clue to figure out what his second order temporal ontology is. His ontology could be any combination which posits a GBT as the first order temporal ontology in Table 1.1. However, I do not think any philosopher who does not state clearly what his or her ontology is is a good idea because different theories of temporal ontology generate different difficulties and possess different advantages. One cannot ambiguously state the ontology, escape from difficulties and enjoy advantages. This is a cheat!

Next, we come to Andrew Law (2018), the motivation of him to posit hypertime is also changing the past. This seems to be the main motivation for positing hypertime in the theory if one wants to change the past genuinely and avoid paradoxes. What is his hypertemporal ontology, let us see the following text:

> **Andrew Law:**
>
> The next step is to make hypertime similar to 'presentist time'. First, we need to be clear on how hypertemporal modifiers, like 'At hypertime ht' or 'It hyper-was the case that' work. If we are to learn from the puzzle of ordinary change, we should suppose that hypertemporal modifiers are operators: these modifiers modify neither the subject nor the predicate of the relevant proposition, but operate over the entire proposition. In particular, 'HYPER-WAS', 'HYPER-PRESENTLY', and 'HYPER-WILL' are fundamental propositional operators. Second, we need to be clear on the onto- logical structure of hypertime. To make hypertime similar to 'presentist time', we should formulate Hyper-Presentism as follows: that only hyper-present objects exist. And finally, let us say that a proposition is true simpliciter if, and only if, the proposition is hyper-presently true. […] [O]n the proposed model, what it is for the past to change is for (i) the past to contain (or not contain) some event, *e*, at some hyper-present hypertime ht, thereby containing (or not containing) e simpliciter and then (ii) the past to lose (or gain) *e* at some distinct hyper- present hypertime ht', thereby not containing (or containing) e simpliciter. Or, to put it more formally, what it is for the past to have changed is

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> for it to be the case that HYPER-WAS[The past contains (or does not contain) e] but HYPER-PRESENTLY[The past does not contain (or does contain) e]. (2018, p. 6)

Law is a little bit different from the former three philosophers since he clearly states what his second-order temporal ontology is but he does not spell out what his first-order temporal ontology is. He wants to make hypertime look like Presentists' view of time and introduces some hyper-operator in his theory. He, then, formulates his hypertemporal ontology as Presentism: the only thing that exists in the block is hypernow objects.

What about Law's first-order temporal ontology? He does not spell it out, but one possibility is what he spends half of his essay working on. He works on how Presentist solves the puzzle of change in the first part of his work: "how can both propositions be true given that it is impossible for something to both be a part and not a part of [an object]." (2018, p. 3) He thinks Presentism is a good candidate to solve this problem and he is inspired by this solution and reckons that this way of change is similar to changing the past. He, then, applies this to the issue of changing the past with hypertime. So, perhaps his first-order temporal ontology is also Presentism.

But there is another hint in the quotation "the past to contain (or not contain) some event, *e*, at some hyper-present hypertime h*t*." This seems to tell us that there is a past in each hypernow. But this is not necessary to rule out Presentism as his first-order temporal ontology because Presentists can use temporal operators such as HYPERNOW, HYPERWAS and HYPERFUTURE to talk about past and future events without ontological commitment. Actually, what he wants is only to change the past genuinely so it seems that each theory of time fulfills this requirement: a block (or a slice) relative to different hypermoments can totally different from others. Thus, I am

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not one hundred percent sure what his first order ontology is because each combination involving Presentism as the second-order temporal ontology seems to fit in his description.

Lastly, I try to point out the hypertemporal ontology in opponents' mind. There are at least two philosophers provide the same (or similar) argument against hypertime: J.J.C Smart (1949) and Earl Conee and Ted Sider (2014). Conee's and Sider's version is more simple than Smart, so I focus on their argument. These opponents do not believe hypertime. (Their targets are who posit hypertime because of the passage of time.) They argue that adopting hypertime will generate infinite regress. So, either the passage of time is not true or the notion of hypertime is not true; or, a B-theorist would say neither of them is true. The following is Conee and Sider's argument (2014, pp. 46-47):

> **Earl Conee and Ted Sider:**
>
> Most motion takes place with respect to the familiar timeline, but time itself moves with respect to another timeline, hypertime. Hypertime is a bad idea. You can't simply stop there; you need more, and More, and MORE. Hypertime is supposed to be a sort of time. So if ordinary time moves, surely hypertime moves as well. So hypertime must move with respect to yet another sort of time, hyper-hyper time. That time must also move, which introduces hyper-hyper-hyper time. And so on. We are stuck with believing in an infinite series of different kinds of time. That's a little much. I can't prove that this infinite series does not exist, but surely there are better options.

Unfortunately, opponents do not clearly state what they are against to. The only hint we can find in the argument is that they claim hypertime passes. So, in their mind, hypertemporal ontology must be A-theorists' view of time. What exactly their hypertemporal ontology is is not clear. But I do not mean that this argument is not severer enough, rather, I think that this argument does put philosophers who accept

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hypertime into danger. (Here, I do not prepare to answer this argument because the goal of this chapter is the exercise of hypertemporal ontology. In this dissertation, I defend GBT which is one member of the A-theory, so I have the duty to respond to this argument if I accept hypertime. In section 2.2.2, I will provide my reply to this argument.)

Finally, I have done all exercises that I propose to do. In this section, there are two goals. One is to introduce what hypertemporal ontology is. The other is to point out that there are many philosophers whatever they are proponents or opponents of hypertime model they do not spell out what their hypertemporal ontology is. Different theories of ontology possess different advantages and difficulties so if one does not state clear, how do others know the theory is consistent or not?

1.2 The passage of time

In our ordinary language, we usually say "time flows", "time passes" or "time flies" to capture how we think time. We keep experiencing change happening in the world and we must experience something changing, so some advocators reckon that human beings can experience change because of the passage of time.[4] The problem of this intuition is that time is defined to move but why does time itself move? If time moves, then how does it move? If time moves, then where does it move? If time moves, then how fast does time move? It seems that if time can move, then there are at least four immediate questions that advocators should respond. In this section, I will respond to these questions in terms of hypertime.

[4] Not all philosophers of time accept this view especially B-theorists. The change in our experience is really result from the passage of time is widely debated. Since I will not join this battle, if one is interested in this issue, please see L.A. Paul (2010) and Simon Prosser (2016)for discussion in detail. Other philosophers who attack my claim are Huw Price (2009) and Barry Dainton (2011).

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1.2.1 Why does time pass?

Why time passes is the first question that an A-theorist should answer. The simple answer is that it is the nature of time which grounds the passage of time. Different A-theories characterize the passage of time in different ways. I have already introduced this in *Introduction*. But this answer for opponents is not sufficient. So, the further reason is that there are changes in reality, and if change happens, then it needs a temporal dimension for it to change. For example, the apple was green and the apple is red. The apple undergoes change with respect to time and if there was no time in reality, then the apple cannot change its properties. If there was no time, then the whole world would be frozen and change cannot occur. It is impossible to imagine a world lack of a temporal dimension but a change can happen.

Moreover, there is the objective now in an A-theorist's view of the world. A-theorist tend to employ the objective now to capture the passage of time. <The apple is green> is true when this proposition is made in the objective now slice, and <the apple is red> is also true when this proposition is made at the objective now. There is no contradiction since the objective now moves, i.e., time passes. But what do exactly make the objective now to move? Bradford Skow provides an explanation:

> On my view, change is the engine that pushes the NOW [the objective now] into the future. There is irresistible pressure for the universe to change; but the universe cannot change if the NOW remains at one time. The pressure forcing the universe to change, then, pushes the NOW into the future. (2012, p. 227)

This is the reason why time moves. However, it is possible that there will be no change happening in the future, i.e., all events in the block are in the end, so in this state of the world, time stops to move according to Skow's approach. But according to A-theorists'

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notion, the passage of time is the nature of time. It is impossible for time to not move. Therefore, there is a contradiction here. Time both moves and does not move. Skow thinks that A-theories (without hypertime) cannot respond to this problem and once A-theorist accepts the notion of hypertime (or supertime) then the problem is solved.[5] But I think an A-theorist can respond to this problem without a hypertime model. There are two options that an A-theorist can choose: either the world will always keep changing or time will eventually stop. In footnote 5, I argue that it is impossible to imagine an A-theorists' view of the world where time is not passing, so the second option is dispelled. How, then, does the first option work if there is no event occurring in the world? Skow mentions a very important notion in A-theory: the universe as a whole must change. That is to say, the universe is changing in each moment without any particular change happening in the universe. For GBT, the new slice keeps adding to the block, so the entire universe is growing even if there is no event located in the slice. In this sense, the three dimensional block changes relative to different moments. For MST, NOW (follow the terminology from Skow) keeps moving to the future even if NOW does not shine on any event. What I want to point out here is that in an A-theorist's view of the world, change is not only in time but also of time, the whole universe is changing. Therefore, the reason why time passes is that change pushes the objective now moving into the future and if there is no event in the block, time still passes in that the whole world keeps changing.

[5] Skow offers a new MST in his work which incorporates hypertime (he calls supertime) to answer this problem. He states a principle called *the necessity of change* which claims that "at adjacent points in supertime, the universe is indistinct superstates." (2012, p. 233) However, I do not think this principle is necessary in our universe. This is because it is possible to imagine a world lack of change and if this was possible, then this principle is not necessary but contingent. Skow responds that "it says that the universe as a whole must [change]." If the passage of time is the nature of time and it cannot stop passing, then my former criticism is not valid. The reason is that it is impossible to imagine a world that is frozen if the A-theory is true. If you thought this is possible, then what in your mind is only a snapshot of a universe rather than the true state of universe. What does Skow mean? Let us back to the essay to see how possible it is.

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1.2.2 Where does time pass?

Where does time pass? What does this problem mean? Let us first consider what motion is because it seems that the passage of time is a kind of motion, according to A-theory. Take an ordinary object, a train, as an example to illustrate this idea. When a train moves, then a train occupies one place in a particular time and the other place in the next moment. At time t1, the train is at Taipei and at a later time t2 and t3, it locates at cities further south, Taichung and Kaohsiung, in Taiwan. There are three things involved when an object moves through space. Firstly, there is a moving object. Secondly, there is a dimension (space) for the object to move. And the third one is that there is another dimension (time) that the movement of an object with respect to.

It is clear what motion means, so what is the problem? If time moves, it needs to occupy some place to move (the second or the third things). But what does an A-theorist mean about "the movement of time"? The movement of time in ab A-theoretic characterization is by the movement of the objective now. For example, the objective now moves from 6:00 a.m. to 12:00 p.m., to 18:00 p.m., and then 21:00 p.m.. Since motion is relative to time, the objective now must occupy different locations, 6:00 a.m., 12:00 p.m., 18:00 p.m., and 21:00 p.m., just like the train moves from Taipei to Kaohsiung.

So, where is the location that time occupies? Time definitely does not move through space, so the only option for it to move is another temporal dimension. The notion of hypertime debuts. The ordinary time passes taking place in hypertime. As I said above, A-theorists characterize the passage of time in terms of the movement of the objective now. So, we can understand the passage of time taking place in the hypertime by the

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example of the train: the train is the objective now and the railroad is the hypertime. That is to say, the objective now moves with respect to the hypertime.

But this characterization of the passage of time generates the problem of infinite regress because if the passage of time is the nature of time, and hypertime is similar to the ordinary time, then hypertime must move but where does it move? Hyperhypertime? This argument is proposed by several philosophers such as C. D. Broad, J. J. C. Smart, and Conee and Sider. The following argument is Broad's:

> [hypertime] is precisely like [time] in all those respects which led people to say that presentness "moves along" the [time] series. Such people [those who favor objective becoming] ought therefore to say, if they want to be consistent, that presentness "moves along" [hypertime] as well. (1938, p. 279)

This is Smart's argument:

> just as we thought of the first time-dimension as a stream, so will we want to think of the second time-dimension as a stream also. (1949, p. 484)

And, this is Conee's and Sider's one:

> Most motion takes place with respect to the familiar timeline, but time itself moves with respect to another timeline, hypertime. Hypertime is a bad idea. You can't simply stop there; you need more, and More, and MORE. (2014, p. 46)

As a HGBTer, I have the duty to reply to the problem of infinite regress since this is a fatal objection to hypertime. There is a simple way to escape it. I only need to adopt a B-theory's view of time as my second order temporal ontology and the objection is automatically dissolved. Although hypertime is similar to the ordinary time, in this sense they are different in the perspective of the passage of time, that is, hypertime does

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not move. If hypertime does not move, then no one needs to posit another temporal dimension for it to move. The picture will be like this: the block grows in virtue of the addition of new slices taking place in a static hypertime. (In addition, there is hyperfuture in reality, so a GBTer no longer needs to bite the bullet about the problem of future. GBTers can give the truth-value to proposition involving future tense because the truthmaker exists in hyperfuture.[6])

(However, I do not think any GBTer or the advocator of the open future view should adopt B-theory as hypertemporal ontology since once we accept this view, then we have to abandon the open future view, and this contradict to our motivation. In addition, there are two motivations about adopting hypertime: the passage of time and time travel. The former is what I discuss in this chapter and the latter is what I will discuss in chapter 2. If the motivation to adopt hypertime is only to account for the passage of time, then to accept a B-theory as hypertemporal ontology is not a big deal, although it will lose the open future view. This loss someone thinks does not cost too much because they could say that given the past facts, an agent still possesses the freedom to do otherwise. However, as I argued in *Introduction*, I do not think this implies real freedom, so I will not and never will subscribe to this view if I insist on the open future view.)

So, is there any other way out for an A-theory? I think it is very hard to hamper the regress but the regress is not necessarily vicious. I do not think that the problem puts my theory, HGBT, into danger. Opponents argue that if time moves, then it needs a place for it to move just like the ordinary object moves. And, if hypertime moves, then it needs hyperhypertime to move. That is, the passage of time is explained by additional

[6] Perhaps, I should say the hyperfuture proposition rather than a future proposition because there is no future in GBT but since we adopt B-theory as our hypertemporal ontology, we can say that there are hyperfuture truthmakers make a hyperfuture sentence true.

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temporal dimension. This picture is just like the story of turtles all the way down. But, everything that needs to be explained in this picture is explained: the passage of time is explained by hypertime and the passage of hypertime is explained by hyperhypertime. Then, what is the problem? Is there any problem of biting the bullet to say that there is infinite regress? Opponents like Daniel Nolan (1997, 2001) say this kind of theory would be extravagance, and a good theory should be parsimony.

However, how to count how many things in reality? David Lewis (1973, p. 87) distinguishes two kinds of parsimony: qualitative and quantitative. Qualitative parsimony counts on kind and quantitative parsimony focus on number. For example, there are 1001 cats and 1 dog in the garden. If we count by quantity, then there are 1002 animals in the garden, but if we count by quality, then there are two species in the garden. Lewis subscribes to qualitative parsimony to evaluate whether a theory is parsimony or not, so I follow him to use qualitative parsimony as criterion and Nolan (1997) also accepts this criterion. My HGBT posits infinite temporal dimensions but all of their structure are the same so they belong to the same kind. I only hope opponents to believe more things in one kind rather than more new kinds. Thus, HGBT passes the test from parsimony.

1.2.3 How fast does time pass?

If there is an object moving on the desk, then it is natural to ask how fast does it move? By classic physical laws, one can calculate how fast does an object move? If this makes sense, then one can ask how fast does time move? This is a question about the rate of time. Consider the formulation from J.J.C Smart:

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> If time is a flowing river we must think of events taking time to float down this stream, and if we say 'time has flowed faster today than yesterday' we are saying that the stream flowed a greater distance today than it did in the same time yesterday. That is, we are postulating a second timescale with respect to which the flow of events along the first time dimension is measured […] Furthermore, just as we thought of the first time dimension as a stream, so will we want to think of the second time dimension as a stream also; now the speed of flow of the second stream is a rate of change with respect to a third time dimension, and so we can go on indefinitely postulating fresh streams without being any better satisfied. (1949, p. 484)

Smart supposes that if the ordinary time passes, then there must be a rate at which it passes. There are three approaches in the literature to respond to this objection: one is Ned Markosian (1993), the other is Bradford Skow (2012) and another is Ross Cameron (2018).

Let us consider Markosian's first. Markosian thinks Smart asks the wrong question: it does not make sense of asking how fast time passes. It makes a category mistake since "the answer would have to involve a comparison between the pure passage of time and the pure passage of time, but such an answer would not make sense because the pure passage of time has a unique status among changes – it is the one to which other, normal changes are to be compared." (Ned Markosian, 1993, p. 847) He does not think A-theorists need to respond to this question. This is because whenever we give a rate to a moving object— such as a train moves from Taipei to Taichung in 60 kilometers per hour— we have already given the rate which time passes at: time passes at the rate of one hour for a train to move 60 kilometers.

The other response is from Ross Cameron (2018). He argues that if Smart asks us to provide a metaphysical ground of the rate of the passage of time, then it does lead to an infinite regress because grounding relation is asymmetry. He argues that:

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> If the [train] travels at the speed it does *in virtue of* something to do with the passage of time then, arguably, time cannot pass at the rate it does *in virtue of* anything to do with the speed of the [train], and so we need to appeal to the passage of a second temporal dimension to provide the ontological grounds of the rate of passage of the first. If the passage of this second temporal dimension grounds facts about the passage of the first temporal dimension, it itself cannot pass *in virtue of* facts concerning the passage of the first, and so we need to appeal to a third temporal dimension, and so on. (2018)

But he does not think when one gives the passage of time a rate, one provides a metaphysical ground. What one shows is only the connection between two objects such as the movement of a train and the passage of time. When one compares two changes, one only points out the way they relate to each other and this is the only sense that we explain the rate (or speed) of an object. Cameron offers an example of a currency exchange. When a tourist wants to use New Taiwan Dollar (NTD) to exchange USD, the staff of the bank tells her that 33 NTD for 1 USD. This is not to say USD has the worth that is in virtue of NTD but the staff merely says the connection between two objects so does the rate of time.

But I think if one adopts hypertime, then it can provide a direct answer to the question: the rate of growth in ordinary time is equal to the rate hypertime grows. So, let us see how Skow (2011) solves this problem. One can measure the ordinary time with respect to hypertime just as one calculates the speed of a train by measuring how many distances it moves in a given duration. Skow argues that time moves at a constant rate of "one second per hypermoment". He offers two reasons to explain why it is constant. The first one is that "time moves at a constant rate" is an analytic statement. The interval between two hypermoments is defined in virtue of the interval between two points in

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time. For any two hypermoments p and q, the interval between them is the interval between the time the spotlight relative to p and the time the spotlight relative to q. (His theory is MST+Hypertime.) The second reason is from the perspective of change. For any two adjacent hypermoments p and its successor, the spotlight moves from p to its successor and the objective now also moves from one moment to another. The rate that the objective now moves is equal to the rate that the spotlight moves. That is, when the objective now moves one second, the spotlight moves an interval between two hypermoment. The second reason secures the constant rate of the passage of time and the first reason provides the answer to the question. So, for HGBT, the rate of the growth in ordinary time is equal to the rate hypertime grows.

1.3 Conclusion

In this chapter, I want to advertise the notion of hypertime model. The main motivation of it is the passage of time and time travel. I focus on the former in this chapter. In the first part, I introduce and discuss what hypertime is and also offer a new perspective of ontology— hypertemporal ontology. There are several exercises in that part, which point out that most philosophers do not spell out what hypertime they endorse exactly is. In the second part of this chapter, I discuss the issue of the passage of time which is one of the characters of A-theory. I reply to three questions in this part: why time passes, where time passes and how fast time passes. Overall, I use the notion of hypertime plus GBT to coherently make responses to all questions I mentioned above to allure philosophers to adopt the notion of hypertime.

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CHAPTER TWO:
The Paradoxes of Time Travel

2.1 What is time travel?

It is always intriguing in reading a story about time-travel. It makes us feel that we can do something that we cannot do in the actual world. For example, we can go back to the time when we have not yet been born to visit our ancestors or to battle with dinosaurs. Or, we can go back to visit our friend who is dead now. Or, perhaps we can travel back to forestall ourselves to do something making us regret now.

But, what does exactly "time travel" means in the field of philosophy? I think the best way to understand it is via a time travel story. I will use my own imaginary story through this entire chapter. The story only involves two protagonists: me and my friend, Yung-Shiang, Liao.

> Liao was my friend during the college time. Although he transferred to another school at the end of the second year of college, we had been through many things and also lived together for a couple of months. After he transferred to another school, we still kept in touch. But, one day, after I finished my class at 7 p.m., my friend sent me two screenshots, one was Liao's Facebook homepage and the other was a piece of news which said that in October 2014, a college student died in the car accident. I was not sure what these two pictures meant so I immediately visited Liao's Facebook homepage. There were many messages posted on it, and all of them hoped him to rest in peace. I still did not understand what happened. A few moments later, I put all the information together and realized that he passed away. It had taken me several years to realize that he will

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not answer me anymore and this fact is a fact that no one can change it. Fortunately, physicists and engineers successfully invent a time-machine in 2020 and I will time-travel to October 2014 that is the date before the car accident to avoid his death.

Now, it is easier to grasp what the notion of time travel is. David Lewis (1976) says that time travel involves "a discrepancy between time and time" (the first word, time, is personal time and the second word, time, is external time). This discrepancy is that an event of time travel takes six seconds for a person to travel back six years ago. How is it possible that there are only six seconds later but I appear six years ago? Lewis distinguishes *personal time* from *external time* to solve this problem. External time is time itself, time corresponds to which I time-travel backward to the past. Personal time is not time itself, it plays a role in arranging personal stages and a measure of changes undergone by a time traveler.[7] I travel to external past six years ago which takes six seconds in my personal time. That is, my presence in the past will be six seconds after I press the button in the time machine. This discrepancy is so-called time travel.

In a scenario of time travel, there are many deep questions that philosophers are interested in such as the ontological problem, the paradox of identity, the paradox of freedom and so on. In the paradox of identity, the questions are that can I exist in different locations at the same time, and which one is me exactly? In the paradox of freedom, philosophers ask: am I free to not to alarm Liao or am I free to not travel back to alarm him if there is a fact that I time-travel in the world? The most fundamental one among these is the ontological problem because there are different forms of paradox in

[7] For every duration of time when an agent exists, long or short, there is necessarily a personal stage of an agent that exists only then.

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different theories of time, and different theories of time face different ontological problems. If any theory of time cannot overcome its ontological problem, then it does not need to deal with other problems because perhaps the problems of time travel show the ontology is false. (Before anyone tackles a paradox of time travel, one should state clearly which theory of time is the background of one's work. This is important and many philosophers overlook this point.)

What is the ontological problem that a GBTer needs to solve? The problem is that my backward time travel perhaps is not possible just in case the basic notion of GBT claims that the past is unalterable. If I succeeded in time-traveling to the past, then I will occupy a place that I have never occupied. If I occupy a place that I have never occupied, then the basic doctrine of GBT is violated. So, time travel and GBT are not compatible.

I definitely will not subscribe to this argument but the conclusion forces me to abandon the notion of an unalterable past. Certainly, I admit that in the GBT view of the world, the past is unchangeable. But it is not necessary to abandon this notion if I want to secure the possibility of time travel. In the GBT, agents are allowed to cause a new event at the objective now. So, if an agent can relocate the objective now, then I can genuinely change the past. (Or, I should say that I can cause a new event at the objective now slice. Thus, in this sense, I do not change the past, rather, I cause a new event at now.) For example, if the 2020-stage of me wants to occupy a place in 2014, then the time machine has to not only relocate the 2020-stage of me but also the objective now to the past. If the machine succeeds in bringing the objective now to 2014, then I can change what happens in 2014 even if I cannot literally erase or add what happened in my memory. But I can cause a new event in 2014, i.e., the 2020-stage of me can occupy in 2014. That is enough for a time-traveler who wants to do when one time-travels to

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the past. Therefore, even if in the GBT view of the world, one cannot literally change the past, but what a time-traveler wants to do can be achieved in the GBT view of the world. (There are some problems in this solution: for example, there is a contradiction that the 2020-stage of me both exists and does not exist in 2014 and it also subjects to the problem of indeterminacy from Ryan Wasserman (2018). I, in the following sections, will gradually solve these problems and provide a coherent story in the conclusion.)

In the following section, I will try my best to seek a way-out to respond to problems for the GBT I mentioned above. Firstly, I will introduce two versions of HGBT and criticize one of them and accept the other one (section 2.2). Secondly, I will discuss Ryan Wasserman's W-model (2018) which is a model he offers for all A-theories to time-travel with fewer problems. But I contend that his mercy for providing a model for all A-theories is not successful because it does not work without hypertime (section 2.3). Thirdly, I will discuss the problem of indeterminacy and Wasserman's solution to it, and also argue that it presupposes the idea of hypertime. In this section, I will also show how hypertime solve the problem of departure, the problem of destination, and the problem of fatalism. (section 2.4).

2.2 The Hypertime Model

Let us read the following story first, which is about what happened after I pressed the button of the time machine.

> I press the button at t3 (2020) to time-travel to t1 (2014). I successful arrives at t1 and the first thing I do is to make a phone call to Liao. When the phone connects, I immediately say "hey, it is no time to explain why I say these. Please

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do not ride the motorcycle or scooter this month. Please take the bus or train. This is weird, but all of these are for the sake of you. Please…" He did not say anything but "ok, I got it." At t2, he is alive, t3 also and so on.

In section 1.1, I introduce the notion of hypertime and in chapter one I say that my theory is "GBT+GBT" (HGBT). But, there are at least two ways to depict this story into diagrams in HGBT view of the world: Sara Bernstein's (2017) movable present (MOP) and Peter van Inwagen's (2010) annihilation world. Van Inwagen's version is drawn in Figure 2.1 and Bernstein's version is depicted in Figure 2.2.[8] In these two figures, the x-axis represents one dimension of time, which is a time that we ordinarily think time itself (t1 is a time before Liao's death in 2014, t2 is a time after Liao's death in 2016, and t3 is a time that I press the time machine's button in 2020). The y-axis represents a second temporal dimension, which is hypertime? H1 to h6 are hypermoments in the world. Each of the horizontal lines represents a block universe with respect to each hypermoment. The black square is where the objective now is.

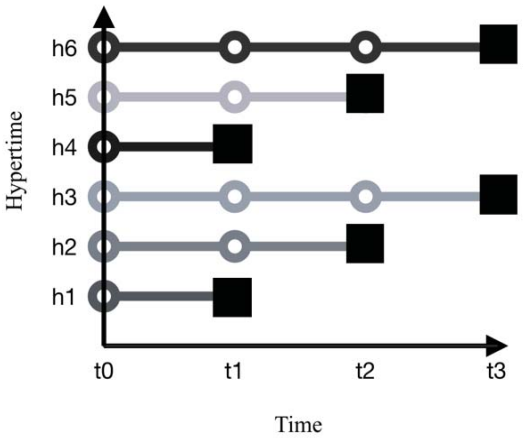

Figure 2.1 Van Inwagen's version

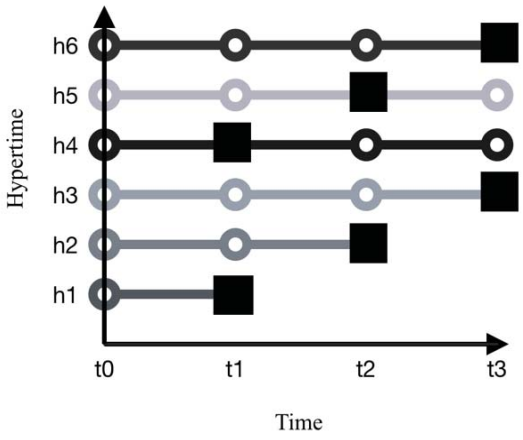

Figure 2.2 Bernstein's version

[8] I'm not sure whether Bernstein would accept Figure 2.2 in that she does not restrict MOP to the GBT as I said in section 1.1.1. Moreover, she discusses the relationship between hyperpresent and the objective now in her work. One of the pictures, she characterizes, for example, is that when the time-travel happens, the block will stop growing but the objective now would be brought back to the time that the machine sets. There are three versions of it, and I only choose one of them (absurdly) to draw Bernstein's picture. But I think this version is the one that can capture C. D. Broad's notion *coming into being* the most. (Coming into being is the most important notion of the GBT.) For further discussion of the relationship between hyperpresent and the objective now, please see pp.87-88 in her work.

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In Figure 2.1, the block with respect to hypermoment h1 to h3 grows normally. But, at (t_3, h_3), I travel in time to warn Liao, so according to van Inwagen's theory, the block shrinks.[9] The block at h4 contains all facts from the beginning of time to the t1 such as the fact that I was born, I entered university, I met Liao and so on. But, the block at h4 does not contain the event of Liao's death and the event that I time-travel to the past. These facts are annihilated, and this annihilation is the essential feature in van Inwagen's theory. If van Inwagen is correct in annihilation, then a time machine is exactly a killing machine: when a traveler travels in time, parts of the block would be annihilated. Van Inwagen himself does not consider this cost is a bad idea, rather, he thinks that this can allow a traveler to change the past without generating paradoxes. Moreover, this picture modifies the definition of time-travel. Traditionally, philosophers define time-travel following Lewisian way: the discrepancy between personal time and external time. But once philosophers endorse a hypertime model, the definition would be modified to "the discrepancy between hypertime and time". Without time travel, time and hypertime agree on their duration; that is, suppose that the block has *n* temporal units long and hypertime is also *n* units long. But, when a time-travel happens, the part of block is annihilated, so the discrepancy appears: the block is annihilated to *m* temporal units but hypertime is *n* units long.

On the other hand, Sara Bernstein (2017) does not want to posit the annihilation feature in her theory, so she creates a new version, MOP, which is depicted in Figure 2.2. Her theory has three main features: the first is that it does not annihilate a part of time, the second is that a time machine generates time slices when it time-travels to the future,

[9] When I want to describe a temporal location, I cannot use the usual way to talk about it or it will generate contradictions. Thus, I need a new way to describe a temporal location: I will use coordinate (h_x , t_y) to represent the temporal location. For example, the event of time travel takes places at (h_4 , t_3).

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and the third is that this theory does not necessitate a change in Reality. (2017, p. 84) When I time-travel at (h_3, t_3), the time machine does not annihilate parts of the block, rather, it only brings the objective now to the past. (The block is growing or not depending on the relationship between change and the objective now. Here, as I said in footnote 8, I characterize a version that block stops to grow when the objective now is brought to the past.) The 2020-stage of me can occupy a spacetime region without a contradiction because I can say that different facts hold relative to different hypermoments. In 2014, (h_4, t_1), the 2020-stage of me can alarm Liao for the car accident and this new fact will be contained in a new 2014-slice and this new slice rewrites the old one.

However, I have two worries about Bernstein's version. Firstly, the third feature is a little bit weird for me because I reckon that even if one time-travels to the past and immediately travels back to the time one leaves, it still generates a change in Reality. The time machine and the traveler occupy a spacetime region that has not been occupied by these two entities. If they successfully arrive, then they generate changes in Reality. Secondly, the MOP seems to not be compatible with the GBT. Bernstein has to say more about the role of the objective now in the MOP. In the GBT, the objective now is defined by the edge of Reality, the latest slice in the block. Prior to the objective now is the past and after the objective now is nothing. But, if one time-travels to the past, both the objective now and the time-traveler are relocated. The worry shows up. When a time-traveler is in the past, the objective now is at the place that there is at least one slice being later than the objective now slice. If this was true, then the objective now is not the edge of Reality and there are future slices in the block. These violate the basic doctrine of the GBT. Thus, if Bernstein wants to leave room for the GBT plus MOP, then she needs to say more about these worries.

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In addition to these, in general, Hud Hudson and Ryan Wasserman (2010) offer a potential problem to anyone who posits hypertime in the theory: what will happen hypernext? The problem supposes that there are at least two time-travelers with at least two time machines. All of them simultaneously push the bottom, and the destinations are different locations in the past. What will happen hypernext? Suppose now there are three time-travelers (Brown, Christina and I) time-travel to the past to warn Liao about the accident. But we choose the different times in the past: I choose t_1, Brown chooses t_2 and Christina chooses t_0. The process of a time machine is that when I time-travel back in one year of time, I will have one second time-travel journey.

In Bernstein's version, there are two results that MOP will generate. One is that there are three objective now slices in each time. This is not possible in that in A-theory, the "objective" now is objective because it is the only one special slice. Therefore, this result is not possible. The other is that one of us successfully brings the objective now to the past, the rest of people either stay in t_3 or are frozen in the time that they time-travel to or are frozen during time-traveling. However, this is not a good result because who is the winner is arbitrary and there is no principle or law that governs this phenomenon. Therefore, if Bernstein wants to preserve the MOP then she needs to say more about this criticism.

What about van Inwagen's version? In this version, it is the case that some people will lose their destinations during time-travel or they will vanish in a few seconds because someone brings the objective now to the further past. So, the hypernext will be like that Brown is the first one to arrive at the past but one second later he and slices are vanished by me locating at t1, and after one second, me and slices are also annihilated because

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Christina arrives at t_0. Christina brings the objective now to the farthest past and van Inwagen's time-travel is to annihilate all slices later than the objective now. Thus, the picture will be like what I state above. Is this plausible? Yes, it is. This is because it avoids the problem of arbitrary and provides an unproblematic answer of multiple simultaneous time-travelers problem: the one who travels the farthest survives.

2.3 The Fall of W-Model

In literature, not all philosophers accept the hypertime model. Ryan Wasserman (2018) criticizes that hypertime is an ontological burden and he provides a way-out setting all A-theories free from time-travel paradoxes. But his mercy is not successful based on the following reasons. I argue that W-model violates the A-Entrance principle that I characterized in *Introduction*. He allows new events to come into being in the past. Even if he adopts Movable Present* (without hypertime) to make an event located at the objective now, it still cannot avoid generating contradictions: both of these two propositions "Liao is dead as of t2" and "Liao is not dead as of t2" are true in W-model. Thus, I claim that W-model malfunctions and the only way-out for it is to incorporate it with a hypertime model.

2.3.1 The W-model

In this section, I will illustrate the idea of W-model from Ryan Wasserman (2018, pp. 99-106). This picture is an eternalist's view of the world with the A-theory doctrines: the passage of time and the irreducible A-properties. This picture is depicted in Figure 2.3 (with the highlighted slice indicating that 2018 has the irreducible A-property of *being present*). But, A-theorists will claim that this picture is only correct in a year since tensed facts are constantly changing: 2018 is present now, but it will be past soon. Given this, the picture will change from Figure 2.3 to Figure 2.4. All things in the block change in virtue of the passage of time.

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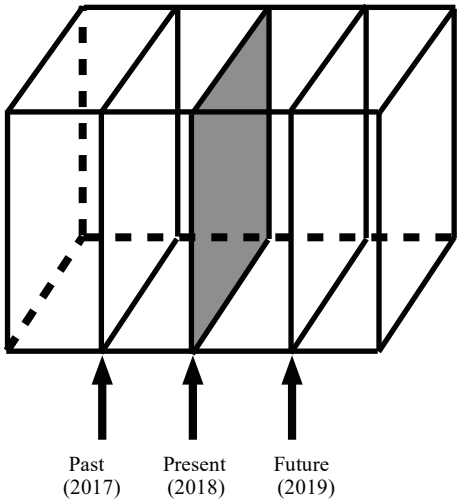

Figure2.3 W-model-1

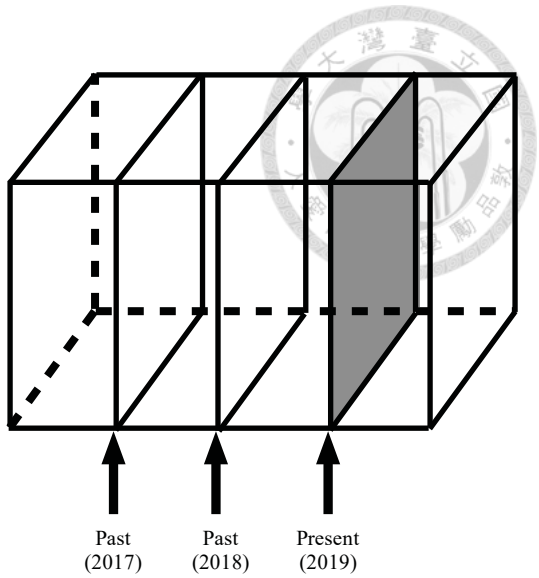

Figure2.4 W-model-2

In his text, he uses bullet propositions to illustrate how to change the past. In the following, I simplify my story into bullet propositions:

- I will time travel.
- Liao will die.
- There is only one stage of me at t_1.

A year later, t_2, these facts change, so the proposition will be:

- I will time travel.
- Liao dies.
- There was only one stage of me at t_1.

Now, it is t_3. I press the button of a time machine and Liao is not dead.

- I have time-traveled.
- Liao was not dead (because of my warning).
- There were two personal stages of me at t_1.

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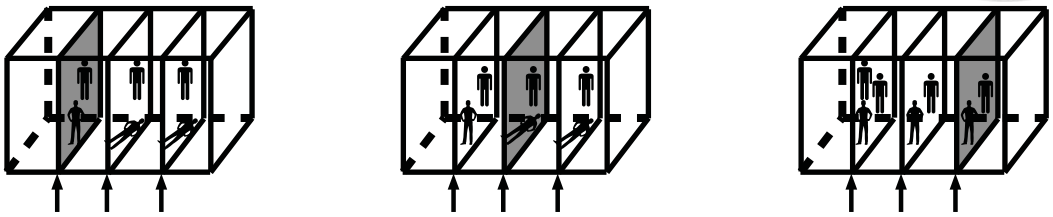
In this sense, the past is changed now. Although it was the case that there are no two personal stages of me at t_1, and I did not warn Liao for the accident, it is now the case that there were and I did. These bullets propositions can be depicted into three pictures below:



When t_1 is now, the block looks like Figure 2.5, when t_2 is now, the block looks like Figure 2.6, and so on. Figure 2.7 is different from others because I at t_3 time-travel to t_1 to warn Liao, so he did and does not die.

Wasserman offers this model to argue how to time-travel in an A-theorist's view of the world without positing hypertime; in addition, we could understand past-alteration in terms of changing irreducible A-properties. I can say that at t_1, there are no two personal stages of me when t_1 is present and there are two personal stages of me at t_1 when t_3 is present. He thinks that this is what A-theorists need in the past-alteration on the W-model. It is parsimony and intuitive. Things change only because of the passage of time.

2.3.2 The Fall

Certainly, Wasserman provides a way-out for A-theorists, but I don't think it works because it violates the A-Entrance principle and it cannot distinguish between two contradicted propositions.

Let's recall what the principle of A-Entrance of Coming into Being is:

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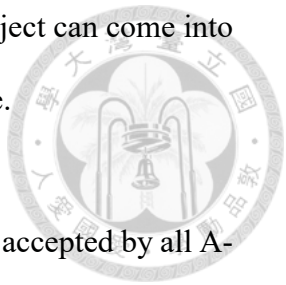

A-ENTRANCE OF COMING INTO BEING: An event or an object can come into being only by acquiring a location in the objective now slice.

This principle is accepted by all A-theories and if W-model could be accepted by all A-theorists, then the A-Entrance principle should be compatible with the W-model. However, the W-model violates the A-Entrance principle because the W-model allows an event to come into being in the past. That is, when the objective now is at t_3, the event of warning Liao for the accident at t_1 is coming into being. Since the objective now is at t_3, the event which is coming into being must locate at t_3, but this event locates at t_1. The first location of this event is not the objective now slice. How is it possible that an event is coming into being but its first location is not the objective now slice? Moreover, if the W-model were true, then this event would never have happened in the objective now slice but it was located in the past. This implication is counterintuitive. If the W-model allows these, then it is apparent that it is not compatible with A-theories.

Now, I think there is an approach that could help Wasserman to overcome my objection. Perhaps, he could adopt Bernstein's MOP to respond to my objection. But he does not want to posit hypertime in his theory so I should eliminate hypertime in the MOP and I call this version the MOP*. The MOP* shares all features from the MOP except the notion of hypertime. So, the story after putting the W-model and the MOP* together is that I time-travel at t_3 and bring the objective now back to t_1. I cause an event to come into being at t_1 and I successfully warn Liao about the accident and Liao stays alive at t_3. Any event I cause at t_1, after I press the button in the time machine, does not violate the principle of A-Entrance because the objective now is at t_1 rather than t_3. This approach is viable and it does save the W-model from the objection of the principle of A-Entrance.

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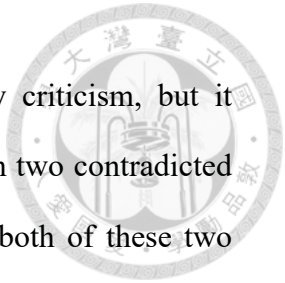

However, the story has not yet ended. The W-model dodge my criticism, but it generates a contradiction. The W-model cannot distinguish between two contradicted propositions: as of t_2 Liao is dead and as of t_2 Liao is not dead: both of these two propositions are true in the W-model. Wasserman could reply that Liao is dead as of t_2 in the perspective of the first round of time, that is, before I time-travel to warn him, he is dead at t_2. And, Liao is not dead after I time-travel to t_1 and warn him, so he does not die at t_2 in the second round. But this response does not succeed in the W-model with the MOP* because it smuggles the notion of hypertime. He does not have any resources to say that there are two rounds because there is only one dimension. Therefore, the W-model walks into a dead end. The only solution for this objection is to endorse hypertime model or the W-model malfunctions. If he accepted hypertime, then these two propositions can be distinguished: Liao was dead as of (h_2, t_2) and Liao was not dead as of (h_5, t_2).

2.4 The Indeterminacy Problem and Ryan Wasserman's solution

Matthew Slater (2005) attacks GBT with a famous objection called the future-photo problem which is a prototype of the indeterminacy problem. Ryan Wasserman (2018) advances Slater's problem and also offers a solution (without hypertime) to it.[10] In section 2.4.1, I will introduce this argument in terms of Wasserman's version and illustrate how he solves the problem. His solution is plausible and I am satisfied with it. But his solution only succeeds in virtue of the idea of hypertime, i.e., he presupposes the idea of hypertime in this solution (section 2.4.2).

[10] There are two sub-problems in the future photo problem: the problem of indeterminacy and the problem of fatalism. I will deal with them in section 2.4.2.

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2.4.1 The Indeterminacy Problem and Wasserman's Solution

When Wasserman characterizes the indeterminacy problem, he presupposes perdurantism is true. (Perdurantism claims that objects persist through time by having different temporal parts at different times.[11]) In the problem, there are four distinct temporal parts (I paraphrase his story by mine which I told in section 2.1): *temporal part-one* (P1) is that I lived in 2014, *temporal part-two* (P2) is that I lived in 2015 after Liao's death, *temporal part-three* (P3) is that I press the bottom of time machine in 2020 and *temporal part-four* (P4) is that I alarm Liao about the car accident. (For convenience, in the discussion, I will only use four temporal parts in my personal time and also only discuss four moments of time: t1 is a time before Liao's death in 2014, t2 is a time after Liao's death in 2016, and t3 is a time that I press the time machine's button in 2020.) I draw this problem into Figure 2.8.

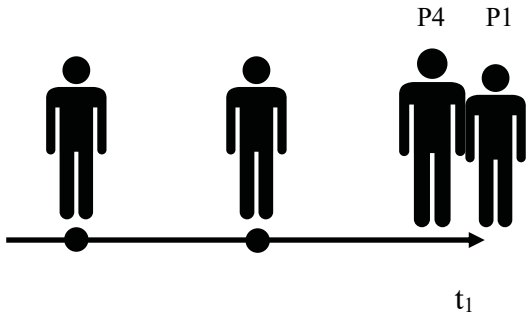

Figure 2.8 Time Travel-1

In Figure 2.8, we can see that the objective now is at t1, and there are four temporal parts (P4, P1 and another two of my younger parts). Except for P4, there is no indeterminacy in the other three temporal parts: the proper name "Yi-Cheng" (my name) refers to the sum of parts except for P4. It is determinately that P1 is not identical with P4 as of t1. ("Yi-Cheng" refers to the sum of three temporal parts since they have causal relations and there is no causal relation between P1 and P4, so "Yi-Cheng" does not

[11] In my dissertation, I usually use "personal stage" to call my temporal part in each time because I endorse Ted Sider's (2001) stage theory in my thesis. Here, since Wasserman presupposes perdurantism in his argument, I use the term temporal part rather than personal stage in this discussion.

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refer to P4.) However, as time passes, the objective now is at t3 (Figure 2.9). P3 time-travels to t1 to be P4 making P4 causally connects to all temporal parts of me. Now, it is determinately that P1 is identical to P4. So, the indeterminacy problem is raised: it is both indeterminately and determinately that P1 is identical to P4. However, Wasserman does not think this is a problem because new facts are coming into being in reality in virtue of the passage of time. The time-travel event grounds the relation of identity between P1 and P4, so it renders the proposition "P1 is not identical to P4" to be false. The basic notion of GBT sets itself free. This kind of phenomena is common in GBT view of the world. For example, I uttered "Taipei is raining now." The true-value of it is true. But as time passes, this sentence is false because new facts are coming into being.

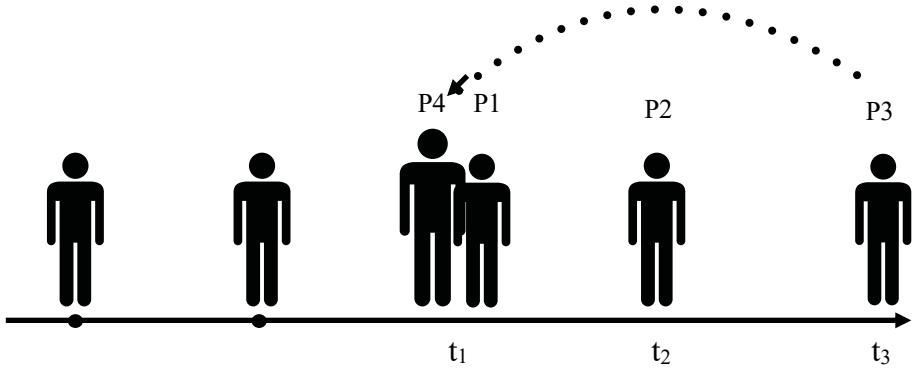

Figure 2.9 Time Travel-2

2.4.2 The presupposition of hypertime

However, this solution is not successful without hypertime. Wasserman has to answer two questions without the help of the notion of hypertime: where does P4 come from and why does P4 possess the knowledge about non-existed future? The simple answer for these is that P4 comes from the future and the block has not grown to the slice where he presses the button, so when the block grows to t_3, these problems are solved. This simple answer is the same as the solution to the indeterminacy problem. However, it

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does not work without hypertime because it faces two problems: the first is that it is subject to the no departure problem and the other is that it results in the fatalism problem.

The no departure problem is that P4 cannot say where he comes from in that P4 comes from a place which does not exist and this is counterintuitive. I use the spatial analogy of this problem to show how severe it is. For example, I took an airplane to the U.S.A from Taiwan. If Wasserman's solution is correct, then the situation will be like this: I am in the U.S.A, but if someone asks me "where are you from?", then I cannot point out a location in a map to answer her. There is no place for me to take an airplane. I am from nowhere. According to Wasserman, the passage of time will bring Taiwan back, but does it really make sense that I travel from Taiwan, but when I arrive, will Taiwan disappear? This is too counterintuitive for anyone to accept.

The fatalism problem is that if P4 is from the future, then it seems that when P1 grows to P4, he will definitely time-travel to the past in that there are facts "P4 exists at t1" and "P3 time-travels at t3". In this sense, I am not free to not time-travel at t3. This is similar to the future photo problem from Matthew Slater (2005).[12] This consequence would not accept by a GBTer. Nevertheless, Wasserman could turn these criticisms to the ontology of the GBT rather than his solution. This is a cheating step. I don't think a GBTer needs to bite the bullet. If a GBTer adopts the notion of hypertime, then these

[12] Slater (2005, p. 363) characterizes the future photo problem as follows: "As Tim rifles through newspapers from the '20s (a favorite pastime), a faded photo catches his eye: it seems to be of Tim himself. How could that be? Tim was born in 1966; the photo dates to 1921. The resemblance is striking but imperfect: Tim has more hair and fewer wrinkles. After ruling out obvious explanations, he considers an unlikely alternative. The mystery man was seen stepping out of a sort of cabinet said to have appeared out of nowhere. Perhaps, Tim thinks, the photo is a photo of me! Perhaps I was caught stepping out of a time machine in 1921. But Tim's excitement at the prospect of time travel (all he might do) gives way to a vague unease: if that was me back in 1921, am I not fated to travel through time? He wonders instead about what he has done."

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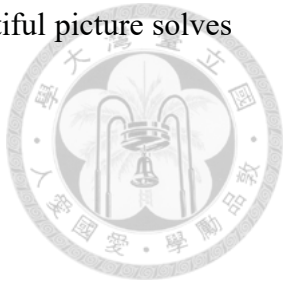
two problems are dissolved automatically. Let us see how this beautiful picture solves these problems.



2.4.3 Solving Paradoxes

Regarding the no departure problem, in Bernstein's version, there is no such problem because her version does not annihilate part of the block and the departure place is still there. Rather, van Inwagen needs to deal with this problem since parts of the block are annihilated. However, if you think like this, then you overlook the hypertime. If I can open the map of the 2-T map, I can point out where I come from. It still exists on the map which is (h_3 , t_3).

(HGBT is not subject to no departure problem, but does it suffer from the no destination problem from Williams Grey (1999)? [13] The problem is that there is no future slice in the block so if one wants to time-travel to the future, then there is no destination for this traveler in HGBT view of the world. I do not think this is a problem. Both of the two versions of HGBT could give a plausible solution to it. On the one hand, Bernstein (2017) claims that a time machine can generate time slices into the block. When one time-travels to the future, the machine will generate a slice into the block and this slice provides a destination for a time machine to land. Given this, MOP is not subject to the no destination problem. On the other hand, van Inwagen (2010, p. 3) says " [a] 'time-machine' for travel to the future need no more than uniformly slow down the physical processes that go on inside it relative to physical processes external to the machine. If all you want of a time machine is that it will be capable of taking you to the future, a

[13] In the paper, Grey does not use the term A- and B-theory to discuss the time travel issue. Rather, he uses Heraclitean and Parmenides to represent A- and B-theory respectively. He (1999, p. 57) says that Heraclitean view of the time is that "the future is genuinely open: there is no realm of determinate future fact, no denizens of the future to identify or talk about, though of course- in the fullness of time- there will be."

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spaceship that can reach speeds near the speed of light will suit your purposes very well." That is to say, as long as it is possible to time-travel to the past, the machine has an ability to time-travel to the future since the process is the same. Once we slow down time in the time machine, we can achieve the goal.)

Before I tackle the problem of fatalism, we need to know where exactly does P4 come from and why does he possess the knowledge of the non-existed future? Apparently, he comes from the future (in this part Wasserman is correct), but he does not come from the hyperfuture, rather, he comes from the hyperpast. If this is the case, then why does P4 say that he comes from the future? This is because before time travel is possible, we are not aware of the second temporal dimension. So, our language does not have any resources to represent this fact. Since we are only aware of the first-order time rather than hypertime, to say that P4 comes from the future is not wrong. Regarding the problem of having knowledge of the non-existed future. This problem only attacks van Inwagen's version because the future still exists in Bernstein's version. The answer is that P4 has knowledge of hyperpast rather than the non-existed place. The reason why P4 says he has the knowledge of the non-existed future is the same as the previous paragraph: he is not aware of the second temporal dimension. The right way to express this is that at (h3 , t3), P3 time-travels to (h4 , t1) with the knowledge he has obtained before (h3 , t3).[14]

Now, I can show why HGBT is not subject to the problem of fatalism. On the one hand, the MOP could say that P4 brings the objective now to the past and he does not time-travel again. Since in each hypermoment, the block is totally different from the previous

[14] Here we can see once posit the hypertime, the temporal order is not ordered by the time rather it is ordered by the hypertime. That is to say, h4 is necessary LATTER THAN h3 and h2 is necessary earlier than h3. This picture still preserves the direction of time and the temporal order.

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one, and Bernstein (2017, p. 87) says "what exists within the objective present is changeable and dynamic", so agents in the objective now can cause new events to come into existence to rewrite the original slice. The block relative to each hypermoment is different, and each block in each moment determines all facts about the past and the present. Thus, even if there is a fact in the hyperpast that P4 has time-traveled, in the hyperfuture, P1 is not determined to time-travel.

On the other hand, van Inwagen could say that the part of the block that contains the fact "P3 time-travels" is annihilated by P3 time-traveling to (h_4,t_1), so there is no fact that P1 has to time-travel in the future. The whole block can grow to a totally different future, that is, a future does not contain the event of time-travel about P3. But, this does not rule out that P3 has time-traveled or I should say "P3 hyperhas time-traveled". That is to say, in the hyperpast, there is a fact about P3's time-travel. But, there is no fact in the ordinary time that P3 has time-traveled after h4 because this part of the block is annihilated. Thus, when the block grows to t3, P3 can decide whether he wants to time-travel or not. Thus, in this sense, the future is still open.

2.5 Conclusion

At the end of this chapter, after I argue about how one time-travels in HGBT view of the world without generating paradoxes, it is time to write the last page of the rescue story I told in section 2.1.

> In 2019, I pressed the button of my time machine and the destination on the screen is Oct. 7, 2014. Five seconds passed, I stepped out of the time-machine. I was sure that I was at Soochow University, Taiwan, but I did not know what time it was. I walked into a building and asked a student what date and what

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time it is. The student felt a little bit weird but she told me that "today is Oct. 7 and it is 3 p.m. now." "What is the year now?" I asked. "It is 2014" she replied. I knew that the past me was taking "Moral Psychology" now, so I could not ask any of my classmates to lend me their phone. I entered into an office where I worked and borrowed the phone to call Liao. When the phone connected, I immediately said "hey, it is no time to explain why I say these. Please do not ride the motorcycle this month. Please take the bus or train. This is weird, but all of these are for your sake. So, please do not ride a motorcycle or scooter. Please…" He did not say anything but "ok, I got it." "When you come back to Taipei, please meet me." I said. "OK" he said and we hung up the phone.

I left the office and went back to my time machine. I set the time 2019 to try to travel back. But the time machine kept saying that "there is no destination". After I tried several times, I realized that the future part of time is annihilated by my time-travel journey. I was stuck in the past or I should say I was stuck in the past but at hypernow. I lived in the past waiting Liao to come back. In Nov. 16, 2014, he finally came back and I picked him up at the train station. I saw him with tears and said "you finally come home and welcome back."

This is the whole story about me time-traveling to the past in the HGBT view of the world. We have seen how hypertime is useful and there are enough reasons to endorse it in a theory when one genuinely wants to change the past. Although some people think that it is an ontological burden and a good theory should be parsimony, if we posit it in our theory and we can solve many problems and paradoxes, then why shouldn't we endorse it? Perhaps, in the end, opponents will be convinced by my arguments in this chapter but they still cannot fully buy van Inwagen's version of hypertime in that it

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implies GBT. Hud Hudson and Ryan Wasserman (2017) argue that GBT is the least plausible and popular theory of time and they deem this as a weakness. But I do not think this is correct because my dissertation is to advertise GBT and in the next chapter, I will provide a response to a fatal objection to GBT—the epistemic problem. If I succeed, then GBT is not the least plausible anymore.

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CHAPTER THREE:
The Epistemic Problem

The epistemic problem is offered by Craig Bourne (2002), David Braddon-Mitchell (2004), and Trenton Merrick (2006). Intuitively, we believe that we are at present, but given a GBT's view of the world, this belief is unsafe. This is because there are many past people who falsely believe that they are at the present such as Caesar, C. D. Broad and even past stages of me. If this is the case, then how can one confidently claim that she is at the present? However, do not other theories of time face this problem? For Presentism, consensus holds that it is not subject to the problem. The reason Craig Bourne (2002) offers is simply that the only time that exists in Presentists' view of the world is present so agents must at the present. But Ross Cameron (2015) argues that if A-theories endorse the strict standard for knowledge, then the standard is so strict that even the Presentism cannot escape from the epistemic problem. (I will discuss this more in section 3.1.1.) On the other hand, MST is in the same position as GBT. People, in the non-presentism A-theoretic view of the world, do not possess any evidence to justify their belief of locating at the objective now (even if actually they are at the objective now). As for B-theory, a static Four-Dimensionalism, it is not subject to the problem in that people in a B-theoretic view of the world do not need to know whether the slice they stand is the objective now slice or not because there is no such slice. As Ted Sider (2001, p. 17) said: "there is no metaphysical distinction to what I call the present; I truly call it "present" simply because it is when my utterance is located." Thus, anyone in any location in the B- theoretic view of the world truly believes that they are at present.

Let's go back to GBT. In literature, there are two kinds of responses. One is from the perspective of the metaphysics and the other is from the perspective of the

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epistemology. The typical response of the former is Peter Forrest's (2004, 2006) "Dead Hypothesis"; he argues that people who locate in past slices lack consciousness and this is the distinction between past slices and the objective now slice. People who cease to be present cease to be conscious at the same time. So, in this view, any agent can know she is at the objective now if she is conscious. But this solution is objected for several reasons. One of which is how do we know that past slices are full of people who lack consciousness. Another is that Forrest only defines the distinction between the past and the present while he does not offer any epistemic evidence to show that we are at the objective now slice. In addition, I still can ask how does an agent know that she is conscious? So, I do not think the approach from the perspective of metaphysics is viable.[15] What about the epistemic approach? I will mainly focus on Ross Cameron's (2015) less strict standard for knowledge. In the following section, I will firstly illustrate why he endorses the less strict standard for knowledge rather than the strict standard for knowledge. After that, I will show how his theory survives from criticisms. Lastly, I will illustrate how this theory set GBT free with the notion of coming into being.

3.1 The Epistemic Solution: Ross Cameron's approach

Ross Cameron (2015) claims that if A-theorists adopt the strict standard for knowledge, then all A-theories are subject to the epistemic problem even Presentists cannot escape it (section 3.1.1). He reckons that A-theorists should adopt the less strict standard for knowledge, which is to believe that our theory is true. If our theory is true and it says one can know that she is in the objective now slice, then she can acquire the knowledge. He believes that if the world cooperates, then A-theorists can know that we are at the objective now. But this approach receives some criticisms from Kristie Miller (2017,

[15] There are many criticisms against Forrest's theory such as Braddon-Mitchell (2013) and Heathwood (2005).

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2018) and J. S. Russell (2017) and I will respond to them respectively (section 3.1.2 and 3.1.3).

3.1.1 Strict and less strict standard for knowledge

Ross Cameron (2015) argues that A-theorists either accept the strict standard for knowledge or abandon the strict standard for knowledge. The strict standard for knowledge in his mind is that: if S knows that *p*, then S's evidential base must be accessible to S and this evidence permits S to rule out that S are in the case that non-*p*. In our daily life, we usually use this method to acquire knowledge. For example, I know that *p* "Liao is playing volleyball in the playground now" because I have evidence that I see him playing volleyball at the playground and he wears the blue volleyball suit that is the same suit he wore when I chatted with him this morning. But when I went back to the classroom, my classmate told me that Liao is at the shop now. She also had evidence that that person was him based on the same outlook of Liao. I asked her what is the color that person wears? She says: "Orange". Unfortunately, the suit he wore was blue rather than orange. I had strong evidence to rule out my friend's belief (non-*p*) because Liao only had one volleyball suit and that one was blue.

Although this method captures our intuition in acquiring knowledge, in facing the epistemic problem, Cameron thinks that this standard is so strict that even if Presentists cannot acquire the knowledge of locating in the objective now slice. His argument is that:

> On strict internalist standards for knowledge, I argued, every A-theory faces the epistemic problem, including presentism and my version of the moving spotlight. […] I argued that the presentist does not avoid the epistemic problem simply because there are no people who falsely believe that they are present. What matters is whether the presentist can rule out the scenario

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> that there are people who falsely believe that they are present. If there is nothing in our present experience that lets us rule out that that experience is being had by a non-present individual, then we do not know that we are present, whether or not any non-present individual in fact has such experiences. (2017, p. 811)

The criterion that he uses to determine which theories of time are subject to the epistemic problem is whether agents can rule out relevant possibilities by "present experience" or not. Even if the world is a Presentist's view of the world, any agent cannot rule out relevant possibilities by present experience. If they cannot rule out close possibilities, then their beliefs are not safe. This consequence is not accepted by most philosophers. So, Cameron suggests that we, A-theorists, should abandon the strict standard for knowledge.

What is the theory of the less strict standard for knowledge in Cameron's mind? He calls the externalism of epistemology the less strict standard for knowledge compared with the internalism, the strict standard for knowledge. The externalism he (2015, pp. 38-49) thinks is that "if the world cooperates, then the theory that is selected as best will be true, and we will know it to be so, and hence we will know that what that theory says is true." The externalist's view of justification is usually used in daily life. For example, I know that there is an apple on the table because I see an apple on the table and in each angle, there is an apple on the table. This knowledge is acquired via the perception (my eyes). But I do not exactly know the function of my eyes. I cannot directly access my evidence that justifies my belief. If I accept the strict stand for knowledge, then I do not gain the knowledge. But if I accept the externalism here, then I acquire the knowledge because agents do not need to directly access the evidence; rather, if the process (the perception) that I form the belief from is reliable and the belief is safe, then I can say that I acquire the knowledge.

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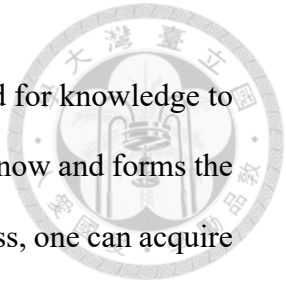

Cameron thinks we, A-theorists, should adopt the less strict standard for knowledge to solve the epistemic problem. When an agent locates at the objective now and forms the belief of locating at the objective now from the belief-forming process, one can acquire the knowledge of locating at the objective now. (The belief-forming process is to believe that you are present as a result of learning a theory of time. (2015, p. 42)) Therefore, the epistemic problem is dismissed. Nevertheless, this approach is subject to criticisms. The following two sections are the objections about reliability and the problem about safety. I will respond to them to argue that Cameron's theory is true.

3.1.2 Reliability

The less strict standard for knowledge is objected by Kristie Miller (2017) who argues that the belief-forming process in Cameron's theory is not reliable. The argument is that:

> Suppose [I] have the belief 'I am present' at S[lice]-10. Consider, first, whether there is a reliable connection between [me] having that belief, and its being true. Notice that given the [MST], said belief is tokened at S10 when it is t_3: i.e. when S10 is objectively future, before presentness has arrived at S10, and it is tokened at S10 when it is t_{20}, i.e. when S10 is objectively past. Indeed, we can map [my] belief to a truth-value when it is t1, when it is t_2, and so on. At each time the belief is mapped to 'false', except in the one case in which S10 is present, namely t_{10}. If there are 100 slices in the world, then [my] belief is mapped to 'false' 99 times, and to 'true' once. On the assumption that a mechanism is reliable only if the ratio of true to false beliefs that it produces is in favour of true beliefs, then the mechanism in question is not reliable. (2017, p. 784)

The point of the argument is that my belief of locating in the objective now slice is mapping to be true only one time and to be false several times. So, the belief-forming

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process is not reliable. But Cameron does not think that Miller's criticism works in that she misunderstands what he says. Even if she wants to evaluate Cameron's theory in virtue of the ratio of true to false beliefs, his theory is not subject to this objection. His response is:

> If the moving spotlight theory is true, it's always the case that when someone goes through this process, the belief formed as a result of that process is true. Merely past people falsely believe that they are present; but their belief was true when they formed it—so at the time they implemented the above process, it didn't take them wrong. (2015, p. 42)

All beliefs are formed to be true, i.e., beliefs are true when they are formed. If I form 100 beliefs through this process and all of them are true, then the result is 100 true beliefs to 0 false beliefs.

The real disagreement between Kristie Miller and Cameron is that they have different conditions of reliability: they have a different criterion to evaluate the belief-forming process. Miller thinks we have to evaluate all beliefs in the block at the same time to know whether the process is reliable or not. (Please see Figure 3.1.) For example, suppose that the hypernow is at h5 and the objective now is at t5. There are six stages of me in the block and each year, I launch the belief-forming process to form the belief of locating at the objective now. Now, it is t5. Past stages of me possessing false beliefs. There are 5 false beliefs and only 1 true belief in the block, so the belief-forming process is not reliable.

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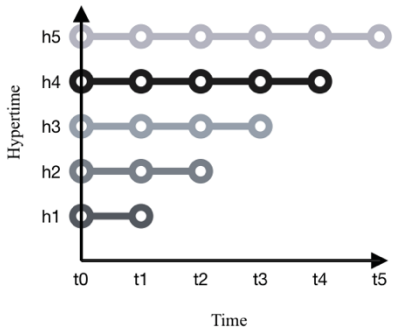

Figure 3.1 Locations of Beliefs-1

On the other hand, Ross Cameron does not use Miller's criterion to evaluate the belief-forming process. Rather, he thinks we should evaluate the belief right after it is generated, i.e., at the moment it is generated. See Figure 3.1 again. Cameron's method is to examine (h_1, t_1), (h_2, t_2), (h_3, t_3), (h_4, t_4) and (h_5, t_5), rather than (h_5, t_1), (h_5, t_2), (h_5, t_3), (h_5, t_4) and (h_5, t_5). Beliefs located at the former position are true, so Cameron concludes that the belief-forming process is reliable.

Whose criterion is correct? I think both of them are plausible, but if one wants to evaluate a diachronic belief-forming process, then I think Cameron's method is correct. I do not say Miller's is false, rather, her method is correct when we evaluate processes that are located in the same slice. Consider the following example. Suppose there is a bubble tea machine and there is a button on it. When someone wants to make a cup of bubble tea, she only needs to press the button and the machine will immediately produce a cup of delicious bubble tea (and suppose that the machine can produce the same delicious cup of bubble tea each time.) Now, Milly wants to examine does this machine really produce the same (delicious) bubble tea each time? She presses the button 100 times and labels each cup of tea a number from 1 to 100. Now, she tastes each of them. She tastes tea-1 and marks "bad" on the sheet and tea-2 is bad, and tea-3 is bad too. After she tastes all of them, she concludes that this machine is not reliable because it cannot produce the same (delicious) bubble tea each time. On the other hand, Camry

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also wants to examine the bubble tea machine. But he uses a different way to examine it. He tastes the tea immediately when the tea is made. After he tastes all cups of bubble teas, he concludes that the machine is reliable since it can produce the same (delicious) bubble tea each time.

The conflict shows up. Why does the same machine produce two contradictory results? Is one of their methods incorrect? No, the reason that causes the result to be different is the passage of time. This is an A-theorist's view of the world, the world is changing. The passage of time adds or deprives something from an object; for example, the passage of time renders the truth-value sentence to be false by adding new facts. So, in this scenario, the passage of time deprives the quality of the bubble tea rather than the machine not produceing the same (delicious) bubble tea. Thus, this is the reason why Miller's result shows the process is unreliable and Cameron's result shows the process is reliable. In the bubble tea case, it is apparent to see that Cameron's approach is correct in evaluating the cross-temporally belief-forming process.

3.1.3 Safety

On safety, Cameron states that S's belief is safe iff S's belief couldn't have easily been false in the sense that most of S's counterparts in the same situation hold the belief truly. That is to say, if I form the belief of locating at the objective now from the belief-forming process and most of my counterparts hold this belief truly, then my belief is safe.

But who is my counterpart? We could adopt David Lewis's methods in *Counterfactual*. According to Lewis (1973, pp. 39-43), each person has many counterparts in other possible worlds; my counterpart and I share the same intrinsic properties and similar

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external relations. Furthermore, if we, in this sense, want to evaluate our beliefs of locating in the objective now slice, we need to examine counterparts in closet possible worlds. The method of choosing close possible worlds here is to find a similar situation that counterparts launch the same belief-forming process. For example, if I evaluate whether my belief of locating in the objective now slice is safe or not, then close possible worlds are worlds including a counterpart of me and he launches the same belief-forming process. If most of the beliefs in these closet possible worlds are true, then my belief is safe.

Nevertheless, many philosophers do not accept the modal realism that David Lewis offered; it should be provided a way for all philosophers who accept different modal theory. Thus, the meaning of counterpart should be more like what Cameron says than Lewisian. Cameron adopts David Manley's (2007) notion and invokes a counterpart relation on thought. So, we do not need to seek counterparts from other possible worlds; rather, counterparts can be found in the actual world: as long as two people share the same relation on thought, they can be deemed as counterparts.

But, if I adopt this approach to choose counterparts, then there are many counterparts holding false beliefs such as C. D. Broad or even past-stage of me. Consider the attack from J. S. Russell (2017). He thinks that since Broad is my counterparts so my belief is not safe. His argument is:

> When we are canvassing for possible cases of belief, we should include in our consideration various ways that reality has been and will be. […] [A]ccording to [the MST and the GBT], beliefs like [Broad's] will continue to be real full-fledged beliefs that happen to be located at past times. When t′ is absolutely present, [Broad's] belief about t will be one of them. A

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> genuine case of belief shouldn't be excluded from consideration as a close case just on the basis of its temporal location. (2017, p. 163)

To solve this problem, Cameron considers that Broad's position is not close enough to be viewed as my counterpart based on the following reasons:

> [W]hen we are to think about close possible circumstances in which something happens, we are (often) to think of collections of world-time pairs in which that something presently happens: i.e. we consider circumstances in which the spotlight falls on the time at which the event we are considering is happening. When thinking about what happens in close possible circumstances in which [Broad writes the *Scientific Thought*], we should think about world-time pairs in which the spotlight shines on [Broad's writing the *Scientific Thought*]. This does not include the actual circumstances, where [Broad writes the *Scientific Thought* a hundred years] before the time on which the spotlight shines.
>
> So now consider the close possible circumstances in which I believe that I am present. In all of them, I am present, precisely because I consider only possible circumstances in which the spotlight shines on the time at which the event I am considering—my believing that it is present—happens. My belief that I am present could not easily have been false, then: the close possible circumstances in which I believe it are ones in which the time at which I have the belief is the time on which the spotlight falls, which is exactly what makes my belief true in those circumstances. (2015, pp. 41-42)

If this works, then Russell's objection fails. When we evaluate a belief whether it is safe or not, we examine counterparts who in the same situation hold the same belief. The way of choosing counterparts that Cameron introduces is not what we are familiar with. He considers that agents who stand on the same slice and are shined by the spotlight at the same time are our counterparts. So, in this sense, Broad is not my counterpart and most of my counterparts truly believe that they are at the objective now.

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If agents on the same slices via the same belief-forming process believe truly, then the belief can be deemed as safe in that most of the counterparts in the same situation do not hold belief falsely.

It is safe to conclude that the belief-forming process is reliable, and the belief of locating at the objective now from it is safe. Therefore, Cameron's theory is viable, and in the next section I will use it in the GBT view of the world to see how it solves the problem.

3.2 Cameron's Approach Set the GBT Free

How to combine GBT and Cameron's theory is the main goal of this section. I will combine Cameron's theory with C. D. Broad's (1923) of notion "coming into being" to strengthen the theory and make it more compatible with the GBT (section 3.2.1). Moreover, I will show how my theory passes the test of reliability and safety of knowledge: it secures the reliability and safety of knowledge (section 3.2.2). In the end, putting them all together is a theory that agents can know that they are at the objective now: the belief-forming process is reliable and the belief is safe.

3.2.1 Coming into Being

Recall what the notion of coming into being is. It is a kind of change implying that before an object undergoes this change, it does not exist and after it undergoes these changes, it begins to exist in the block.

How does "coming into being" relate to "the belief-forming process"? Firstly, I treat the belief-forming process as an event that involves process and the belief.[16] When I

[16] An event is a particular existing in the four-dimensional manifold.

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utter “the event is coming into being”, what I mean is that both the belief-forming process and the belief are coming into existence. Moreover, according to the A-Entrance principle, an event is coming into existence which only happens in the objective now slice; that is to say, an event in the past is not coming into existence. What does this mean? I need to illustrate clearly the distinction between the event coming into existence and the event not coming into existence. The distinction is that the former occurs in the objective now slice and before the event is coming into existence, it does not exist. When I locate in the objective now slice, I form a belief about locating in the objective now slice. Before I launch the belief-forming process, the belief does not exist (whatever it is tense or tenseless). The latter is that people located in the past formed the belief of locating in the objective now slice, but the belief and process are not coming into existence: they already exist (tenseless) in the block. Past people only implemented the process to form the belief and the event just happened. For instance, when Broad was writing *Scientific Thought* at (h_1, t_1), he believed that the time he wrote *Scientific Thought* was present (Figure 3.2). He launched the belief-forming process and obtained the belief of locating at the present. When the objective now is at (h_1, t_1), his belief of locating in the objective now slice is true. But, when time passes and the objective now is at (h_5, t_5), his belief is not true. This is because his belief is located at (h_5, t_1) and this belief is not coming into being: it already existed before he implemented the belief-forming process.

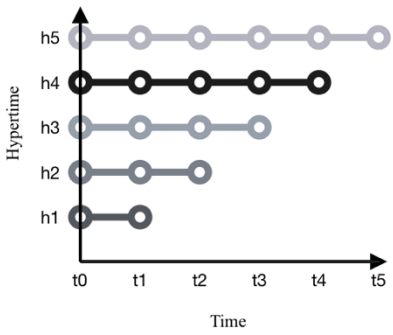

Figure 3.2 Locations of Beliefs-2

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The overall picture is that suppose I am at the objective now, 2019, and I consider that the GBT is the best theory among others, and this best theory says that I am at the objective now slice, so if I believe the GBT, then I can acquire the knowledge of locating at the objective now. The belief of locating at the objective now is safe and the belief forming-process is reliable because both of them are coming into existence. Moreover, once this stage of me ceases to be present, even if that stage of me launched the belief-forming process, the belief of that stage of me is not true in that he couldn't make the event come into existence: he only launched the process to generate the belief rather than brought the belief into existence.

3.2.2 Reliability and Safety

How does this combination strengthen the reliability of the belief-forming process and the safety of the belief of locating in the objective now slice? I will show how this combination solves the criticisms. Kristie Miller (2017) objects that the belief-forming process is not reliable because the process generates more false beliefs than true beliefs in the block. J. S. Russell (2017) contends that there are many past stages of me or counterparts falsely believing they are at the objective now, which renders my belief unsafe. How does my theory respond to these objections?

We should determine firstly who are my counterparts when I evaluate whether my belief-forming process is reliable and the belief of locating in the objective now slice is safe or not. Following the method from section 3.1.3, I should find who launches the same belief-forming process as me. But this is not enough because Broad and past-stages of me also launch the same belief-forming process. I think we should add "coming into being" as a condition to choose who is my counterparts. My counterparts are who bring the belief-forming process and the belief coming into being. So, my

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counterparts are who locate at the same slice as me. Namely, those who locate at the objective now slice. Now, we know who is my counterparts, so let us begin to examine my theory.

For the reliability, the reliability of the process not only relies on the quality of the product but also the process itself. That is, if the process is coming into being when I form the belief of locating in the objective now slice, then it increases the degree of reliability of the process. Now, let's examine my counterparts' belief when I obtain the belief of locating in the objective now slice. My counterparts are who stands in the same slices and launches the belief-forming process. Then, how many agents obtain false belief from the process? The answer is that nobody launches the same process and acquires the false belief. All beliefs in this examination are true. So, according to the ratio of the true to false beliefs, the belief-forming process of locating at the objective now is reliable. On the other hand, is my belief safe? The answer is apparent by the examination of the reliability. All of my counterparts hold true beliefs, so my belief is safe. Thus, my theory passes the test.

But, traditionally, the safety account of the knowledge is subject to the criticism about the unnecessarily and insufficient condition. I only reply briefly because of the limited space. I bite the bullet that the condition of safety is not sufficient, so I think the knowledge should also be satisfied with another condition "reliability". On the other hand, I think that safety is necessary for the condition of knowledge. For a simple answer, if the belief is easy to be false in relevant possibilities, then is it qualified with knowledge? Doesn't the true belief I get involving the portion of luck? I think many epistemologists do not accept the belief involving the portion of luck that could form a knowledge.

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3.3 Conclusion

In this chapter, three key elements to solve the epistemic problem from the perspective of the GBT are the notion of coming into being, the safety and the reliability. The first key is from C. D. Broad and it also is the fundamental feature of the GBT, so I do not add anything in my ontology. Moreover, both the second and the third are from Ross Cameron, but I advance his theory. I put the reliability and the "coming into being" together for establishing a stronger theory to secure knowledge. Therefore, once we put these three keys together, agents locating in the objective now slice knows that she is at the objective now: the belief-forming process is reliable, and the belief is safe.

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CONCLUSION

The most famous theory of time is B-theory and the second famous is Presentism or someone would say the MST since it combines the virtues from A- and B-theory. In literature, there are few essays discussing the GBT and I do not think the GBT deserves this treatment. It is not only capture pre-theoretical intuition but also theoretical concerns. If this is true, then why do philosophers treat it like this? It does not fair! If some people say that this is because the GBT cannot coherently answer objections from epistemology and time travel and even it cannot illustrate the passage of time unproblematically, then I do not think the GBT is as bad as opponents' claims and I think I have offered a coherent and holistic version of the GBT to dispel these objections together.

In the first chapter, I introduce a new theory—hypertemporal ontology. This is a breakthrough in the philosophy of time because most philosophers of time endorsing hypertime in their theories do not notice that hypertime possesses ontology as well. This overlook might lead their theories to collapse or to generate contradictions. Moreover, if they do not make hypertemporal ontology clear, then they might respond to some problems that they do not need to reply to or claim that there are some virtues to adopt their theories but their hypertime model does not really possess that virtues. If they clearly state what their hypertemporal ontology is, then this concern vanishes. In the second half of this part, moreover, I show how hypertime helps the GBT to solve four questions about the passage of time. HGBT can holistically explain why time passes, how time passes, where time passes, and how fast time passes.

In the second chapter, I also use hypertime plus the GBT (HGBT) to respond to all severe objections to the GBT in the issue of time travel. I want to illustrate how an agent

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time-travels in the GBT (or HGBT) view of the world. More specifically, how an agent time-travels to the past and changes the past without generating paradoxes. There are three paradoxes I focus on: the future photo problem, the indeterminacy problem and the no destination problem. HGBT provides a good solution for all of them. At the same time, some philosophers object to theories involving a hypertime model and I argue against them altogether. I do not think hypertime itself generates any problem or contradiction. For the first and second chapter, I show that why one should adopt hypertime in one's theory. I have done my best to advertise this notion.

In the last chapter, I offer a response to the epistemic problem and I think this is the fatal objection to the GBT. In literature, the reliabilism of epistemology does offer a way to solve this problem. But, this approach is subject to several objections. However, I do not think these objections sentence the reliabilism death. I think if I combine the reliabilism with the notion of coming into being, then I can solve objections. This combination advances the reliabilism to make the belief-forming process more reliable and beliefs of locating in the objective now slice generated by it are safe. Thus, we who stand in the objective now slice can say we know we are at the objective now.

Based on these three chapters, I think the GBT is not what philosophers say "the most unpopular theory of time". Since I respond to many objections it receives and characterize it as a more plausible theory to everyone. Therefore, I think it deserves the same treatment as other theories of time on the battlefield.

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