Persistence as Transition

— A New Perspective on Persistence —

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Introduction

A New Perspective on Persistence

There is *one* predominant framework in the current debate on persistence. You might doubt this because there are actually *three* standard theories of persistence, endurantism, perdurantism, and exdurantism. It is true, but what is meant here is that all the three theories are actually within *one general framework*. What is the general framework? Consider a situation where we explain persistence to students who have no idea about it. We might take a 3-D object in front of us such as a rubber ball and say that the persistence of the ball is that it exists at more than one time. For example, we might say 'the persistence of a ball is that it existed at a past time, say yesterday, and it still exists at the present time, say today'. If we are asked about temporal locations, we explain there is another (fourth) dimension as time and it offers temporal locations for this persisting rubber ball. As we can tell easily, in this explanation, we introduce time as the fourth dimension and locate objects at times. This is the general framework mentioned above. Since we are so familiar with this framework that we even might not notice that the three standard theories share this general framework for understanding concrete reality including persistence.

Suppose these students get a sense of persistence by our explanation, although introducing a fourth dimension itself may be a bit tough for them to swallow. Now, according to them, the picture we offered is *static* because if we locate objects at times, they are always stationary at their own times and never move. They think persistence is more like a *dynamic* phenomenon: it is something like 'moving through time'. Since we are not sure about what they mean by 'dynamic' and 'moving through time', we gently ask for some articulation. Unfortunately, we receive no further explanation. Without any articulation about dynamicity, all we can say is something like this: whatever persistence as a dynamic phenomenon means here, we do not need to deny that there is a dynamic phenomenon itself. We can be just

reductionist about it. We understand something dynamic in terms of more basic *non*-dynamic things (objects located at times). At least this is our framework for understanding persistence. We conclude that if they share the same explanatory framework but still think persistence is a dynamic phenomenon in an *irreducible* sense, we who accept the general framework in this case have no idea about it. It is just incomprehensible for us without any articulation.

You might wonder whether there is *any* way to defend the idea of persistence as an irreducibly dynamic phenomenon. I think we can, but this cannot be done within the general framework above (we will see why this is so in later chapters). Thus, in a sense, our reply is correct in that their idea is indeed incomprehensible *within* the framework. What we need to do is to build a *different* framework in which persistence as an irreducibly dynamic phenomenon is comprehensible. For, as will see later, we cannot achieve the defence by just taking some concrete reality as fundamental and regarding it as irreducibly dynamic within the *same* general framework in which persistence is understood in terms of objects being located along the fourth dimension. For example, we might take temporally extended 4-D entities at spatiotemporal regions (e.g., processes) as metaphysically fundamental and just regard them as irreducibly dynamic. We cannot just do this because theorists in the general framework above also accept temporally extended 4-D processes but usually do not regard them as dynamic: they are just located at spatiotemporal regions, and nothing more or less. Without offering a clear metaphysical basis for this irreducible dynamicity, we never even make ourselves understood. Unfortunately, we cannot offer such basis within the general framework, or so I shall argue.[1]

If we can defend persistence as an irreducibly dynamic phenomenon but cannot do it within the same framework, how can we offer a new perspective on persistence that is different from the general framework above? The

[1]For more detail, see Ch.3-4.

best way is to start with a phenomenon that the theorists in the original framework also regard as dynamic. Of course, they will not take the dynamicity of the phenomenon as fundamental and so reduce it to something non-dynamic. But the point here is to build a common ground for discussing dynamicity. Once we have a common ground, we can meaningfully classify two different views on dynamicity. One view is to take something dynamic as non-fundamental and reduce it to more basic non-dynamic things. That is, we are reductionist about dynamicity. Another view is to take something dynamic as irreducible and explain non-dynamic things in the first view in terms of that dynamic thing. That is, we are non-reductionist about dynamicity.

What does this alternative framework look like more specifically? In the rest of Introduction, I try to describe the basic ideas of this new framework. In what follows, I distinguish theories of persistence into two different kinds. This distinction is given from a more general point of view than the current popular one, i.e. endurantism, perdurantism, and exdurantism. These two kinds are, what I call, *state theories* and *transition theories* of persistence. State theories include current standard theories of persistence such as endurantism, perdurantism, and exdurantism. By contrast, transition theories offer a new perspective on persistence, which is based on the Flux-first view developed by Stephen Barker.[2] This distinction will help us not only get a sense of transition theories but also get a better understanding of current standard state theories of persistence.

State Theories of Persistence

While the term 'state theories' is new, we are already familiar with the general framework of state theories because this has been the popular idea in the problem of persistence. In state theories, the persistence of a concrete object is understood by (i) introducing a fourth dimension and (ii) locating

[2]Barker (unpublished).

objects along the fourth dimension. That is, they understand persistence in terms of locations along the fourth dimension. Let us call this framework the *state-theoretic* framework. Standardly, time (with time instants) is introduced as the fourth dimension and 3-D objects are located along the fourth dimension. Of course, times on the fourth dimension does not need to be time instants; they might have some non-zero extension. The crucial idea here is to understand a fourth dimension as offering locations for persisting objects and persistence in terms of these locations along the fourth dimension. Let us here accept the standard assumptions, and consider the persistence of a concrete object, say a blue rubber ball. The following Fig.1 is a simple illustration of this state-theoretic framework:

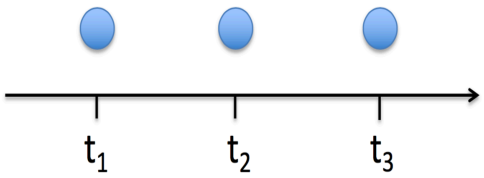


Fig. 1:

That is, we set time as the fourth dimension and locate 3-D balls b_i at times t_i on the fourth dimension. In Fig.1, a 3-D ball b_1 is at t_1, a 3-D ball b_2 is at t_2, and a 3-D ball b_3 is at t_3. What is at issue in state theories is this: *what* are these 3-D objects located at times? For example, these 3-D objects at times are the object itself or temporal parts (stages). Let us call these objects with properties located at times as *states*.[3] So, for example, one state in Fig.1 is a blue rubber ball b_1 being located at t_1.

Keeping this general framework in mind, let us take a quick look at how three standard state theories understand persistence.[4] In endurantism,

[3]While we can use 'states' with 'dynamic' as in 'dynamic states', in this dissertation, we use the term 'states' only in this *locative* sense.

[4]We will look at these standard theories in more detail in Ch.1. Here, we only make sure that these three standard theories share the state-theoretic framework.

an object O persists by the same O's being at different times. In our ball example, this means all the 3-D balls b_i at t_i are identical. In perdurantism, O (as a 4-D spacetime worm) persists by O's having different temporal parts at different times. In our ball example, this means all the 3-D balls b_i at t_i are different temporal parts of the ball as a 4-D spacetime worm. In exdurantism, O persists by its being in a temporal counterpart relation to another numerically distinct object O' at a different time.[5] In our ball example, this means b_1 at t_1 is in a temporal counterpart relation to a numerically different 3-D ball b_2 at t_2. The crucial point here is that all these three theories understand persistence in terms of (i) 3-D objects (with properties) being located at times (i.e. states) and (ii) a certain relation between 3-D objects at different times. That's why we call these three standard theories *state* theories.

You might think this state-theoretic framework is so obvious that we even cannot imagine an alternative framework for persistence. That is, whatever we have as a theory of persistence, the theory has to understand persistence by introducing time as the fourth dimension and locating objects at times. While there are varieties of theories of persistence, they might be all within this state-theoretic framework after all. It is true that we are so familiar with this framework that it is really difficult to think of an alternative framework. However, of course, this does not imply there is actually no alternative. In the rest of Introduction, let us try to describe an alternative framework, transition theories, which is based on the Flux-first view proposed by Stephen Barker.[6]

Transition

Let us first explain the core idea of transition theories, *transition*. Transition itself is not a technical term created by transition theories. Rather, we are

[5] A temporal counterpart relation between O and O' is a certain continuity required for O to persist. For more detail, see Ch.1.

[6] Barker (unpublished).

all familiar with transition or motion because we experience it in our daily life. For example, consider a case where a ball B transits or moves through 3-D space (in a football game or whatever). This is an example of transition and captured by Fig.2-4 below (although 3-D space is expressed as 2-D in Fig.2-4 and they falsely give static images of a ball B's transiting through 3-D space):

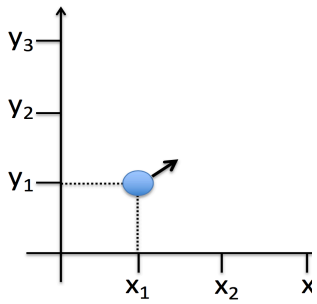


Fig. 2:

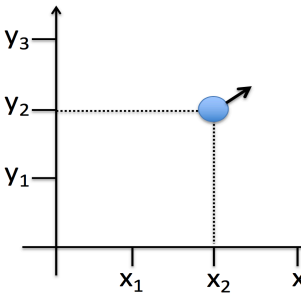


Fig. 3:

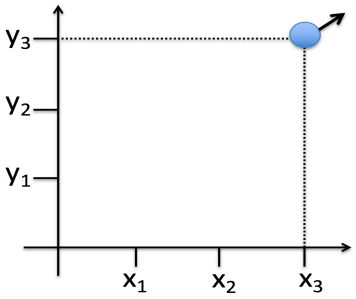


Fig. 4:

The black arrows in Fig.2-4 express that the blue ball is *not* located or stationary at (x_i, y_i) but is transiting or moving through 3-D space in a certain direction *without being located at* them, just as when you are getting into your house, you are passing through the door without being located at the door.[7] Let us call this feature that makes the ball with this feature incompatible with its being located at 3-D points as the *transiting feature*. For example, when a car has this transiting feature (when a car is moving on a street without being located at any points), we never find the car located at a spatial point on the street. Of course, the car can be located at an intersection when it waits for a green light, but in that case, the car is not moving.

Even if we often experience the transiting feature of a 3-D concrete object in our daily life, it does not follow from this that this is a *fundamental* or an *irreducible* feature of concrete reality. For example, when we go up to

[7]The claim here is not that your movement cannot be analyzed in terms of your being different spatial locations at different times. Here, we are talking about how we experience transition in our daily life before we start the analysis of it.

a higher dimension, i.e. a fourth dimension, the purported incompatibility disappears. This is captured by the following Fig.5:

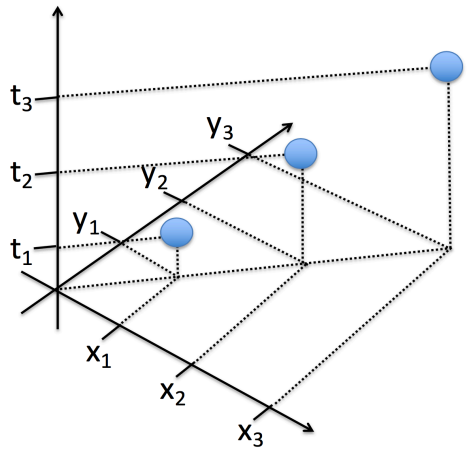


Fig. 5:

This is because going up to a higher dimension makes it possible to understand 3-D transition in terms of a higher-order sequence of 3-D states, i.e. b_i's being located at different spatial points *at different times*. Actually, this move is exactly what state theorists take. As we saw above, state theorists understand the persistence of B when it transits through 3-D space by introducing time as the fourth dimension and locating 3-D balls b_i with properties at times in 4-D spacetime. In Fig.5 above, the persistence of B when it transits through 3-D space is understood by 3-D states, i.e. 3-D balls b_i being located at (x_i, y_i) at t_i (or at (x_i, y_i, t_i)). Here, the transiting feature of B captured by Fig.2-4 is reductively understood as a higher-order 4-D sequence of these 3-D states. That's why we do not find any black arrow in Fig.5. In state theories, the transiting feature expressed by the black arrows in Fig.2-4 is not an irreducible feature of concrete reality.

We have so far talked about 3-D transition and its reductive understanding in the state-theoretic framework. In order to understand the main thesis of transition theories, we have to make two more steps. The first step is to think of a higher-order transition, i.e. transition along a fourth dimension (4-D transition). The second step is to think that this transition is irre-

ducible to a higher-order sequence of states. In what follows, let us make these two steps one by one.

Transition Theories of Persistence

Someone might wonder why we need to think of 4-D transition. This is because 3-D transition itself is not even a necessary condition of persistence. For example, your house persists without transiting or moving through 3-D space. In other words, persistence itself is compatible with being at rest with respect to the three dimensions, and so 3-D transition cannot be a necessary condition of persistence. Of course, this does not mean that transition itself has nothing to do with persistence. Indeed, if we want to connect persistence with transition, we have to think of transition along a fourth dimension. Just as state theorists introduce a fourth dimension and understand persistence in terms of locations along the fourth dimension, transition theorists also introduce a fourth dimension but understand persistence in terms of transition along the fourth dimension.

What does this 4-D transition look like? Remember that Fig.2-4 capture the transition of a ball B through 3-D space, wherein we understand that the ball is not located or stationary at 3-D slices in its transition, which means we are not analysing transition through location in a higher dimension, like time.

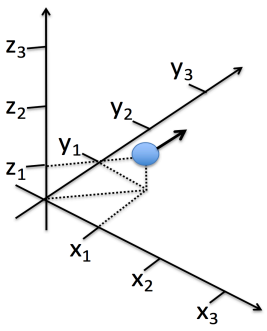


Fig. 6:

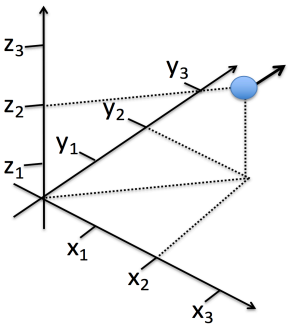


Fig. 7:

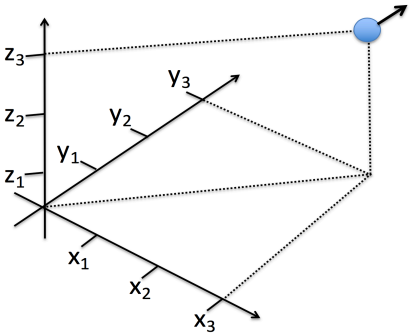


Fig. 8:

Since we want to consider transition along a fourth dimension, what we need to do is to introduce a fourth dimension into Fig.2-4 and think that the ball B is three-dimensionally transiting and is also transiting along a fourth dimension as in Fig.6-8 above (although they again falsely give us static images of transition).[8] In Fig.6-8, the black arrows express the transiting feature of B: the blue ball is transiting or moving through 4-D space *without being located at* (x_i, y_i, z_i). As we saw in 3-D transition, without going up to a higher dimension, this 4-D transition itself is not compatible with being located or stationary at points on the fourth dimension.

The second step is to think that transition along a fourth dimension is irreducible to a higher-order sequence of states. This second step is quite simple: we do not take a step of introducing a fifth dimension to understand 4-D transition reductively in terms of a higher-order sequence. This means the transiting feature of B expressed by the black arrows in Fig.6-8 is an irreducible feature. That is, the transiting ball is *irreducibly* transiting through 4-D space. Once we accept irreducible transition, we are in a position to understand the basic idea of persistence in transition theories. For comparison, let us first state the core idea of state theories. State theories claim that a concrete object persists by the object itself or its temporal parts *being located at* different times. By contrast, transition theorists claim a concrete object persists by a 3-D object's *irreducibly transiting* through 4-D space, without being located at any points or regions in 4-D space. This transition-theoretic framework is a defence for persistence as an irreducibly dynamic phenomenon: a persisting object is irreducibly dynamic because it is irreducibly transiting along the fourth dimension without being located or stationary at any points on the dimension.

[8]Here, a fourth dimension is not time whose metaphysical role is to offer temporal locations for concrete objects. For more detail about a fourth dimension here, see Ch.7.

Summary

Persistence is usually not regarded as an irreducibly dynamic phenomenon. I think this is not because persistence itself is a static concrete phenomenon but because persistence has been understood in the state-theoretic framework. I agree that if we understand persistence in the state-theoretic framework, it should be regarded as a static phenomenon or a reductively dynamic phenomenon (as we will see in later chapters). However, I disagree that the state-theoretic understanding of persistence is the correct one because I believe persistence is an irreducibly dynamic phenomenon. Therefore, in this dissertation, in order to show that persistence is not a static phenomenon but an irreducibly dynamic one, I try to offer an alternative framework in which persistence is understood as an irreducibly dynamic phenomenon. For the preliminary, in Introduction, we distinguished two different theories of persistence, state theories and transition theories. State theories understand persistence in terms of locations along a fourth dimension (e.g., being located at times or lengths of time). This idea can be called as *persistence as location* (along the fourth dimension). By contrast, transition theories understand persistence in terms of transition along a fourth dimension. We might call this idea *persistence as transition* (along the fourth dimension). This distinction paves the way for our discussion in later chapters. If we have a viewpoint from which we compare two different theories, this is quite useful to (i) get a sense of a new framework (the transition-theoretic one) and (ii) get a better understanding of the current framework (the state-theoretic one). In what follows, we examine these two different frameworks one by one. The first part (Ch.1-4) is devoted to the state-theoretic framework, and the second part (Ch.5-8) is to the transition-theoretic framework.

In Ch.1, we take a closer look at three standard state theories, i.e. endurantism, perdurantism, and exdurantism. Especially, we consider how they deal with other concrete phenomena concerning persistence, i.e. change

and coincidence. In this framework, change is connected with the problem of temporary intrinsics according to which the idea of genuine change offered by endurantists is inconsistent. Perdurantists and exdurantists offer their own different conceptions of change, although endurantists offer several ways to dismiss the problem of temporary intrinsics. Another important concrete phenomenon is coincidence. Generally, the debate on coincidence is concerned with whether coinciding objects are identical or not. While some enduratists accept that coinciding objects are non-identical, others including the rest of endurantists think coinciding objects are identical.

In Ch.2, we examine the picture of concrete reality in the state-theoretic framework. In this framework, concrete phenomena such as persistence, change, and transition, are understood in terms of objects possessing properties at times, i.e. states. As we will see, if we understand concrete reality in this way, we become reductionists about these phenomena. These three different kinds of reductionism tell us the following picture of concrete reality: persistence is not an irreducible concrete phenomenon because it is understood in terms of objects being located at or existing at more than one time; change is also not an irreducible concrete phenomenon because it is understood in terms of persisting objects possessing incompatible properties; transition is not an irreducible concrete phenomenon because it is understood in terms of a higher-order sequence of states. For example, as we saw in Introduction, 3-D transition is understood in terms of a higher-order 4-D sequence of 3-D states. Obviously, if the state-theoretic framework is reductionist about transition, it is also reductionist about dynamicity that is understood in terms of irreducible transition. That is, state theories cannot defend persistence as an irreducibly dynamic phenomenon in terms of this dynamicity.

In Ch.3, we examine A-theoretic state theories, i.e. the combination of state theories with A-theories of time. Someone might wonder whether there is any way to defend the idea of persistence as an irreducibly dynamic

phenomenon *within* state theories. While irreducible transition is a way to capture the dynamicity of persistence, it does not follow from this that irreducible transition is *the only way* to defend dynamically persisting objects. There might be another way to deal with dynamicity, which is available for state theories. For example, state theories with A-theories of time such as the moving-spotlight view, the growing-block view, and presentism might accommodate the idea of persistence as an irreducibly dynamic phenomenon. In the state-theoretic framework, when we introduce dynamic processes that are irreducible to a higher-dimension, they have a certain characteristic feature: one stage first occurs, then another stage in turn occurs. That is, the stages of the process successively occur one after another. However, as we will see, this feature (called one-after-another succession) leads to several serious problems that make state theories inconsistent. Therefore, if state theorists accept dynamic processes with the feature of one-after-another succession, they become inconsistent; if they do not, they fail to defend the idea of persistence as a dynamic phenomenon, although this does not mean state theories themselves are inconsistent.

In Ch.4, we examine the combination of state theories with, so called, dynamic ontology such as powers ontology and process ontology. Someone might think even if A-theoretic state theories are not viable, there is another hope: dynamic ontology. Some powers ontologists indeed consider a world with powers as dynamic and active, and compare this dynamic world with a static and passive world without powers. Therefore, the combination of state theories with powers ontology might secure a sense of dynamicity in terms of which we claim persistence as a dynamic phenomenon. Also, process ontologists think processes are metaphysically fundamental and dynamic. Since what persists in process ontology is a process, it is natural to think that the persistence of a process is a dynamic phenomenon. However, as we will see, the combinations with dynamic ontology either do not offer an appropriate idea of dynamicity or face the same problems in Ch.3.

In Ch.5, we take a closer look at the basic ideas of transition theories. We first review the concept of transition and identify several characteristic features of transition. As we saw above, this transition with these characteristic features is the common ground for the two different frameworks. On the one hand, state theorists take transition as reducible and so think of the transiting features (recognized by transition theories) as reducible. On the other hand, transition theorists take transition as irreducible and so its features as irreducible. Based on the idea of irreducible transition, transition theorists propose that persistence should be connected not with locations along the fourth dimension (as in state theories) but with irreducible transition along the fourth dimension.

In Ch.6, we consider possible variations of transition theories. Transition theories of persistence are defined in terms of the following two fundamental claims: (I) persistence is understood in terms of transition and (II) transition is irreducible to states (objects with properties being located at times). This general definition of transition theories might allow some variations, just as state theories have three standard variations, i.e. endurantism, perdurantism and exdurantism. In the case of state theories, we have these three variations because each theorist has a different answer to what trans-temporal relation holds between 3-D objects located at times. In the case of transition theories, we might have some possible variations because transition theorists might have different answers to what are a transiting object O and 4-D space S through which O transits. For example, some theorists might think O and S are already concrete in themselves independently from the transition of O through S, while other might not. However, after considering four possible options, we argue that only one of them is viable as a transition theory. Let us call this *the* transition theory in the rest of Introduction.

In Ch.7, we consider the picture of other concrete realities in the transition theory in terms of (i) a fourth dimension and (ii) time. In this theory, the fourth dimension does not play the metaphysical role of offering tempo-

ral locations for persisting objects as in the state-theoretic framework. In the transition theory, instead of being located or stationary along the fourth dimension, persisting objects irreducibly transit along the fourth dimension. Of course, in the transition theory, a persisting object transits through 4-D space, it also transits along the other three dimensions as well as the fourth dimension. What is special about the fourth dimension is that a persisting object is never at rest with respect to the fourth dimension and so always in transit along the dimension as long as it persists. Also, as we will see, in this theory, the fourth dimension can be neither concrete nor abstract time. Indeed, it has nothing to do with time in itself. However, if a fourth dimension is not time, how can we understand time in this framework? We consider this question in terms of temporal duration, the direction of time (the B-series time order), and tense.

In Ch.8, we make the final consideration on the picture of other concrete realities in the transition theory. The first one is a trans-temporal relation. Transition theorists partially agree with perdurantists and exdurantists who deny the tenseless identity between objects at different times. Nevertheless, transition theorists also partially agree with endurantists who deny that persistence is about numerically distinct objects at different times. Transition theorists think there is a tensed trans-temporal relation that is something in between, i.e. a relation that is neither numerical identity nor numerical distinctness. The second one is coincidence. As we saw above, since transition theorists do not understand concrete reality in terms of objects being located at times, coincidence cannot be understood in terms of being located at or exiting at the same place at the same time. Of course, this does not mean coincidence cannot be understood in this framework. Rather, coincidence is understood in terms of transition. The third one is concerned with the fundamental difference between dynamic processes in A-theoretic state theories and irreducible transition in the transition theory. As we said above, any dynamic processes in state theories have the feature of one-after-

another succession. However, irreducible transition in the transition theory does not have this feature. This difference explains why only dynamic processes in state theories face the problems that are posed by the feature of one-after-another succession.

Part I

The State-Theoretic Framework

Chapter 1

State Theories of Persistence

Introduction

In Introduction, we distinguished two different theories of persistence, state theories and transition theories. On the one hand, state theories understand persistence in terms of states, i.e. objects located or stationary at spatiotemporal points or regions. We call this view persistence as location (along a fourth dimension). On the other hand, transition theories understand persistence in terms of transition along a fourth dimension. We call this view persistence as transition (along the fourth dimension). This distinction between state and transition theories was given in Introduction in order to look at state theories against this broader perspective. It was crucial for us to get a perspective from which we understand that the state-theoretic framework is not *the* framework for persistence but is only *a* specific one. The next step will be to examine three standard state theories (endurantism, perdurantism, and exdurantism) in terms of this broader perspective that gives us a better understanding of what state theorists actually do. In this chapter, we will do this by considering how they deal with other concrete phenomena concerning persistence, change (Sec.2) and coincidence (Sec.3). While the three state theories have different conceptions of change, they share one general idea of understanding change: change is persistence with incompat-

ible properties. This is a natural move in their state-theoretic framework because, in this framework, persistence is understood by existing (or being located) at different times, and so change will be understood by existence at different times, having incompatible properties. In the state-theoretic framework, coincidence is concerned with whether coinciding objects, say the statue and a lump of clay, are identical or not. Some endurantists think the statue and the lump of clay are non-identical. That is, numerically distinct objects are in the same place at the same time, being made up of the same parts. By contrast, perdurantists, exdurantists, and other endurantists think the statue and the lump of clay are identical. We will not get into the debates on change and coincidence in this framework. Our intention is to make clear the state-theoretic understanding of change and coincidence in order to compare it with the transition-theoretic one in later chapters.

1.1 Three Standard State Theories

State theories of persistence understand persistence in terms of states by introducing a fourth dimension and locating objects along the fourth dimension. Since the fourth dimension is usually time with time instants, 3-D objects are located at times along the fourth dimension. Current standard theories of persistence, endurantism, perdurantism, and exdurantism, all share this state-theoretic framework. In Introduction, since we focused on comparing this state-theoretic framework with the transition-theoretic framework, we did not take a closer look at each state theory. Therefore, we start with how they differ within the state-theoretic framework, and examine how they treat other related concrete phenomena such as change and coincidence.

Let us consider a case where a balloon B expands (changes its shape and size) as it three-dimensionally transits through the air, captured by Fig.1.1 below:

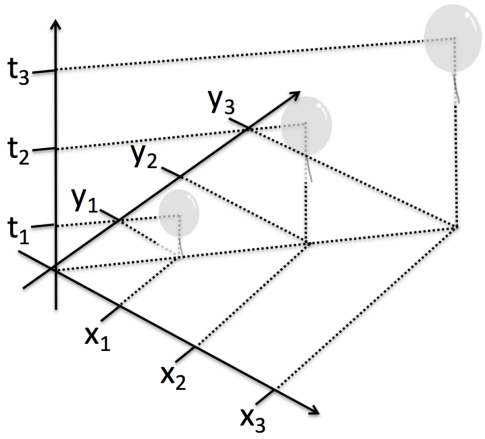


Fig. 1.1:

How do three standard state theories understand the persistence of B? According to endurantism, when B persists from t_1 to t_2, (i) a 3-D balloon b_1 with a shape s_1 is at (x_1, y_1, t_1) and (ii) a 3-D balloon b_2 with another shape s_2 is at (x_2, y_2, t_2) and (iii) b_1 and b_2 are *numerically identical*, i.e. one and the same thing B.[1] That is, the trans-temporal identity holds between b_1 at t_1 and b_2 at t_2. Here, the core idea of endurantism is that the persistence of B is understood by its being *temporally multiply located* at different times.[2] In Introduction, we looked at this idea in terms of states and the identity relation. That is, the persistence of B is understood by states, b_i's having s_i at a time t_i (or at (x_i, y_i, t_i)) and the identity relation between b_i: b_1's having s_1 at t_1, b_2's having s_2 at t_2, and $b_1 = b_2$.

By contrast, according to perdurantism, when B persists from t_1 to t_2, (i) a 3-D balloon b_1 with s_1 as a temporal part is at (x_1, y_1, t_1) and (ii) a 3-D balloon b_2 with s_2 as another temporal part is at (x_2, y_2, t_2), and (iii) b_1 and b_2 are *numerically distinct* temporal parts of a temporally extended

[1]Some endurantists are Wiggins (1980), van Inwagen (1990), Fine (2006), Baker (2007), Mackie (2008) Lowe (2009), and Shoemaker (2012).

[2]One standard definition of endurance is in terms of the non-temporal extendedness of enduring objects: an object O endures over time iff O is wholly present at each time of that duration. Some philosophers such as Merricks (1999), Crisp and Smith (2005), and McCall and Lowe (2009) offer different characterizations without using 'wholly present'. Others such as (Barker and Dowe, 2007) argue that there is no viable articulation available for this term. Moreover, (Barker and Dowe, 2003, 2005) argue that endurantism is inherently paradoxical.

4-D object B.[3] That is, B itself is a 4-D entity called a *spacetime worm* and has 3-D temporal parts at times. Here, unlike in endurantism, the trans-temporal identity does not hold between b_1 at t_1 and b_2 at t_2. Thus, the core idea of perdurantism is that the persistence of B (as a 4-D spacetime worm) is understood by B's having numerically distinct temporal parts at different times.[4] In Introduction, we looked at this idea in terms of states and the trans-temporal part-whole relation. That is, the persistence of B is understood as follows: b_1 has s_1 at t_1, b_2 has s_2 at t_2, and b_1 and b_2 are temporal parts of B.

Finally, according to exdurantism, when B persists from t_1 to t_2, (i) a 3-D balloon b_1 with s_1 at (x_1, y_1, t_1) is B itself and (ii) another 3-D balloon b_2 with s_2 at (x_2, y_2, t_2) is B' that is numerically distinct from B. These B and B' are called *temporal stages*.[5] While, as in perdurantism, the trans-temporal identity does not hold between B and B', there is another relation, what is called a *temporal counterpart relation*, between them.[6] This temporal counterpart relation is concerned with conditions that must hold between stages in order for objects to persist. Thus, the core idea of exdurantism is that the persistence of B from t_1 to t_2 is understood in terms of non-identical two temporal stages B and B' being in a temporal counterpart relation. In Introduction, we looked at this idea in terms of states and their temporal counterpart relation. That is, the persistence of B is understood by $B(= b_1)$'s having s_1 at t_1, $B'(= b_2)$'s having s_2 at t_2, and the temporal counterpart relation between B and B'.

In this way, three variations in state theories are those on trans-temporal relations within the state-theoretic framework. They differ in what trans-

[3]Some perdurantists are Lewis (1986a), Noonan (1988), Rea (2003), and Della Rocca (2011).

[4]For variations of temporal parts, see (Hawthorne, 2006, p. 87). For other characterizations, see Parsons (2007) and Noonan (2009).

[5]Therefore, this view is also called the *stage theory*. Some stage theorists or exdurantists are Sider (2001) and Hawley (2001). In this dissertation, we use the term 'exdurantism' suggested by Haslanger (2003).

[6]See (Sider, 2001, p. 200) and (Hawley, 2001, Ch.3).

temporal relation they choose for objects at different times. Endurantists choose the trans-temporal identity relation; perdurantists choose the trans-temporal part-whole relation; exdurantists choose the temporal counterpart relation.

1.2 Genuine Change and the Problem of Temporary Intrinsics

How do these three state theories understand change? They all understand change in terms of persistence with incompatible properties. Of course, this does not mean that they have the same conception of change. Indeed, they have different conceptions of change based on how they understand 3-D entities located at times. Let us start with the conception of *genuine change* given by some endurantists.

Some philosophers such as Mellor claim that *genuine change* is the possession of incompatible properties at different times by one and the same object.[7] Here, we can find two intuitive assumptions. Consider the persistence of a balloon B when it expands, i.e. changes its shape from s_1 at t_1 to s_2 at t_2, depicted in Fig.1.1. When the balloon B changes its shape from t_1 to t_2, it seems the same thing B must exist before and after the change. Otherwise, the change of B would not make sense. For example, suppose that B has s_1 and only exists at t_1, and that another numerically distinct B' has s_2 and exists at t_2. Is there any change in the shape of B? It seems not. Let us call this assumption Transtemporal Identity (TI) before and after change:

TI: One and the same thing exists before and after the change.

As we saw above, this is the core idea in endurantism, i.e. the temporal multiple-location of a persisting object. If we do not accept TI, then there

[7] See (Mellor, 1998, Ch.8).

are two numerically different objects before and after change. Let us call what exists before the change as Before and what exists after the change as After. In our balloon case, b_1 is Before and b_2 is After. If we accept TI, Before and After are numerically identical; if we do not, Before and After are numerically different. Another assumption is Incompatibility Properties (IP):

IP: Before and After have incompatible properties.

Actually, this is assumed not only by endurantism but also by the other two, perduratism and exdurantism. It seems obvious that when B changes its shape from t_1 to t_2, Before and After must have different shapes at different times. Otherwise, the change of B's shape would not make sense again. For example, Before has s_1 at t_1 and After has s_1 at t_2. Is there any change in the shape of B? It seems not, although we can say B persists.

If we combine TI and IP, we have the following conception of change, what we might call, Endurantist Change (EC):

Endurantist Change: The same thing exists and has incompatible properties before and after the change.

That is, according to EC, when a balloon B changes its shape from s_1 at t_1 to s_2 at t_2, Before (b_1 at (x_1, y_1, t_1)) has the property *being* s_1 and After (b_2 at (x_2, y_2, t_2)) has the property *being* s_2, and Before = After.

However, EC seems to face the problem of temporary intrinsics according to which we have inconsistency when it is combined with Leibniz's law (LL):

Leibniz's Law: If two objects are identical, they share all the properties they have.[8]

Consider our balloon case: B changes its shape from s_1 at t_1 to s_2 at t_2. According to EC, B exists both at t_1 and t_2, and B has s_1 at t_1 and s_2 at t_2. In other words, Before and After are numerically identical, and Before has s_1

[8]While this is a standard formulation of Leibniz's law, there are several versions some of which might be accepted by relative identity theorists. See Gallois (1998).

and After has s_2. According to LL, since Before and After are identical, they share all the properties they have. Therefore, B has both s_1 and s_2 that are incompatible with each other.

If we want to keep LL, it seems we have to give up EC and look for a different conception of change. Or, if we want to keep EC, it seems we have to give up LL. Which option should we take? In the following, we first look at perdurantism and exdurantism that reject TI and look for a different conception of change. Second, we consider two endurantist attempts to keep both EC and LL.

1.2.1 Change in Perdurantism and Exdurantism

As we saw above, perdurantism and exdurantism deny TI but accept IP. That is, Before and After are numerically distinct objects and have incompatible properties. When we reject TI, how can we understand change?

Here is the suggestion from perdurantism, Perdurantist Change:

Perdurantist Change: A temporally extended object has different temporal parts tp_1 and tp_2 that have incompatible properties.

For example, a balloon B as a spacetime worm changes its shape from s_1 at t_1 to s_2 at t_2 by having different temporal parts tp_1 (a 3-D balloon b_1 at (x_1, y_1, t_1)) and tp_2 (another 3-D balloon b_2 at (x_2, y_2, t_2)). Here, we can tell that change is understood in terms of persistence with incompatible properties. A temporally extended balloon B persists by its having temporal parts tp_1 and tp_2 at different times, and B changes by its having temporal parts tp_1 and tp_2 that have incompatible properties from each other. That is, persistence does not but change does require that tp_1 and tp_2 have incompatible properties.

Exdurantists also think that change can be understood by the possessing of incompatible properties by numerically distinct objects.[9] Here is the suggestion from exdurantism, Exdurantist Change:

[9]For example, see (Hawley, 2001, Ch.3)

Exdurantist Change: A temporal stage is in a temporal counterpart relation to another temporal stage and they have incompatible properties.

For example, a balloon B with s_1 at (x_1, y_1, t_1) changes its shape from s_1 at t_1 to s_2 at t_2 by its being in a temporal counterpart relation to another 3-D balloon B' with s_2 at (x_2, y_2, t_2). Here, again, we can tell that change is understood in terms of persistence with incompatible properties. A temporal stage B at t_1 persists by its being in a temporal counterpart relation to another temporal stage B' at t_2, and B with s_1 changes its size by its being in a temporal counterpart relation to B' with s_2 at t_2.

In both perdurantism and exdurantism, in order for something to change from t_1 to t_2, (i) TI is not required, and (ii) change is understood by persistence with incompatible properties. The latter (ii) implies that an object can persist without change, and so change and persistence can be separated.

1.2.2 Change in Endurantism Revisited

Endurantists have two different ideas to deal with the problem of temporary intrinsics: relationalism and adverbialism. On the one hand, relationalist endurantism focuses on *what* a balloon B has: B has incompatible *relations* to different times, not monadic properties.[10] On the other hand, adverbialist endurantism focuses on *how* a balloon B has monadic properties: the instantiation of a property by B is *relative* to times.

Let us start with relationalism. According to this view, when a balloon changes its shape from s_1 at t_1 to s_2 at t_2 as in Fig.1.1, this is not because B has different monadic properties such as *being* s_1 and *being* s_2. Instead, B is in a *relation* of *being* s_1 *at* to t_1 and in a different relation of *being* s_2 *at* to t_2. Here, *being* s_1 *at* and *being* s_2 *at* are incompatible relations in that nothing can be in these two relations to the *same* time. The suggestion here is Relationalist Change (RC):

[10](Lewis, 1986a, p. 204).

Relationalist Change: The same thing is in incompatible relations to different times.

Since B can be in these incompatible relations if it is in these relations to *different* times (t_1 and t_2), we no longer have the inconsistency above. Here, we can also tell that change is understood by persistence with incompatible *relations*. B persists by its being located at different times, and B changes by being located at different times and being in incompatible relations to these times.

Someone might say that if we accept relationalist endurantism, we lose an important sense that we want to keep by EC.[11] This can be expressed as one important difference between EC and RC:

1. In EC, the same thing loses and gains properties: it has different properties before and after change.[12]

2. In RC, this loss and gain does not make sense: it remains in the same relations to the same times before and after change.

According to RC, we have B with s_1 at (x_1, y_1, t_1) because B is in the relation of *being* s_1 *at* to t_1. This B with s_1 at (x_1, y_1, t_1) is also in the relation of *being* s_2 *at* to t_2. Now, we have B with s_2 at (x_2, y_2, t_2) because B is in the relation of *being* s_2 *at* to t_2. This B with s_2 at (x_2, y_2, t_2) is also in the relation of *being* s_1 *at* to t_1. That is, each b_i at (x_i, y_i, t_i) is in the same relations to the same times. Of course, that's why relationalist endurantism can meet Leibniz's law. However, if so, it seems relationalism can keep TI but cannot keep what EC wants to secure, i.e. 1.

Is there any way to keep both in the endurantist framework? This is where adverbialist endurantism comes in. According to this view, we have B with s_1 at t_1 and B with s_2 at t_2 because the instantiation of *being* s_1 by B is relative to t_1 and that of *being* s_2 is to t_2.[13] Let us express this relativized

[11]For example, see Goswick (2013).
[12]For example, this idea is called Property Change in Sullivan (2012).
[13]See Johnston (1987).

instantiation relation as follows: B has-at-t_1 *being* s_1. If we accept this view, we have the following conception of change, Adverbialist Change (AC):

Adverbialist Change: the same object has-at-t_i a property and has-at-t_j its incompatible property (where $i \neq j$).

For example, we have B with s_1 at t_1 and B with s_2 at t_2 as in Fig.1.1 because B has-at-t_1 the property *being* s_1 and has-at-t_2 the property *being* s_2. Therefore, each B at (x_i, y_i, t_i) relatively instantiates s_i to t_i, and so there is no inconsistency here. Moreover, this captures the same object B's having different properties at different times (EC) because B's having-at-t_i s_i means the instantiation of s_1 by B is restricted to t_i. Here, again, we can tell that change is understood in terms of persistence with incompatible properties. In adverbialism, B persists by its existing at different times, and B changes by its existing at different times, having incompatible properties.

We will not get into the debate on the problem of temporary intrinsics. After all, this is the problem within the state-theoretic framework. Our objective here is to make clear how the three standard state theories understand change. We will examine this understanding in terms of reductionism about change in Ch.2 and compare this understanding with the transition-theoretic understanding of change in Ch.6.

1.3 The Problem of Coincidence

Coincidence is also another important concrete phenomenon concerning persistence. In the state-theoretic framework, the coincidence of two objects O_1 and O_2 is characterized as follows:

> O_1 and O_2 coincide iff they exist in the same place at the same time, being made up of the same parts.[14]

[14]For example, see Wiggins (1968) and (Sider, 2001, Ch.5).

For example, consider a case where we make a snowman. We first make two snowballs, the head-part and the body-part, and at t_1 we put the head-part on the body-part so that we get a snowman (call it *Snowman*). Since Snowman is made of a lump of snow, we can also say that we get a lump of snow that is made up of the two snowballs (call this lump of snow *Snow*). Thus, Snowman and Snow exist in the same place at the same time (being made up of the same snow balls). Unfortunately, two hours later, at t_3, Snowman melted into one big lump of snow with no snowman-shape. Here, it seems there is still Snow but no longer Snowman. The situation here is described by the following two stages:

(1) Snowman and Snow coincide at t_1 and t_2.

(2) Only Snow still exists at t_3.

Here, there is ambiguity about *what* are coinciding. (1) and (2) are only acceptable for endurantists. We will see the perdurantist and exdurantist versions of (1) and (2) soon. Before considering coincidence in each theory, let us look at the problem of coincidence at first.

What is the problem of coincidence? The problem arises when we ask the following question: what is the relation between Snowman and Snow? It seems we only have two answers here: (i) they are identical, or (ii) they are non-identical. When we choose (i), what we need to explain is this: if Snowman and Snow are identical, how is it possible for *only* Snow to exist at t_3? For, if they are identical, and if Snow exists at t_3, Snowman also must exist at t_3. By contrast, if we choose (ii), what we need to explain is this: if they are non-identical, how is it possible for numerically distinct concrete objects to exist at the same spatial location at the same time, being composed of the same things? How do state theorists deal with this problem of coincidence? Perdurantists, exdurantists, and some endurantists choose (i), although other enduratists choose (ii). In the following, let us look at how coincidence is understood in each theory and consider how they answer

the question above, although we will not get into details here.

In endurantism, persisting objects, Snowman and Snow, are non-temporally extended 3-D objects, and they persist by being temporally multiply located at different times. For example, when Snowman persists from t_1 to t_2, both a 3-D snowman at t_1 and a 3-D snowman at t_2 are identical to Snowman. In other words, the identity relation holds between them. Of course, this is also true of a lump of snow, i.e. Snow, when it persists from t_1 to t_2. If this is true, and if we accept (1) and (2), then it seems the only answer to the question above is (i): Snowman and Snow are non-identical coinciding objects. This is because if they were identical, (2) would be rejected. Let us call this kind of coincidence *non-identical coincidence*. According to this coincidence, we are inclined to think there is only one physical object at one place at a time, but this is just a wrong intuition.

Some endurantists accept this non-identical coincidence, although others do not. Advocates of this coincidence usually introduce the idea of *constitution*, in order to explain the non-identical relation between two different coinciding objects.[15] For example, according to them, when Snowman is *constituted* by Snow, Snowman somehow has different causal powers, modal properties and so on from Snow. Since they have different properties, they are two distinct objects by Leibniz's Law. Other endurantists do not accept non-identical coincidence. One way to deny it is to accept relative (or temporal) identity: two objects can be identical at a time but be non-identical at another time.[16] If we accept this relative identity, we can accept (1) and (2) without accepting non-identical coincidence because (2) does not require for Snowman to also exist at t_3. Another way is to deny (2) in a certain way. For example, according to Burke, we have a lump of snow at t_3, but it is *not* Snow. Why? This is because a lump of snow at t_1 and t_2, i.e.

[15]See Johnston (1992) and Baker (1997).

[16]See, for example, Myro (1997) and Gallois (1998). Another famous relativism is that A is identical as a certain sortal concept with B but not identical as another sortal concept with B. See Geach (1967) and Wiggins (2001).

Snow, is snowman-shaped, but a lump of snow at t_3 is not. Burke thinks this difference is enough to make them numerically distinct.[17]

How about perdurantism? In this view, persisting objects, Snowman and Snow, are temporally extended 4-D objects called spacetime worms, and they persist by having different temporal parts at different times. For example, when Snowman persists from t_1 to t_2, Snowman as a spacetime worm has different temporal parts at t_1 and t_2. Here, two temporal parts at t_1 and t_2 are numerically distinct. This is also true of Snow when it persists from t_1 to t_3. If this is true, (1) and (2) above are understood as follows:

(1′) A temporal part of Snowman at t_1 (t_2) and a temporal part of Snow at t_1 (t_2) coincide at t_1 (t_2).

(2′) Only Snow has its temporal part at t_3.

That is, coinciding objects at t_1 (t_2) are temporal parts of Snowman and Snow, not Snowman and Snow themselves.

What is the relation between these coinciding temporal parts at t_1 (t_2)? According to perduratists, they are *identical*. In other words, Snowman and Snow share a temporal part at t_1 (t_2). Therefore, the perdurantist answer is this: there are no non-identical coinciding objects at t_1 (t_2). There is only one temporal part at t_1 (t_2). This temporal part is of both Snowman and Snow. Here, while Snowman and Snow share temporal parts at t_1 and t_2, perdurantists do not need to accept that Snowman and Snow themselves are also identical. For they are different: Snowman has temporal parts only at t_1 and t_2 but Snow has its temporal part also at t_3 in addition to t_1 and t_2.[18]

What do exdurantists think about coincidence? In exdurantism, persisting objects, Snowman and Snow, are non-temporally extended 3-D objects,

[17] See Burke (1994).

[18] There is a well-known counterexample against the perdurantist understanding of coincidence. Gibbard (1975) describes the situation where Snowman and Snow come into existence at the same time and cease to exist at the same time. In this case, perdurantists have to say Snowman and Snow themselves are identical. However, we still might think they are different because only Snow could survive getting round. For a reply from perdurantists, see Noonan (1993).

and they persist by its being in a temporal counterpart relation to another numerically distinct object at another time. For example, when Snowman persists from t_1 to t_2, Snowman at t_1 is in a temporal counterpart relation to a numerically distinct snowman (let us call Snowman$'$) at t_2. Of course, this is true of Snow at t_1. We have temporal counterparts, Snow$'$ at t_2 and Snow$''$ at t_3. This means (1) and (2) must be revised as follows:

(1$''$) Snowman and Snow coincide at t_1, and Snowman$'$ and Snow$'$ coincide at t_2.

(2$''$) There is only Snow's temporal counterpart, Snow$''$, at t_3.

That is, coinciding objects at t_1 are Snowman and Snow, but coinciding objects at t_2 are not Snowman and Snow but their temporal counterparts, Snowman$'$ and Snow$'$; what exists at t_3 is not, Snow itself, but Snow's temporal counterpart, Snow$''$.

What is the relation between coinciding objects, Snowman and Snow at t_1 (Snowman$'$ and Snow$'$ at t_2)? According to exdurantists, they are *identical*. That is, Snowman and Snow (Snowman$'$ and Snow$'$) are one and the same thing. Therefore, the exdurantist answer is this: there are no non-identical coinciding objects at t_1 (t_2).[19] But, someone might wonder why only Snow has its temporal counterpart Snow$''$ at t_3 if Snowman and Snow are identical. If a temporal counterpart relation were just the identity relation as in endurantism, there would have to be Snowman's temporal counterpart, Snowman$''$, at t_3. However, a temporal counterpart relation is not identity. It is a weaker trans-temporal relation between numerically distinct objects at different times. Even if a snowman-shaped lump of snow at t_1 (L_1) is in the lump-counterpart relation to a non-snowman-shaped lump of snow at t_3 (L_3), this itself does not require that L_1 be also in the snowman-counterpart relation to L_3. Rather, since L_3 is not snowman-shaped, the

[19]See (Sider, 2001, p. 200).

snowman-counterpart relation does not hold because of the discontinuity as a snowman.

Conclusion

State theories understand persistence by introducing a fourth dimension and locating objects along the fourth dimension. This is the state-theoretic framework of persistence. Usually, they introduce time (with time instants) as the fourth dimension and locate 3-D objects at times. There are three standard state theories, endurantism, perdurantism, and exdurantism. These three theories share the state-theoretic framework but introduce different trans-temporal relations among 3-D objects located at times. Endurantism introduces the trans-temporal identity relation: each 3-D object at a time is identical with the other 3-D objects at different times. Perdurantism introduces the trans-temporal part-whole relation: each 3-D object (each temporal part) is part of a 4-D object as a spacetime worm. Exdurantism introduces a temporal counterpart relation: a 3-D object at a time is in a temporal counterpart relation to another 3-D object at another time.

These three state theories have their own conceptions of change. In endurantism, an object changes by its having incompatible properties at different times. In perdurantism, an object (as a spacetime worm) changes by its having temporal parts with incompatible properties at different times. In exdurantism, an object changes by its being in a temporal counterpart relation to another object at another time and their having incompatible properties. These three theories also have their own conceptions of coincidence. Some endurantists accept non-identical coincidence in which numerically distinct objects, say Snow and Snowman, exist in the same place at the same time. Other endurantists deny non-identical coincidence and think when Snow and Snowman coincide, they are identical. In perdurantism, unlike endurantism, coinciding objects are not objects themselves but temporal

parts of 4-D spacetime worms. When a temporal part of Snow at a time and a temporal part of Snowman at the time coincide, they are identical: these two different spacetime worms share one temporal part. Therefore, there are no non-identical coinciding objects. In exdurantism, like endurantism, coinciding objects at a time are objects themselves, i.e. Snow and Snowman. By introducing a temporal counterpart relation that is weaker than identity, exdurantists can accept they are identical, allowing one of them, say Snow, to persist after the melting.

In the next chapter, we will examine the state-theoretic picture of concrete reality. When we understand persistence in terms of states (objects with properties at times), there are several important consequences to change, persistence, and transition. As we will see later, all the three standard state theories are reductionist about these three phenomena. The next chapter will pave the way for comparing the state-theoretic picture with the transition-theoretic one in later chapters.

Chapter 2

The State Theoretic Picture of Concrete Reality

Introduction

As we saw in Ch.1, when state theorists understand the following three concrete phenomena, persistence, change, and transition, their basic framework is to locate objects at times and consider a certain relation between these objects at different times. For example, when we consider the persistence of a balloon B when it transits in the air, changing its shape, it is understood by 3-D balloon's being located at different spatial locations at different times, having different shapes. When we understand these phenomena in this way, persistence, change, and transition become *non*-fundamental features of concrete reality because they are understood in terms of states, i.e. objects' being located at or existing at times. In other words, the state-theoretic framework is reductionist about persistence, change, and transition. In the following, let us first suggest the definition of reductionism in general. Then, we make clear why the state-theoretic framework is considered as reductionist about these phenomena, mainly assuming eternalism in this chapter. As we will see, if this framework is reductionist about transition, then it is also reductionist about dynamicity that is understood in terms of transition.

2.1 Reductionism

What is the basic idea of reductionism? When we offer reductionism about X, we define or understand X in terms of more basic entities Y and Z that do not ontologically depend on what is reduced, i.e. X. For example, consider reductive physicalism in the Mind-Body problem. If we take a version of functionalism, each mental state is defined as a physical state playing a function role. In order for this reduction to work, a physical state and a function role must be ontologically independent from what is reduced, the mental state. In other words, the physical state and the functional role are basic entities that can be defined or understood without the mental state. Indeed, in our functionalist case, the physical state will be defined as a certain neural activity in the brain; a functional role is defined by inputs (stimuli) and outputs (responses).[1] The idea here is captured as follows:

X Reductionism: X is understood in terms of more basic entities Y and Z that do not ontologically depend on X.

It should be noted that reductionism about X does not deny the existence of X itself. For example, while there are mental states, they are *non*-fundamental in that they are understood in terms of more basic entities.

In this idea, the reduction of X to Y and Z fails if at least one of them ontologically depends on X. In other words, at least either Y or Z cannot exist without X. For example, consider the reduction of a physical state (playing a functional role) to a mental state given functionalism. Obviously this fails. But why? As we saw above, in functionalism, a mental state is understood as a physical state playing a functional role. That is, the mental state cannot exist without and so ontologically depends on the physical state. Therefore, there is no point in making this 'reduction' because nothing gets reduced after all: a physical state is 'reduced' to a mental state that is the

[1] See, for example, Lewis (1972) and Block (1978).

physical state playing a functional role. Based on this definition, in what follows, we examine the state-theoretic framework in terms of reductionism about persistence, change, and transition.

2.2 Reductionism about Persistence

While three standard state theories are theories of persistence, this does not mean persistence is an irreducible concrete phenomenon in them. It is quite important to consider persistence in this respect in order to understand the picture of concrete reality to which state theorists are committed. As we saw above, three standard theories share the state-theoretic framework of introducing a fourth dimension as time and locating 3-D objects at times. In Fig.2.1 below, when they understand the persistence of a balloon B, they only differ in what relation is used for 3-D balloons b_i located at times t_i.

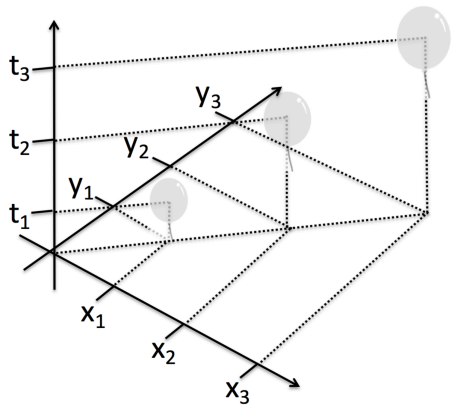


Fig. 2.1:

Endurantism uses the identity relation: they are one and the same thing. Perdurantism uses the part-whole relation: each b_i is part of a 4-D space-time worm B. Exdurantism uses a temporal counterpart relation: they are in a temporal counterpart relation. As we will see in this section, this state-theoretic framework is connected with reductionism about persistence: persistence is reduced to more basic concrete realities, i.e. states that have

nothing per se to do with persistence. Thus, entities located at times are not essentially persisting things or connected with persistence.

Let us first quickly look at the definition of reductionism about persistence:

Persistence Reductionism: Persistence is understood in terms of more basic entities Y and Z that do not ontologically depend on persistence.

In other words, if more basic entities Y and Z can be defined without persistence, the view is reductionist about persistence. By contrast, if not, the view is non-reductionist about persistence.

In order to consider whether three state theories are reductionist about persistence, what should we do? In the state-theoretic framework, since persistence is understood by (i) states (i.e. 3-D balloons' b_i located at (x_i, y_i, t_i) and (ii) a certain relation between b_i, what we need to do here is to examine whether (i) and (ii) ontologically depend on persistence. About (i), we take one state S_1, i.e. a 3-D balloon b_1 (with a certain shape s_1) being located at (x_1, y_1, t_1), and ask whether S_1 itself ontologically depends on persistence. Since (i) itself is shared by the three theories, we do not need to ask this question separately in each theory. By contrast, since each theory uses its own characteristic relation, we have to ask whether each relation ontologically depends on persistence one by one.

Let us start with whether S_1 ontologically depends on persistence. Obviously, S_1 just tells us that a 3-D balloon b_1 with s_1 is located or exists at t_1, and nothing more. That is, b_1 with s_1 at t_1 *itself* does not involve or imply persistence. This holds whether b_1 at t_1 is either the object itself as in endurantism and exdurantism or a temporal part as in perdurantism. Suppose b_1 is the object itself, i.e. a balloon B. Does S_1 (B with s_1 at t_1) imply the persistence of B, i.e. the existence of B at another time? No. It just tells us that B with s_1 is at t_1, and nothing more. Obviously, this is true of the case where b_1 is a temporal part. Of course, this fact itself is not problematic for the state-theoretic framework. State theorists just say we

need something more. What else do we need to determine whether a balloon B persists? They suggest we need two more things: (i) a 3-D balloon b_i at another time t_i, and (ii) a certain characteristic relation between them. Since this is true of all the other states S_i, each S_i tells us only that b_i with s_i is located or exists at t_i, and nothing more. That is, each 3-D state itself can exist without persistence and so does not ontologically depend on it.

Of course, this is not the end of the story. We also need to consider another important aspect of the three state theories. As we saw above, what makes three state theories differ is what trans-temporal relation they introduce for these 3-D objects located at times. Let us consider each theory one by one. In endurantism, the identity relation is introduced for b_i located at different times t_i. This makes it possible for endurantists to claim that a balloon B is temporally multiply located at different times: b_1 located at t_1 is B, and b_2 located at t_2 is B, and so on. Now, does the identity relation have something to do with persistence? Obviously, the answer is no. For example, consider the following identity relation: $2+2 = 4$.[2] It does not make sense that this identity relation involves or implies the persistence of 4. Therefore, since states and the identity relation do not depend on persistence, endurantism is reductionist of persistence. It should be noted that the claim here is not that we cannot use the identity relation to understand persistence, but just that such an understanding is reductionist.

In perdurantism, the part-whole relation is introduced between each b_i at t_i and a balloon B as a spacetime worm. This makes it possible for perdurantists to claim that a balloon B as a 4-D spacetime worm have different temporal parts at times. That is, they understand persistence in terms of having temporal parts at times. Does this part-whole relation have something to do with persistence? Again, the answer is no. For example,

[2]It is assumed here that the identity relation used by endurantism is the relation that satisfies the three formal features (reflexivity, symmetry, and transitivity) and the indiscernibility of identicals.

consider the following example: my arm is part of my body.[3] Since this relation is just a mereological relation that can be applied to two 3-D objects, the relation itself has nothing to do with the persistence of my body (or my arm). Therefore, since we have states and the part-whole relation without persistence, perdurantism is also reductionist of persistence. Again, the claim here is not that we cannot apply the part-whole relation to 3-D objects (temporal parts) and a 4-D object (a spacetime worm) in order to understand persistence, but just that such an understanding is reductionist.

In exdurantism, a temporal counterpart relation is introduced for b_i located at different times t_i. This makes it possible for exdurantists to claim that a 3-D balloon b_i at t_i persists without being temporally multiply located at times: B (b_i at t_i) persists by being in a temporal counterpart relation to another numerically distinct B' (b_j at t_j). Does this relation have something to do with persistence? When B and B' are in a temporal counterpart relation, there is some kind of continuity between them.[4] For example, they both have a ball-shape and are spatiotemporally adjacent and so on. Although exactly what conditions are required for the continuity of an object is not clearly stated, let us consider here whether we have the two conditions without persistence. First, B and B''s having a balloon-shape itself has nothing to do with the persistence of B. Indeed, it must not be so. For example, consider a case where B is at t_1 and B' is also at t_1. Obviously, B''s having a balloon-shape at t_1 has nothing to do with the persistence of B. Also, B and B''s being spatiotemporally adjacent has nothing to do with the persistence of B. Again, indeed, it must not be so. For example, consider a case where B and B' are spatiotemporally adjacent, but B' at t_2 is squashed and so it does not have a balloon-shape. In this case, exdurantists want to say the ball B does not persist. In this way, since each

[3]It is assumed here that the part-relation used by perdurantism is the relation that satisfies the three formal features (irreflexivity, asymmetry, and transitivity). See (Simons, 1987, p. 10) and (Casati and Varzi, 1999, pp. 37-8).

[4]See (Sider, 2001, p. 200). There are different kinds of continuity relative to kinds of things, such as a lump of clay and a state.

condition required for the continuity might be necessary but not sufficient, the holding of each condition does not ontologically depend on persistence. Therefore, since we have states and the temporal counterpart relation without persistence, exdurantism is also reductionist about persistence. Again, the following should be made clear: the claim here is not that we cannot use the trans-temporal relation to understand persistence, but just that such an understanding is reductionist.

What does this reductionism about persistence tell us about the underlying picture of concrete reality in state theories? As we saw above, in all three theories, persistence is understood in terms of being located at or existing at times. That is, what is fundamental in their picture of concrete reality is objects' *being located at* or *existing at* times, not persistence. Persistence is a non-fundamental concrete phenomenon. In this respect, we can restate the point here in the following way. In endurantism, the persistence of B is understood by B's existing at different times. In perdurantism, the persistence of B (as a 4-D spacetime worm) is understood by B's temporal parts existing at different times. In exdurantism, the persistence of B is understood by B's existing at a time and its temporal counterpart B''s existing at another time.

2.3 Reductionism about Change

As we saw above, while three standard theories offer different conceptions of change, they share one general framework: change is understood in terms of persisting objects possessing incompatible properties. Let us simply say this as persistence with incompatible properties. Obviously, this general framework is a specific application of the state-theoretic framework of persistence (introducing time as a fourth dimension and locating things with properties at times). The only difference is that properties are replaced by incompatible properties. That is, while persistence is understood by things

with properties located at times, change is understood by things with *incompatible* properties located at times. As we will see below, this state-theoretic framework is connected with reductionism about change: change is reduced to persistence with incompatible properties, and so after all reduced to being located at or existing at different times with incompatible properties.

Let us start with the definition of change reductionism[5]:

Change Reductionism: Change is understood in terms of more basic entities Y and Z that do not ontologically depend on change.

As we will see below, when we determine whether a theory is change reductionism or not, we should be careful about the following point. Suppose change is understood by things, say Y and Z, in a theory. When we cannot have one of them, say Y, without change, we should ask whether Y is a *reducible* concrete phenomenon or not. If Y is an *irreducible* concrete phenomenon in the theory, the theory is non-reductionist about change. If Y is reducible to W in the theory, then we in turn have to ask whether W ontologically depends on change. If we have W without change, the theory is reductionist about change. If we do not, then we repeat the same procedure until we reach a fundamental concrete reality in the theory.

In the state-theoretic framework, change is understood by persistence with incompatible properties, i.e. by (i) (at least) two states S_1 (b_1 with s_1 at t_1) and S_2 (b_2 with s_2 at t_2) and (ii) a certain relation between them. Therefore, what we need to do here is to examine whether (i) and (ii) are understood without change. Let us start with (i) and take S_1, i.e. b_1 with s_1 at t_1. Do we have this state without change? Obviously, S_1 *itself* has nothing to do with change. Indeed, their conceptions of change *require* unchanging states S_i. Suppose S_1 (b_1 with s_1 at t_1) *itself* would change. For example, S_1 would become another state S_1' (b_1 with another shape s_2 at t_1). Then, we would have the following two different states: S_1' (b_1 with s_2 at t_1) and

[5]See (Barker, unpublished, Ch.2).

S_2 (b_2 with s_2 at t_2). This would undermine the change of the balloon B in its shape. Therefore, if they want to keep their conceptions of change, they have to guarantee that these states S_i are unchanging. In other words, we need two unchanging states S_1 and S_2 in order to understand the change of a balloon B in its shape. Fortunately, there is no problem here. Almost all theories of time including A-theories as well as B-theories are designed to rule out this kind of change.[6] This is because if this type of change were possible, we would have no guarantee that the past is fixed and so unchanged. Thus, all we need to do is to choose one of these theories of time in which this type of change is inconsistent. As you might think, the story here may be the other way around: since they take one of these theories of time, they understand change in this way. Anyway, this is enough to show that states (b_i with s_i at t_i) themselves are understood without change.

Next, let us consider whether we have three characteristic relations introduced by the three standard state theories without change. In general, each characteristic relation (the identity relation in endurantism, the part-whole relation in perdurantism, and the temporal counterpart relation in exdurantism) has nothing to do with change. If we understand change by persistence with incompatible properties, change is understood as a kind of persistence. In other words, persistence is more basic than change, and change and persistence can be separated in that concrete objects can persist without change. Since each characteristic relation can be applied to persistence without change, it must be ontologically independent from change. Indeed, each relation has nothing to do with change. For example, consider the following identity relation: the morning star = the evening star. Obviously, the identity relation has nothing to do with change. Of course, this claim does not imply that we cannot use the identity relation as a trans-

[6] As far as I know, only Skow (2012) suggests a version of a A-theory that does not rule out this type of change. Of course, there are some A-theorists who accept not this type but another type of change concerning spacetime. Some examples are the shrinking-tree theory proposed by McCall (1994) and the minimal A-theory proposed by Sullivan (2012). We will examine the latter in Ch.3.

temporal relation between objects at different times. For the part-whole relation in perdurantism, consider the following example: my room is part of my house. It is just a mereological relation between two objects, and has nothing to do with change. As we saw in persistence reductionism, a similar argument is also true of the temporal counterpart relation in exdurantism.

Someone might argue that endurantism is actually *not* reductionist about change because they 'genuinely' talk about the change of B by some difference of the *same* thing, compared to perdurantism and exdurantism that deny such a difference. In endurantism, the (intrinsic) change of B over time is explained by some metaphysical difference of B during that period, i.e. B's having different properties at different times. The idea here is that if we want to talk about the endurantist conception of change, we need to talk about some metaphysical difference of B *itself*. Otherwise, the change of B would be explained without any metaphysical difference of B itself. Indeed, in perdurantism and exdurantism, the (intrinsic) change of B over time is not explained by any metaphysical difference of B itself during that period. For example, in perdurantism, the change of B (as a 4-D spacetime worm) from t_1 to t_2 is explained by its having temporal parts, tp_1 and tp_2, that have incompatible properties. Here, B's having different temporal parts at different times does not involve any metaphysical difference of B itself, just as my body's having a left arm and right arm at different spatial regions does not involve any difference of my body. In exdurantism, the change of B from t_1 to t_2 is explained by its being in a temporal counterpart relation to another temporal stage B' at t_2 and their having incompatible properties. Here, B's being in a temporal counterpart relation to B' does not involve any metaphysical difference of B because what has a different shape is B' at t_2.

Does this argument show that endurantism is non-reductionist about change? We can accept that some metaphysical difference of B over time does involve B undergoing change. However, this involvement itself is not at

issue in the definition above. What is at issue is whether the metaphysical difference is an *irreducible* concrete phenomenon in endurantism. That is, before we conclude that endurantism is non-reductionist about change, we need to examine this question. If the metaphysical difference of an object is indeed irreducible, endurantism is non-reductionist about change by our definition. However, as we saw above, the metaphysical difference of B itself is explained by unchanging states S_i, i.e. b_i's having different shapes s_i at different times t_i. Therefore, after all endurantism is reductionist about change by the definition above. We have no intention to deny that endurantism can explain change in its own way. Obviously, it can. What we want to claim here is only that the explanation is *reductive*.

Let us sum up the point here. The three standard state theories are all reductionist about change. The argument here is not that state theories are reductionist about change and so they are wrong. Rather, their reductionism about change tells us how they understand concrete reality. Change is understood by persistence with incompatible properties. Therefore, change is less fundamental as a concrete phenomenon than persistence. That is, change is a *non-fundamental* feature of concrete reality. Since persistence is understood by being located or existing at times, persistence is less fundamental than being located or existing at times. Therefore, change is ultimately reduced to being located or existing at times with incompatible properties.

2.4 Reductionism about Transition

Some endurantists might suggest persistence is a dynamic phenomenon: a persisting object 'moves through time'.[7] what does this 'moving through

[7]For example, the term appears in (Baker, 2007, pp. 155-6), although by this term Baker does not mean transition as multiple-location below. What she means by moving through time is, so called, the passage of tense that, according to her, is irreducible and only resides in our experience of concrete reality. Since we will talk about a tensed definition of transition in Ch.3, let us here focus on state theorists (especially endurantists)

time' mean in endurantism? Is this something like irreducible transition in transition theories? If so, they might be able to say a persisting object is irreducibly dynamic because it irreducibly transits along the fourth dimension. However, as we will see, 'moving through time' is only reductively understood in endurantism. Therefore, there is actually no way to talk about the irreducible dynamicity of a persisting object in terms of irreducible transition along the fourth dimension.

As we did for persistence and change, let us first make clear the definition of transition reductionism:

Transition Reductionism: Transition is understood in terms of more basic entities Y and Z that do not ontologically depend on transition.

The basic idea here is this: if we can have Y and Z without transition, the theory is reductionist about transition. If we cannot have them without transition, it is non-reductionist about transition.[8]

Let us first remember the state-theoretic framework for the persistence of a balloon B when it transits through the air (captured by Fig.2.1):

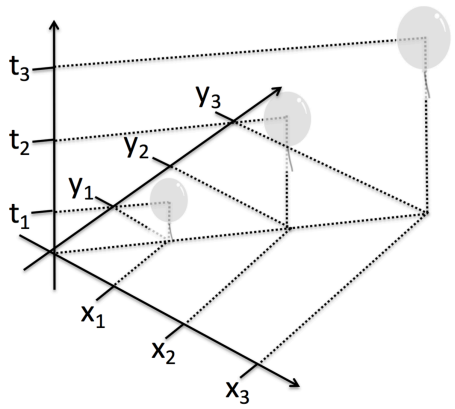


Fig. 2.1:

In Fig.2.1, we introduce a fourth dimension as time and locate 3-D balloons b_i with a certain shape s_i at different times t_i: b_1 with s_1 at t_1, b_2 with s_2 at

who might combine the idea of moving through time with the eternalist block universe.

[8]It should be noted that transition non-reductionism does imply that transition is an irreducible concrete phenomenon but does not imply that it is metaphysically primitive.

t_2, and so on. In endurantism, by introducing the identity relation holding between b_i, we claim that all the b_i at t_i are identical to B: the same object B is temporally multiply located at different times t_i. When we understand the persistence of B in this way, how can we understand the moving through time or 4-D transition? The one and only way will be to understand 4-D transition in terms of temporal multiple location:

Transition as Multi-Location: A persisting object transits through time by its being temporally multiply located at times (among which the B-series time order holds).

That is, we understand transition in terms of a 4-D sequence of 3-D states in Fig.2.1. For example, in this idea, when B moves through time from t_1 to t_2, this just means B is at t_1, and the *same* B is *also* at t_2, and t_1 is *earlier* than t_2. In other words, 'moving through time' is a metaphorical or poetic way of talking about persistence in endurantism. As we can tell easily, this transition as multi-location is quite different from irreducible transition along a fourth dimension in transition theories, captured by Fig.2.2-2.4 below (although they falsely give static images of irreducible transition):

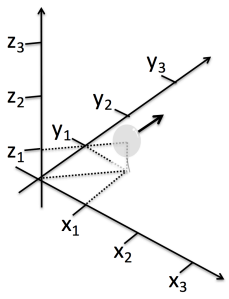


Fig. 2.2:

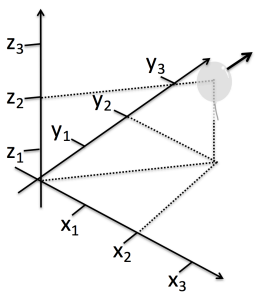


Fig. 2.3:

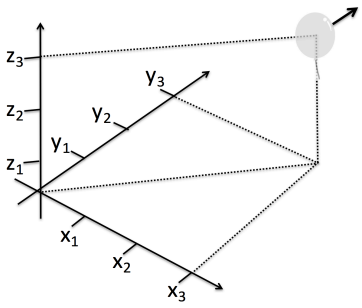


Fig. 2.4:

In Fig.2.2-2.4, a balloon B is irreducibly transiting through 4-D space without being located or stationary at any points. Here, the crucial difference between transition as multi-location and as irreducible can be described in the following way. On the one hand, a persisting object B in Fig.2.1 has

no transiting feature expressed by the black arrow because, in transition as multi-location, 3-D balloons b_i are *located* or *stationary* at times t_i along the fourth dimension. On the other hand, a persisting object B in Fig.2.2-2.4 has the transiting feature expressed by the black arrows because, in irreducible transition along the fourth dimension, a *non-locatable* balloon transits through 4-D space *without being located at* any points or regions.[9]

Is transition as multi-location a reductive understanding of transition? In this idea, transition is understood in terms of the temporal multi-locations of a persisting object. This temporal multi-location is made possible by introducing the identity relation holding between b_i at t_i. Therefore, what we need to do is to examine whether we have the following (i) and (ii) without transition: (i) 3-D states (b_i with a certain shape s_i at a time t_i) and (ii) the identity relation holding between b_i at t_i. I think it is obvious that the identity relation has nothing to do with transition, so let us here focus on (i) 3-D states, and take one state S_1, i.e. B (b_1) with s_1 at t_1. Does B itself in S_1 have something to do with 4-D transition of B? Obviously, no: B (b_1) is just stationary at t_1, and nothing more. If we want to say B 'moves through time' from t_1 to t_2, keeping B at t_1, we temporally duplicate the numerically identical B and locate it at t_2 as in Fig.2.1. This is the idea of temporal *multi*-locations of B. Since this is true of all the other states (b_i with s_i at t_i), endurantism that takes transition as multi-location is reductionist about transition.

When endurantism is reductionist about transition, it is also reductionist about dynamicity that is understood in terms of transition. As we saw in Introduction, a persisting object is irreducibly dynamic because it has the transiting feature expressed by the black arrows in Fig.2.2-2.4. In other words, a persisting object is irreducibly dynamic because it irreducibly transits through 4-D space *without being located or stationary at* points or regions

[9]For more detail about irreducible transition of a non-locatable object along a fourth dimension, see Ch.5.

in the space. However, as in Fig.2.1, if we understand the transition of a persisting object by a 4-D sequence of 3-D states, i.e. the same object's being temporally multiply located at times, we reduce the transiting feature of a persisting object to the 4-D sequence. This is captured by b_i at t_i without the black arrow in Fig.2.1. Therefore, while dynamicity that is understood in terms of transition is available for state theorists, it is only given reductively.

Let us sum up the point here. Some state theorists, especially endurantists, might talk about persistence in a dynamic way: a persisting object 'moves through time'. When we take the endurantist conception of persistence, this 4-D transition (moving through time) is understood in terms of a 4-D sequence of 3-D states. If we take this transition as multi-location, since this understanding of transition is reductive, dynamicity that is understood in terms of transition also becomes reductive. What does this reductionism tell us about the picture of concrete reality in the state-theoretic framework? The 4-D transition (moving through time) of a persisting object is understood by a sequence of states, i.e. objects being locates at times. Therefore, transition is a *non-fundamental* feature of concrete reality. This also means dynamicity that is understood in terms of transition is a non-fundamental feature of concrete reality.

Conclusion

State-theorists of persistence are committed to a certain picture of concrete reality. That is, they are reductionists about persistence, change, and transition. They are reductionists about persistence: persistence is understood by being located or existing at times. Also, they are reductionists about change: change is understood by persistence with incompatible properties. Since persistence is understood by being located or existing at times, change is ultimately understood by being located or existing at times with

incompatible properties. Finally, they are reductionists about transition. Moving through time or transition along a fourth dimension is understood by the same object's being temporally multiply located at times. Therefore, in this framework, persistence, change and transition are all treated as non-fundamental and reduced to other concrete realities, states (objects with properties at times). In short, there is no persistence, change, and transition at the fundamental level of concrete reality in the state-theoretic framework.

This means state theorists cannot treat persistence as an irreducibly dynamic phenomenon in terms of irreducible transition as in transition theories. However, it does not follow from this that state theorists cannot think of persistence as an irreducibly dynamic phenomenon in *any* way. For example, there are A-theories of time such as the moving-spotlight and growing-block theory, and dynamic ontology such as process ontology and powers ontology. Therefore, someone might think that state theories combined with a dynamic theory of time or dynamic ontology can deal with persistence in an irreducibly dynamic way. In the next chapter, we first examine A-theoretic state theories, i.e. the combination of state theories with A-theories of time.

Chapter 3

A-theoretic State Theories

Introduction

In Ch.1, mainly assuming eternalism, we have argued that state theories of persistence accept the general framework of introducing a fourth dimension (usually time) and locating things with properties along the fourth dimension. In this framework, persistence is understood in terms of states, i.e. things with properties located at times. That's why theories of persistence that accept this general framework are called *state* theories. In Ch.2, we have made clear the state-theoretic picture of concrete reality by considering whether state theorists are reductionists about persistence, change, and transition. They are reductionists about these phenomena because these three phenomena are reductively understood in terms of states.

Since our objective is to defend the idea of persistence as an irreducibly dynamic phenomenon, if we want to keep the state-theoretic framework, we need to find a way out of reductionism about dynamicity. One natural suggestion is that state theorists are reductionists about the dynamicity of a persisting object because eternalism is mainly assumed in Ch.1-2. In other words, when state theories are combined with A-theories of time (e.g., the moving-spotlight theory, the growing-block theory, and presentism), they might be able to deal with the dynamicity of a persisting object irreducibly.

Indeed, A-theories of time bring irreducible tense into concrete reality by introducing a certain dynamic process. Therefore, A-theoretic state theories might have a way to defend persistence as a dynamic phenomenon. As we will see, when we introduce a dynamic process in the state-theoretic framework, it has a certain characteristic feature: one stage first occurs, then another stage in turn occurs. That is, the stages of the process successively occur one after another. Unfortunately, dynamic processes with this feature face serious problems that cannot be solved as long as we are in the state-theoretic framework. In the following, let us first look at four standard theories of time and the distinction between A-theories and B-theories of time. After that, we examine A-theoretic state theories and conclude that while they seem plausible at the first sight, they face the problems mentioned above.

3.1 A-Theories and B-theories

Four standard theories of time, eternalism, the moving-spotlight theory, the growing-block theory, and presentism, are often characterized in terms of their claims about the ontological status of past, present, future objects:

Eternalism: Past, present, future objects all exist.[1]

Presentism: Only present objects exist.[2]

The Growing Block Theory: Only past and present objects exist.

The Moving Spotlight Theory: Past, present, future objects all exist.

[1]Some eternalists are Mellor (1981), Lewis (1986a), Sider (2001), and Rea (2003).

[2]There is so called *the triviality problem* about how we should understand 'exist' in presentism. Typically, the argument starts with the following two trivially true and false statements: (i) if this 'exist' is tensed, then this says something trivially true: only present objects *exist now*; (ii) if 'exist' is a disjunction of '*did* exist', 'exist *now*', and '*will* exist', then this says something trivially false: only present things *did* exist, exist *now*, or *will* exist. Then, the argument in turn considers other ideas such as (i) 'exist *tenselessly*', (ii) 'exist *simpliciter*', or (iii) the unrestricted existential quantifier $\exists$. See, for example, Crisp (2004), Ludlow (2004), Dorato (2006), Mozersky (2011), Lombard (2010), Gołosz (2013), Noonan (2013).

While this characterization is quite popular and useful for a certain purpose, this is not so useful for our purpose because we cannot tell how theorists of time think of the dynamicity of concrete reality.

We can also classify theories of time in terms of whether they bring tense into concrete reality in an irreducible way or not. In the recent debate in philosophy of time, eternalism is classified as a *B-theory*, and the other three theories are classified as *A-theories* or 'dynamic' theories of time. A-theories and B-theories of time are typically understood in terms of whether they accept the present as privileged or not[3]:

A-Theory: There are non-relative facts that make the present privileged.

B-Theory: There are no non-relative facts that make the present privileged.

In other words, A-theorists think absolute tensed sentences (or facts) are irreducible to relative tenseless sentences (or facts), and B-theorists think they are reducible. For example, consider the following two facts: (i) an absolute tensed fact that a balloon B *has* the shape s_2 and (ii) a relative tenseless fact that B has s_2 at t_2.[4] B-theorists such as eternalists think that (i) is reducible to relative tenseless facts such as (ii) and temporal relations (e.g., *earlier than* and *later than*) between them.

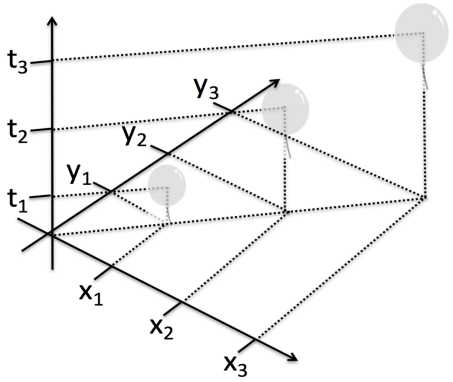


Fig. 3.1:

[3]See, for example, Zimmerman (2005) and Deasy (2015).

[4]In this paper, if we emphasize that facts or sentences are tensed, they are italicized in the following way: I *had* much money; I *have* some money; I *will* have no money.

To see this point, let us consider 4-D spacetime called *the block universe* which includes all the past, present future objects and events. One region of the block universe concerning our balloon example is depicted by Fig.3.1 above. As we saw in Ch.2, this is a static image of the persisting balloon because each 3-D balloons b_i are eternally located at its own time: a 3-D balloon b_1 is located at (x_1, y_1, t_1), a 3-D balloon b_2 is located at (x_2, y_2, t_2), and a 3-D balloon b_3 is located at (x_3, y_3, t_3). B-theorists accept the block universe partially described by Fig 3.1 and claim (i) is reducible to relative tenseless facts and their temporal relations: B's having s_2 at t_2 is earlier than B's having s_3 at t_3 and later than B's having s_1 at t_1. There is no irreducible absolute tensed fact that makes the present privileged. If this is true, our universe is nothing but the block universe and so there is no dynamic process that brings irreducible tense in concrete reality.

A-theorists think that absolute tensed facts are irreducible to relative tenseless facts and their temporal relations. In some A-theories, irreducible tense is brought into concrete reality by a certain dynamic process. One example is the moving-spotlight theory according to which there is a dynamic process, i.e. the movement of the NOW that moves through the block universe from earlier times to later times. Another example is the growing-block theory according to which there is a dynamic process, i.e. the growth of the block universe itself. The important point for our purpose is that, in both cases, irreducible tense is brought into concrete reality by a dynamic process. In other A-theories, tense is irreducible but there might or might not be a dynamic process. That is, irreducible tense and a dynamic process are not connected. For example, in presentism, concrete reality is not a 4-D spacetime but a non-temporally extended 3-D space. In this theory, the irreducibility of tense consists in this strict ontology: only present objects exist.[5] While this claim itself does not commit us to the existence of a dynamic process, presentists usually do introduce a dynamic changing

[5]Another example is Fragmentalism in Fine (2005).

process about what is the present (or present objects): what is the present (or present objects) dynamically changes.[6]

Therefore, if state theories are combined with some A-theories that introduce a dynamic process in concrete reality, they might have a way to defend the idea of persistence as an irreducibly dynamic phenomenon. As we will see below, each combination seems to have a way to talk about persistence as an irreducibly dynamic phenomenon. Before we start to examine each combination one by one, it is better to make clear what it is for the combination of state theories with a A-theory of time to work well for dealing with persistence as an irreducibly dynamic phenomenon. Obviously, even if we have a dynamic process, if persistence is understood independently from the dynamic process, the combination is useless because the dynamic process has nothing to do with persistence. In other words, the following requirement should be satisfied: the persistence of an object cannot be understood without the dynamic process. If this condition is met, a dynamic process is said to be in the very understanding of persistence.

3.2 Permanent A-Theories

In this section, we examine three different permanent A-theories: (i) the moving-spotlight theory, (ii) the passage theory, and (iii) the minimal A-theory. Some A-theorists as well as eternalists think nothing comes into existence or ceases to exist: nothing changes with respect to existence. In other words, they accept the following thesis:

Permanent Existence: Everything always (or eternally) exists.[7]

[6]While some presentists such as Tallant (2010) accept that things change, they do not accept a changing process itself. Change is understood in terms of irreducible tense, and nothing more. For example, the intrinsic change of a ball in its shape is understood as follows: a ball *is now* round and *will* be oval. However, by thinking of tensed facts, they are not ontologically committed to a process, i.e. a changing process from one state (a ball's being round) to another (its being oval).

[7]See Sullivan (2012).

B-theorists such as eternalists accept this thesis (e.g., the unchanging block universe), and nothing more. Permanent A-theorists also accept this thesis but think there is something more in concrete reality than what this tells us.[8] This something more that distinguishes them from eternalism is a dynamic changing process about what time is the present. What makes the three theories (i)-(iii) differ within permanent A-theories is how these theorists understand this dynamic changing process. In what follows, we will examine whether this dynamic process can be used for defending persistence as an irreducibly dynamic phenomenon.

3.2.1 The Moving-Spotlight Theory

Let us start with the moving-spotlight theory.[9] According to this theory, everything always *concretely* exists. In other words, past, present, future objects all exist at their own times. Like eternalism, it accepts the block universe depicted by Fig.3.1. Thus, in our balloon case, a 3-D balloon b_1 is located at a concrete time t_1, and a 3-D balloon b_2 is located at a concrete time t_2, and so on. What is the difference between eternalism and the moving-spotlight theory? Unlike eternalism, moving-spotlight theorists think there is some dynamic process in our universe, i.e. the movement of the NOW: the NOW moves through the block universe from earlier times to later times.[10] Usually, the movement of the NOW is explained in the following way: the NOW is first *at* t_1, then the NOW is in turn *at* t_2, and so on. It

[8]Other non-permanent A-theorists such as the growing block theory think something comes into existence and(or) ceases to exist. In other words, they accept the following thesis, Temporary Existence: some objects change with respect to existence. See Sullivan (2012).

[9]Recent moving-spotlight theorists are Skow (2009, 2012), Deasy (2015). Deasy(2014) does not distinguish the moving-spotlight theory from the passage theory below, and regards the former as the traditional one. Others such as (Sider, 2011, Ch.11.9) and (Brogaard and Marlow, 2013, p. 636) distinguish the moving-spotlight theory from the passage theory. In this dissertation, I will follow the latter distinction.

[10]There is a famous problem concerning the moving spotlight theory (and the growing block theory in Sec.2 below), known as the 'two times' problem: one time is based on time dimension, another is based on the position of the moving NOW (or the present edge of the block universe). See Bourne (2002), Braddon-Mitchell (2004), Forrest (2004), Heathwood (2005), Merricks (2006), Button (2006), Tallant (2011).

should be noted that the movement of the NOW is different from irreducible transition in transition theories. As we saw in Introduction, an object transits through 4-D space *without being located at* any 4-D points in transition theories. There is no point of view (in transition theories) from which we can say an object is first at a point and then in turn at another point. Such a view point is only available in the state-theoretic framework. The dynamic process of the moving NOW is something we might call *pseudo-transition* because it moves through time by its first being *at* a time then in turn being *at* another time, and so on.[11]

As we can easily tell, the moving-spotlight theory takes the state-theoretic framework of introducing a fourth dimension as time that offers temporal locations for objects. Therefore, state theories can be combined with the moving-spotlight theory, and the combination has a dynamic process in concrete reality.[12] Now, can state theorists defend the idea of persistence as a dynamic phenomenon by the movement of the NOW? As we mentioned above, we can do so only if the persistence of objects cannot be characterized without the pseudo-transition of the NOW. However, it seems the definition of persistence is given independently from the dynamic process. For example, the persistence of a balloon B in this combination seems to be completely understood by states, i.e. 3-D balloons b_i with s_i at different times t_i. Whether the NOW moves through time or not, a balloon B persists from t_1 to t_2 if and only if b_1 with s_1 is at t_1 and b_2 with s_2 is at t_2 (and there is an appropriate trans-temporal relation between them). If so, while there is a concrete dynamic process in this combination, this itself has nothing to do with persistence.

However, someone might think, unlike eternalism, persistence is irreducibly tensed because of the dynamic movement of the NOW, and claim

[11]Therefore, this kind of transition can be called 'at-at' transition. For more detail, see Ch.8.3.

[12]It is assumed here that the movement of the NOW is irreducible to a higher-order sequence of states.

that persistence is an irreducibly dynamic phenomenon because persistence is irreducibly tensed. For example, suppose the NOW *is* at t_2. Then, we can say B *is* persisting and *will* be persisting. This is because (i) b_2 is at t_2, (ii) b_3 is at t_3, (iii) there is an appropriate relation between b_2 and b_3, *and* (iv) the NOW *is* at t_2. Suppose further that the NOW *is* at t_4 and there is *no* appropriate relation between b_3 at t_3 and any 3-D ball at t_4. Then, we can say B *was* persisting but *is not* persisting. This is because (i) b_3 is at t_3, (ii) there is no appropriate relation between b_3 at t_3 and any 3-D ball at t_4, *and* (iii) the NOW *is* at t_4. Therefore, persistence is irreducibly tensed because of the dynamic moving process of the NOW. If so, we might claim that persistence is an irreducibly dynamic phenomenon because whether B is persisting or not changes in an irreducibly way as the NOW moves from earlier times to later times. Here, we are trying to understand dynamicity in terms of irreducible tense. According to this idea, persistence is an irreducibly dynamic phenomenon because persistence is irreducibly tensed.

If we accept dynamicity in this sense, since persistence is irreducibly tensed because of the dynamic moving process of the NOW, it seems the combination of state theories with the moving-spotlight theory has a way to defend persistence as an irreducibly dynamic phenomenon. Since we have no reason to reject this combination so far, let us keep this until we find some serious problems against it.

3.2.2 The Passage Theory

Let us move to the passage theory.[13] As permanentists, the passage theorists think past, present, future objects always exist at their own times.[14] However, unlike the moving spotlight theorists, they reject the idea that all times are concrete locations of objects. Rather, they think the one and only one

[13]The idea can be found in Williamson (1998, 2002), and Brogaard (2012).

[14]Unlike eternalists, since permanent A-theorists think there is a concrete changing process about what is the present, this should be included into what they mean by 'everything' in addition to past, present, future objects located at times.

time, i.e. the present, is the concrete location of objects. Of course, there are other times, but they are (at best) *abstract* locations of objects. Therefore, while they introduce a fourth dimension as time whose metaphysical role is to offer temporal locations for objects, they reject the concrete block universe where all times are *concrete* locations of objects. They or at least some of them also introduce a dynamic changing process about what time is the concrete location of objects: one time first becomes the present as a concrete location for objects, then another time in turn becomes the present as a concrete location for objects, and so on. The dynamicity introduced by this process is different from dynamicity that is understood in terms of irreducible transition. While, in the latter case, dynamicity is understood in terms of an irreducibly transiting entity, there is no transiting entity in the former case. Rather, this process is dynamic because the concretization of times *occurs successively*. For example, suppose t_1 (at which b_1 with s_1 is located) *is now* the concrete location of objects. Then, t_1 ceases to be the concrete location and t_2 (at which b_2 with s_2 is located) in turn becomes the concrete location for objects, and so on. In this idea, concrete reality is dynamic because times are successively concretized one after another. Let us call this dynamic process *successive concretization*.

Passage theorists accept the state-theoretic framework of introducing a fourth dimension as time and locating objects at times. Therefore, state theories can be combined with the passage theory, and the combination might defend the idea of persistence as a dynamic phenomenon by successive concretization. Can state theorists successfully defend the idea? Consider how objects persist in this combination. It seems the answer is this: a balloon B persists from t_1 and t_2 iff b_1 with s_1 is at t_1 and b_2 with s_2 is at t_2. That is, the persistence of B is completely understood by states (i.e. 3-D balloons b_i with s_i at t_i) and so is given independently from the dynamic process of successive concretization. If so, while there is a dynamic process in this combination, this itself has nothing to do with persistence.

However, as we saw in the moving-spotlight theory, someone might think, unlike eternalism, persistence is irreducibly tensed because of the dynamic process of successive concretization, and claim that persistence is an irreducibly dynamic phenomenon because persistence is irreducibly tensed. For example, suppose t_1 and only this time *is now* concretized. Then, we can say B *is* persisting and *will* be persisting. This is because (i) b_1 is at t_1, (ii) b_2 is at t_2, (iii) there is an appropriate relation between b_1 and b_2, *and* (iv) t_1 *is now* concretized. Suppose further that t_3 *is now* concretized and there is *no* appropriate relation between b_2 at t_2 and any 3-D ball at t_3. Then, we can say B *was* persisting but *is not* persisting. This is because (i) b_2 is at t_2, but (ii) there is no appropriate relation between b_2 at t_2 and any 3-D ball at t_3, *and* (iii) t_3 *is now* concretized.

If we accept dynamicity that is understood in terms of irreducible tense, since persistence is irreducibly tensed because of the dynamic process of successive concretization, it seems the combination of state theories with the passage theory has a way to defend persistence as an irreducibly dynamic phenomenon. Since we have no reason to reject this combination so far, let us keep this until we find some serious problems against it.

3.2.3 The Minimal A-theory

According to the minimal A-theory, everything including 4-D spacetime always exists.[15] In this sense, the minimal A-theory is similar to eternalism and the moving-spotlight theory because all times, i.e. past, present, future times, are concrete locations for objects. However, there is a big difference between them. In the block universe in eternalism or the moving-spotlight theory, each time (or time-slice) is filled with objects. That is, present objects are located at the present time, past objects are located at past times, and future objects are located at future times. That's why past, present, and future objects are all real in these theories. By contrast, in the minimal

[15]See (Sullivan, 2012, 2016).

A-theory, objects are located at only one time-slice that is the present, and nothing is located at all the other time-slices. That is, only one time-slice is filled with objects, but the other time-slices are all empty. Also, the minimal A-theorists introduce a dynamic changing process about which time-slice is filled with objects: one time-slice first gets filled with objects, then another time-slice in turn gets filled with objects, and so on. Therefore, when objects *are now* located at t_2, t_1 (t_3) *was* (*will be*) a temporal location for objects but nothing *is now* located there. Let us call this process *transient filling*.

For a comparison, consider 4-D spacetime (or the block universe) in eternalism or the moving-spotlight theory, which is captured by Fig.3.1. In Fig.3.1, t_1, t_2, and t_3 are all concrete temporal locations for objects and b_1 is at t_1, b_2 is at t_2, and b_3 is at t_3. By contrast, 4-D spacetime with the

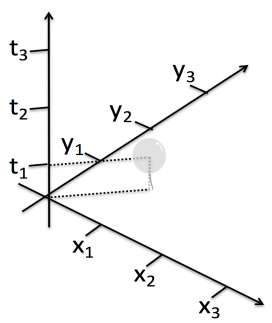


Fig. 3.2:

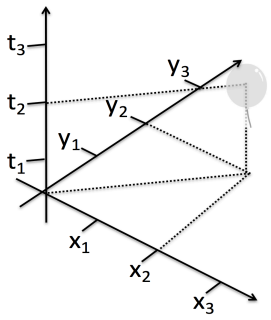


Fig. 3.3:

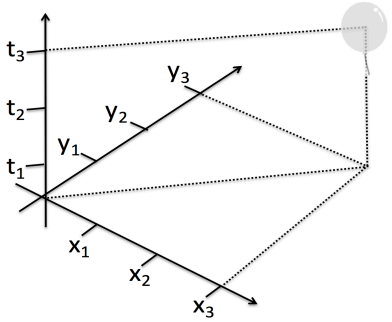


Fig. 3.4:

transient filling in the minimal A-theory is cashed out by Fig.3.2-3.4 above. In Fig.3.2, t_1 *is now* the only concrete location at which objects including b_1 with s_1 are located, and the other times including t_2 and t_3 *were* or *will be* concrete locations for objects but nothing *is now* located there. By transient filling, as in Fig.3.3, t_2 *is now* the only concrete location at which objects including b_2 with s_2 are located, and the other times including t_1 and t_3 *were* or *will be* concrete locations for objects but nothing *is now* located there. The same is true of t_3 in Fig.3.4. This is the dynamic process of transient filling.

The minimal A-theory accepts the state-theoretic framework of introduc-

ing a fourth dimension as time and locating objects at times, it seems state theories can be combined with this theory. Indeed, Meghan Sullivan who has proposed the minimal A-theory is an endurantist. Although Sullivan does not talk about how endurance is defined in this theory, we cannot straightforwardly accept a standard tenseless definition of endurance here. At least, we cannot use the following definition: an object endures over time iff the object is wholly present at each time of the duration. For example, a balloon B persists from t_1 to t_2 iff B is located at t_1 and the same B is also located at t_2. This definition only makes sense in the block universe captured by Fig.3.1. If so, how can we understand endurance in the minimal A-theory? Instead of the tenseless definition, we have to think of a tensed definition of endurance here. Consider the persistence of B in Fig.3.3. In this case, the persistence of B from t_1 to t_3 will be understood in the following way: B *was* located at t_1, the same B *is now* located at t_2, and the same B *will be* located at t_3. While we accept this tensed definition of persistence, this is just a halfway through the complete understanding of persistence in the minimal A-theory because 'objects persist through the loss of all location relations' in this theory.[16] In other words, the existence of persisting objects is not related to its being located at spatiotemporal regions. If so, how do objects persist (endure) when they have no spatiotemporal locations?

While it is not so clear how the general definition of persistence (in time and not in time) can be given, let us ask the more important question for our purpose: can state theorists defend the idea of persistence as a dynamic phenomenon by the dynamic process of transient filling? Since persistence is irreducibly tensed, and what underlies this irreducible tense is the dynamic process of transient filling, the persistence of an object cannot be separated from this dynamic process. Therefore, it seems we can accept this combination as a way to defend persistence as an irreducibly dynamic phenomenon. Let us keep this option until we find some serious problems

[16]See (Sullivan, 2012, p. 167).

against it.

3.3 The Growing-Block Theory

Like moving-spotlight theorists, growing-block theorists think times are concrete locations of objects and all objects at times are concrete. However, unlike permanent A-theorists who think all past, present, and future times all exist, growing-block theorists think only past and present times exist.[17] That is, future objects and times simply do not exist, although future objects will exist. In this sense, the growing block theorists accepts the block universe in a limited way: the block universe includes only past and present times. According to them, there is a dynamic growing process of the block universe itself. That is, the block universe itself is getting bigger and bigger. How does it grow? The block universe grows by new spacetime segments' getting added to the edge of the block universe (called *the present*) one after another. For example, consider the block universe that includes also past times $(t_1, ..., t_{n-1})$ and the present (t_n) that is the edge of the block universe. After a new spacetime segment t_{n+1} gets added to the edge (t_n), this block universe is bigger than before because it now includes past times $(t_1, ..., t_n)$ and the present (t_{n+1}). Let us call this dynamic process *successive addition*.

For a comparison, consider again the block universe in Fig.3.1 in which past, present, and futures times are all included. By contrast, the block universe with successive addition is cashed out by Fig.3.5-3.7 below. In Fig.3.5, t_1 is the present edge of the universe. By successive addition, a new spacetime segment (t_2) gets added to t_1. In Fig.3.6, this newly added spacetime segment (t_2) becomes the present edge of the universe. Again, by successive addition, a new spacetime segment (t_3) gets added to t_2. Fig.3.7,

[17] In addition to Broad (1923), some recent growing blockers or no-futurists are Tooley (1997), Forrest (2006), Button (2007), Earman (2008), and Diekemper (2013). While Briggs and Forbes (2012) offers an ersatzist approach for dealing with future statements in this theory, their argument is not for the theory itself.

this newly added spacetime segment (t_3) becomes the present edge of the universe.

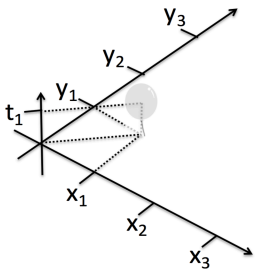


Fig. 3.5:

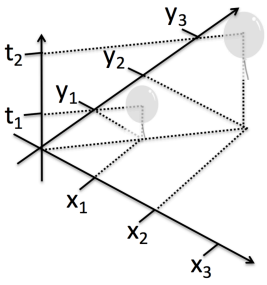


Fig. 3.6:

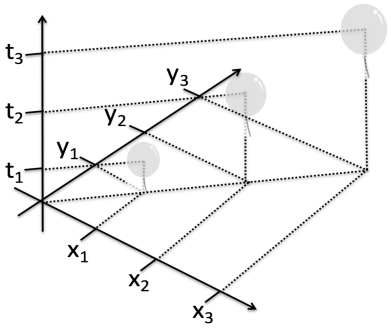


Fig. 3.7:

The growing-block theory accepts the state-theoretic framework of introducing a fourth dimension as time and locating objects at times, and so it seems state theories can be straightforwardly combined with the growing-block theory. Indeed, unlike in the minimal A-theory, when we consider the persistence of B within the block universe (e.g., from a past time to the present), the standard tenseless definition works. For example, consider the persistence of B from t_1 to t_2 in Fig.3.7. In this case, the persistence can be understood in the following way: b_1 is located at t_1 and b_2 is located at t_2 (and they are in an appropriate trans-temporal relation). However, like the minimal A-theory, when we think of the persistence of B from the past or present time to a future time, we cannot straightforwardly accept the standard tenseless definition. For example, suppose t_1 is the present edge of the universe as in Fig.3.5 and consider the persistence of B from the present (t_1) to a future time t_2. Obviously, we cannot understand the persistence here in the following way: b_1 is located at t_1 and b_2 is located at t_1. This is because b_2 simply does not exist when t_1 is the present edge. Therefore, as in the minimal A-theory, a tensed version of persistence should be given in the following way: B *will* persist because b_2 *will* be located at t_2.

Like in the minimal A-theory, it is not so clear how we can give the general definition of persistence that is concerned with all times from a past

time to the present time, to a future time. If we want to defend persistence as a dynamic phenomenon, it is not a good idea to take an ersatzist approach here. For example, if we introduce an abstract B-series time-order and understand the persistence of B by being located at different abstract times, persistence has nothing to do with the dynamic process of successive addition. If so, what is the general definition of persistence? It is not so clear. It might be disjunctive. However, putting aside this problem, let us ask the most important question for our purpose: assuming the tensed definition of persistence, can state theorists defend the idea of persistence as an irreducibly dynamic phenomenon by successive addition? Since persistence is irreducibly tensed, and what underlies this irreducible tense is the dynamic process of successive addition, the persistence of objects cannot be separated from this dynamic process. So, it seems we can also accept state theories combined with the growing-block theory as a way to defend persistence as a dynamic phenomenon. So, again, let us keep this option until we find serious problems against it.

3.4 Presentism

As we saw above, permanent A-theorists think past, present, future times all exist.[18] The growing-block theorists think only past and present times exist. By contrast, presentists think only the present exists. In other words, the present is the only concrete location for objects, and so only present objects exist. In this respect, the minimal A-theory and presentism have something in common: objects are only located at the present. Of course, while there is a temporally extended 4-D spacetime in the minimal A-theory, there is a non-temporally extended 3-D space in presentism.[19] As other A-theorists

[18]Some recent presentists are Crisp (2003), Markosian (2004), Zimmerman (2005), Bourne (2007), (Merricks, 2007, Ch.6), Fiocco (2007), Hestevold (2008), Cameron (2011), Tallant (2014), and Ingram (2016).

[19]Some philosophers are sceptical about this idea and claim that in order to make clear what the present is and make presentism compatible with relativity, the debate

do, some (but not all) presentists introduce a dynamic changing process about what is present. In the dynamic process, what is present changes by non-temporally extended 3-D spaces' successively coming into existence and ceasing to exist one after another: one 3-D space comes into existence and immediately ceases to exist, then another 3-D space comes into existence and immediately ceases to exist, and so on. The idea here is that concrete reality is a non-temporally extended 3-D space, but what is 3-D is not fixed but is always changing. Let us call this dynamic process *ephemeral becoming*.

For a comparison, consider 4-D spacetime and the changing process about what is present in the minimal A-theory. As we saw above, the 4-D space included all past, present and future times, but only the present time is filled with objects: objects are only located at the present. This idea is captured by Fig.3.2-3.4. For example, in Fig.3.2, t_1 is the present and only this time is filled with objects including b_1 at (x_1, y_1). By contrast, in presentism, there is no 4-D spacetime that itself changes from one state as in Fig.3.2 to another state as in Fig.3.3.

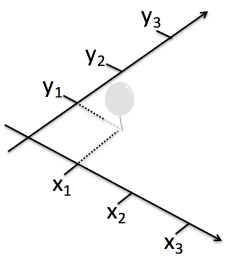


Fig. 3.8:

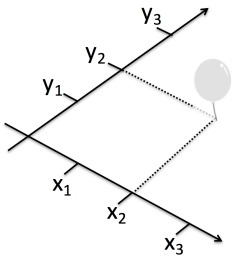


Fig. 3.9:

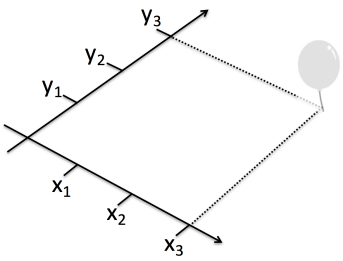


Fig. 3.10:

Rather, 3-D spaces successively come into existence and immediately cease to exist one after another. Let us express 3-D space where a 3-D ball b_i is located at (x_i, y_i) as 3-D$_i$: for example, in 3-D$_1$, b_1 is located at (x_1, y_1), and

between Eternalism and Presentism should be carried out relative to some background *space-time theory* (Savitt, 2006, p. 123). In a similar vein, Arthur (2006), Dieks (2006), Dolev (2006), and Savitt (2009) are all concerned with the 'moving' or transient nows and special relativity in Minkowski spacetime. An important point is that the nows in these papers are just some regions in Minkowski spacetime. There are also some presentists who think the present has some duration. See Hestevold (2008).

in 3-D_2, b_2 is located at (x_2, y_2), and so on. Then, the dynamic process of ephemeral becoming is cashed out by Fig.3.8-3.10 above. In Fig.3.8, 3-D_1 where b_1 is located at (x_1, y_1) is the present. By ephemeral becoming, 3-D_1 immediately ceases to exist, and then another 3-D_2 where b_2 is located at (x_2, y_2) comes into existence as in Fig.3.9. Again, by ephemeral becoming, 3-D_2 immediately ceases to exist, and then another 3-D_3 where b_3 is located at (x_3, y_3) comes into existence as in Fig.3.10, and so on.

Presentists do not straightforwardly accept the state-theoretic framework of introducing a fourth-dimension as time and locating objects at times. However, this itself does not mean state theories cannot be combined with presentism. Indeed, they still accept the state-theoretic framework in a quite limited way: they introduce 3-D space (called the present) and locate objects at the present. This is enough to have a state theory of persistence. Of course, as we saw in the minimal A-theory and the growing-block theory, the standard tenseless definition of persistence also does not work for the same reason as given above. Consider the persistence of a balloon B (b_2) in Fig.3.9. Obviously, there is no time including past and future times at which a 3-D balloon can be located simply because concrete reality is just 3-D. Therefore, as in the minimal A-theory and the growing-block theory, a tensed version of persistence should be given in the following way: b_2 *now exists*, and b_1 *did* exist and b_3 will exist.[20]

Can state theorists defend the idea of persistence as a dynamic phenomenon by ephemeral becoming? Since persistence is irreducibly tensed, and what underlies this irreducible tense is the dynamic process of ephemeral becoming, the persistence of objects cannot be separated from this dynamic process. So, it seems we can also accept state theories combined with presentism as a way to defend persistence as a dynamic phenomenon. However,

[20]See (Hestevold and Carter, 2002, p. 507). If we want to be endurantists, we somehow have to secure the identity relation among 3-D balloons b_1, b_2, b_3 each of which successively comes into existence and immediately ceases to exist one after another. For a perdurantist version of presentism, see Brogaard (2000) and (Hestevold, 2008, p. 340).

what is the metaphysical status of the dynamic process of ephemeral becoming?[21] This is a *concrete* changing process about what is the present. According to presentism, concrete reality is just 3-D. Therefore, if this concrete changing process is 3-D, it can be accommodated in the ontology of prsentism; if not, it cannot be. Is the changing process of ephemeral becoming 3-D? Obviously not. If it were, the process *itself* would be something like 3-D space captured by Fig.3.8, but the dynamic process of ephemeral becoming as a 3-D entity does not make any sense. Therefore, this concrete process is not 3-D. However, if it is not 3-D, it cannot be accommodated in presentism. Of course, (i) we can reject this concrete dynamic process as some presentists actually do or (ii) we can take an ersatzist approach as we saw in the growing-block theory. But, if we want to defend persistence as an irreducibly dynamic phenomenon, neither (i) nor (ii) is available for us.

3.5 Problems with Dynamic Processes in A-Theories

So far we have examined the combinations of state theories with A-theories of time, i.e. A-theoretic state theories. Obviously, state theories of persistence and A-theories theories of time can be naturally combined because both theories share the state-theoretic framework of introducing a fourth dimension as time and locating objects at times. As we saw above, each combination (except for the one with presentism) seems to have a way to talk about persistence as an irreducibly dynamic phenomenon. That is, A-theoretic state theorists bring irreducible tense by introducing a dynamic process into concrete reality and make persistence itself inseparable from the dynamic process in that persistence becomes irreducibly tensed. However, as we will see below, dynamic processes in the state-theoretic framework

[21]The argument here that ephemeral becoming is not something acceptable in the ontology of presentism is given in Aoyama and Barker (unpublishedb).

face several serious problems.[22]

As we saw above, A-theories of time share the general idea of introducing a fourth dimension as time and locating objects with properties at times, although in the case of presentism 3-D space called the present is introduced, instead of 4-D spacetime. If we introduce a dynamic process based on this state-theoretic framework, the dynamic process has a characteristic feature. While we can find this feature in all dynamic processes in A-theories, let us focus on transient filling in the minimal A-theory and successive addition in the growing-block theory. In the dynamic process of transient filling, different concrete times successively get filled with objects one after another: one time t_1 first gets filled with objects, then another time t_2 in turn gets filled with objects, and so on. In the dynamic process of successive addition, different new spacetime segments successively get added to the present edge of the block universe one after another: a new spacetime segment (t_1) first gets added to the present edge (t_0), then another new spacetime segment (t_2) in turn gets added to the present edge (t_1), and so on. What is characteristic about these two processes is that the filling or addition of a time-slice successively occurs one after another. Let us call this feature *one-after-another succession* and processes with this feature *one-after-another processes*.

If we want to defend persistence as a dynamic phenomenon, transient filling or successive addition must be irreducible. If we reduce these processes to a higher-order 5-D sequence of 4-D states, these dynamic processes are dynamic only in a reductive sense.[23] Now, what are these metaphysically fundamental processes? Although it is meaningless to ask a reductive explanation about them, we are allowed to ask for some articulations. For example, processes are in general either continuous or discrete, and so a

[22]The basic structure of the argument in Sec.5 is based on Aoyama and Barker (unpublisheda). The basic structure is as follows: (i) dynamic processes in state theories are continuous or discrete; (ii) if they are continuous, they face the problem of infinite candidates; (iii) if they are discrete, they face the problem of reduction. What is added by me (my reconstructing part) is to explain why they face these problems by the fact that they have the charactristic feature of one-after-another succession.

[23]For more details, see Sec.3.7 below.

one-after-another process is also either continuous or discrete. So, let us examine the process in this respect. Suppose first that the process is continuous and take the growing-block theory as an example. When the growth is continuous, then the time dimension of the block universe must be a dense order of times such that between any two times t_1 and t_2, there is another t_3 in between (i.e. $t_1 < t_3 < t_2$). Suppose t_1 is the present edge of the block universe. By successive addition, a new spacetime segment will get added to the present edge t_1. However, if the growth is continuous, we have to ask the following question: what is *the next segment* that gets added to the present edge? You might think it's obvious: It's t_2. However, this is not true because there is t_3 in between. So, is it t_3? No, because there is yet another time between t_1 and t_3. Since this question will be repeated infinitely, we never reach to the next spacetime segment that will get added to the present edge. Therefore, a continuous one-after-another process is inconsistent because we need the next time in this process but there is not such thing as the next time in this process. Let us call this *the problem of infinite candidates*.

How about a discrete one-after-another process? When the growth of the block universe is discrete, a new spacetime segment that will get added to the present edge have non-zero duration. In this case, there is no problem of infinite candidates because the time dimension is finitely divisible and indeed there is a unique adjacent time that will get added (given the direction of successive addition). However, in this case, a higher-order time or supertime must be introduced for the following reason. Suppose t_1 is the present edge of the block universe and the next segment (t_2) with non-zero duration will get added to the present edge (t_1). The question here is this: is there any interval from the addition of t_1 to t_0 to the next addition of t_2 to t_1? That is, does the spacetime segment (t_2) get added to t_1 simultaneously with the addition of t_1 to the present edge (t_0)? If it is simultaneous, since *all* the new segments get added simultaneously, all future segments are already there as the eternalist

says. This means there is no growth of the block, but this is inconsistent with the growing-block theory. If it is not simultaneous and there is some interval, this interval must be cashed out on a higher-order time because this is concerned with the growth of the 4-D spacetime itself. However, once we introduce a higher-order time to cash out the one-after-another process, its dynamicity is reduced to a higher-order sequence of 4-D states. This means a discrete one-after-another process is also untenable because discreteness requires a higher-order time that undermines irreducible dynamicity. Let us call this *the problem of reduction*.

Let us sum up the point here. When concrete reality is understood in terms of being located at or existing at times, a dynamic process is conceptualized in terms of one-after-another succession: *one* time-slice *first* gets added, then *another* time-slice *in turn* gets added, and so on. When we conceptualize a dynamic process in terms of one-after-another succession, we face the problems of infinite candidates and reduction. Obviously, the argument here is applied to the dynamic process of transient filling in the minimal A-theory. All we need to do is to replace 'added' with 'filled' in the above conceptualization (see Sec.3.7).

3.6 State Theories and the Problem of Infinite Candidates

While A-theoretic state theories introducing dynamic processes face the problem of infinite candidates, this does not mean all state theories face this problem. Indeed, there is the one and only way for state theorists to deal with the problem of infinite candidates. What is the way out? It is helpful to start from a famous Zeno paradox about the 3-D transition of Achilles. Let us call a blue ball Achilles and put it at the starting point (x_1, y_1) as in Fig.3.11. We push the ball and so it starts to transit through 3-D space, and is now passing the point (x_2, y_2) as in Fig.3.12. Again, Fig.3.12 itself is

a static picture, but it is transiting without being located or stationary at any 3-D points and this is expressed by the black arrow. Finally, it reached the goal (x_3, y_3) as in Fig.3.13. So, Achilles completed its transition through the segment between (x_1, y_1) and (x_3, y_3).

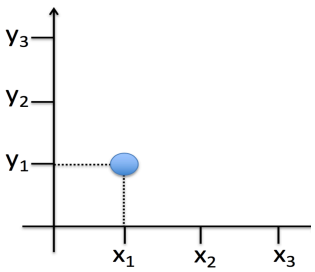


Fig. 3.11:

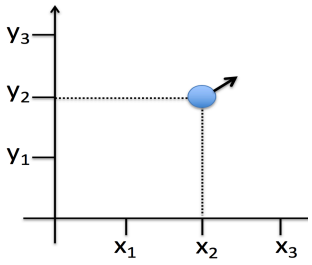


Fig. 3.12:

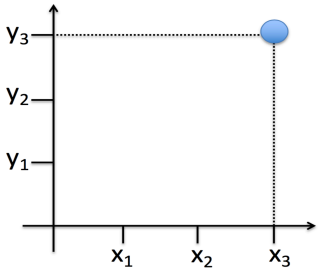


Fig. 3.13:

However, according to the Zeno's paradox, if the segment is continuous and so infinitely divisible, the ball Achilles can never reach the goal (x_3, y_3), contrary to our daily experiences. Consider the following process: we divide a segment into half and choose the second halved segment and divide it into half again. For example, if we start with the segment from (x_1, y_1) to (x_3, y_3), the second halved segment is from (x_2, y_2) to (x_3, y_3). If we divide this segment into half again, we get the second halved segment $(x_{2.5}, y_{2.5})$ to (x_3, y_3). If we repeat this process, the second halved segment from (x_i, y_i) to (x_3, y_3) gets closer to zero extension because (x_i, y_i) gets closer to (x_3, y_3). If we can repeat this process infinitely, the second halved segment differs infinitesimally from zero extension because (x_i, y_i) infinitely gets closer to (x_3, y_3). It should be noted that even if (x_i, y_i) is infinitely close to (x_3, y_3) but not (x_3, y_3) itself. Therefore, the segment between (x_i, y_i) and (x_3, y_3) has an extension that differs by an infinitesimal amount from zero. Based on this, we can consider an infinite series of points that infinitely get closer to its limit (x_3, y_3): (x_1, y_1), (x_2, y_2), $(x_{2.75}, y_{2.75})$, $\cdots$.[24] Now if this is true, in order for Achilles to finish the transition, it has to pass an infinite series

[24]See Sainsbury (1988) and (Barker, unpublished, Ch.7).

of points none of which is the goal (x_3, y_3) itself. If so, Achilles can never reach the goal, contrary to our daily experience. What's wrong with this argument?

Here is a natural answer from state theorists. In the argument, the transition of the ball is considered as *irreducible*. This is indicated by the black arrow in Fig.3.12. However, we do not need to accept this as an irreducible feature. Indeed, in state theories, this is reduced to a higher-order 4-D sequence of 3-D states, b_i being located at different spatial locations (x_i, y_i) at different times t_i. That is, for them, concrete reality is given as the 4-D spacetime called the block universe in which past, present, future events are all included and located at their own spatiotemporal regions. That is, the correct picture of Achilles' transition is captured by Fig.3.14:

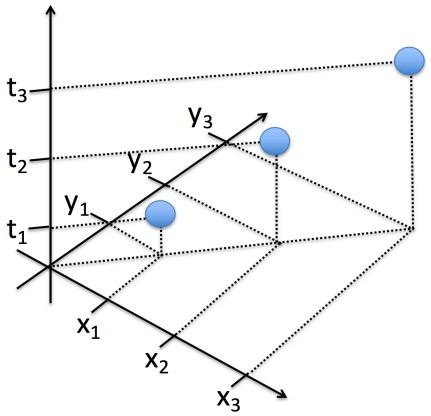


Fig. 3.14:

In Fig.3.14, the transiting feature (expressed by the black arrow) disappears because it is not fundamental and reduced to a higher-order 4-D sequence as we saw in Ch.1. That is, in this picture of concrete reality, there is no 3-D transition in an irreducible sense, although there is 3-D transition in a reductive sense. According to these state theorists, we reached the unacceptable conclusion in the Zeno's paradox because we assumed two things, (i) irreducible transition and (ii) an infinitely divisible continuous space(time). Since, in state theories (i) is rejected, we do not reach the unacceptable conclusion.

Someone might think even if 3-D transition is reducible, the problematic structure of the argument still remains. In this state-theoretic framework, the 3-D transition of Achilles the ball is a temporally extended 4-D continuous manifold, and we find Achilles at a certain spatial location (x_i, y_i) at each time t_i of that duration. Since this 4-D manifold is continuous, we can carry out the process above: we divide the manifold into half and choose the second halved manifold and divide it into half again. If we repeat this process infinitely, the second halved manifold differs infinitesimally from zero extension because (x_i, y_i) differs by an infinitesimal amount from (x_3, y_3). Here, again, (x_i, y_i) differs by an infinitesimal amount from (x_3, y_3) but not (x_3, y_3) itself. Therefore, the manifold from (x_i, y_i) to (x_3, y_3) has a temporal extension that is infinitely close to zero but not zero-extension. If so, we again have an infinite series of segments that infinitely get closer to its limit (x_3, y_3): (x_1, y_1), (x_2, y_2), $(x_{2.75}, y_{2.75})$, $\cdots$. Once we have the infinite series, it seems we can say Achilles the ball cannot reach the goal (x_3, y_3) because it has to pass an infinite series of points none of which is the goal (x_3, y_3) itself. However, this argument smuggles the idea of irreducible transition when it is said that Achilles cannot reach the goal when it passes (transits) (in an irreducible sense) through an infinite series of points above. If we accept the state-theoretic framework, concrete reality is already given as the block universe that includes the 4-D event of Achilles' transition with its last instant of time in which Achilles is located at the goal (x_3, y_3). This is the sense of transition as reducible to a higher-order 4-D sequence of states. Therefore, there is no problem to understand Achilles' transition as the infinite series of the segments above *plus* Achilles' being located at (x_3, y_3).

3.7 The State-Theoretic Solution to the Problem of Infinite Candidates

It is possible for A-theoretic state theorists who face the problem of infinite candidates to use the idea here. They can do it but only if they give up a dynamic process as irreducible and so have to accept it as reducible to a higher-order sequence of states. Focusing on successive addition here, let us illustrate exactly what is the reductive successive addition by comparing the reduction of 3-D transition to a higher-order 4-D sequence with that of successive addition to a higher-order 5-D sequence.

As we saw above, in the case of 3-D transition as reducible, we have 4-D spacetime called the block universe which includes all the past, present, future events. The block universe already and eternally includes a temporally extended 4-D event, Achilles' running, which is located at a certain spatiotemporal region. Since this 4-D manifold is continuous and infinitely divisible, we can (infinitely) divide it until we reach to instants of time (or 3-D slices) each of which can be said to have zero temporal extension in the sense in which its extension is close enough to zero (or infinitely close to zero). In each of these instants of time, we find Achilles the ball located at a certain spatial location. But, why can we say that this 4-D manifold is the 3-D transition of Achilles from (x_1, y_1) to (x_3, y_3)? This is because if we look at spatial locations of Achilles at different instants of time based on the B-series time order, we find the following higher-order 4-D sequence of 3-D states (b_i's being located at different spatial locations (x_i, y_i) at different times t_i): if an instant of time t_i gets closer to t_z at which Achilles is located at the goal (x_3, y_3), his spatial location also gets closer to (x_3, y_3). For example, if $t_j < t_k$, then (x_k, y_k) is closer to (x_3, y_3) than (x_j, y_j).

Keeping this structure in mind, let us move the reduction of a dynamic process of successive addition to a higher-order 5-D sequence. In this case,

we have the 5-D manifold which includes all the growth of the block universe as its 4-D slices, just the 4-D manifold as the eternalist block universe includes all the past, present, and future events. Since this 5-D manifold is continuous (since we are assuming the growth of the block is continuous), we can infinitely divide it until we reach to instants of supertime (or 4-D slices) T_i each of which can be said to have zero fifth-dimensional (or super-temporal) extension in the sense in which its extension is close enough to zero (or infinitely close to zero). Here, each of these instants T_i is the block universe B_i with a certain size. Now, why can we say that this 5-D manifold includes all the growth of the block universe if the growth has its direction? This is because if we look at the sizes of the blocks B_i based on the priority relation among T_i (which is the counterpart of the B-series time order), we find the following higher-order 5-D sequence of 4-D states (B_i's being located at different T_i): for any two 4-D blocks B_j and B_k, if T_j at which B_j is located is prior to T_k at which B_k is located, B_k is bigger than B_j. This is the basic idea of successive addition as reducible.

Obviously, A-theoretic state theorists can avoid the problem of infinite candidates in this way. However, once we take this reduction, we become eternalists at a higher-order level in that the 5-D manifold that already and eternally includes all the growth of the block universe is given as concrete reality. Once we become eternalists in this sense, we have to give up defending the idea of persistence as an irreducibly dynamic phenomenon because it is no longer irreducibly dynamic. Therefore, state theories face the following dilemma: if they try to defend persistence as an irreducibly dynamic phenomenon by accepting some A-theories that introduce a dynamic process in an irreducible sense, they face the problems of infinite candidates and reduction; if they try to avoid the problems by accepting a dynamic process in a reductive sense, they fail to defend persistence as an irreducibly dynamic phenomenon. Therefore, we conclude there is no way to defend the idea within A-theoretic state theories.

Conclusion

'Dynamic' or A-theories of time bring irreducible tense into concrete reality by introducing dynamic processes. Therefore, A-theoretic state theories might have a way to defend the idea of persistence as an irreducibly dynamic phenomenon. Indeed, as we saw above, each combination (except for the one with presentism) has a way to talk about persistence as a dynamic phenomenon. That is, A-theoretic state theorists bring irreducible tense by introducing a dynamic process into concrete reality and make persistence itself inseparable from the dynamic process in that persistence becomes irreducibly tensed. However, any dynamic process in the state-theoretic framework faces the problem of infinite candidates and the problem of reduction. In this framework, we understand a dynamic process in terms of one-after-another succession because we understand concrete reality in terms of objects' being located at or existing at times. But, once we think of a dynamic process in this way, we cannot avoid these problems. Of course, this does not mean all state theories have no solution to these problems. Indeed, a higher-order version of B-theoretic state theorists can solve the problem of infinite candidates by reducing a dynamic process to a higher-order 5-D sequence. That is, state theorists can dismiss the problem but only if they give up defending the idea of persistence as an irreducibly dynamic phenomenon.

Is there any other way to defend the idea in the state-theoretic framework? One natural suggestion is to give up thinking of concrete reality in terms of objects being located at or existing at times. For as long as we stick to the state-theoretic framework and accept objects located at times, it seems we never escape the conceptualization of a dynamic process in terms of one-after-another succession. Another suggestion is to look at not theories of time but, so called, dynamic ontology such as powers ontology and process ontology. It seems they attempt to understand dynamicity in a different way from A-theories of time. In the next chapter, let us explore this

suggestion.

Chapter 4

State Theories with Dynamic Ontology

Introduction

The objective of this dissertation is to defend the idea of persistence as a dynamic phenomenon in an irreducible sense. In Ch.3, we have considered the combination of state theories with A-theories of time. A-theoretic state theorists bring irreducible tense by introducing a dynamic process into concrete reality and make persistence itself inseparable from the dynamic process in that persistence becomes irreducibly tensed. Though it is the postulation of an irreducibly dynamic process combined with the idea that a transiting entity is located at times, any postulation of an irreducibly dynamic process in state theories faces the problem of infinite candidates and the problem of reduction. There is no way out of these problems as long as we stick to the state-theoretic framework. Someone might think there is another hope, dynamic ontology such as process ontology and powers ontology. That is, the combination of state theories with dynamic ontology might have a way to defend persistence as a dynamic phenomenon. Indeed, some powers ontologists consider a world with powers as dynamic and active and compare this dynamic world with a static and passive world without powers. There-

fore, the combination of state theories with powers ontology might secure a sense of dynamicity in terms of which we claim persistence as a dynamic phenomenon. Also, process ontologists think processes are fundamental to concrete reality and dynamic. Since what persists in process ontology is a process, it is natural to think that the persistence of a process is a dynamic phenomenon. In the following, let us first consider the combination of state theories with powers ontology and then that of state theories with process ontology.

4.1 Powers Ontology

There are two fundamental claims in powers ontology.[1] To see these two claims, consider a case where you and I are infected with the same virus (e.g., flu viruses): you stay at home and do not leave your room, while I often leave my room and chat with my friends. Shortly after that, these poor friends also get infected with the same virus. A question is this: what would have happened, if you also had left your room and talked with others? It seems if you had left your room and met and chatted with others, more people would have been infected. If this is true, what makes it true, or what grounds the possibility of your infecting others? Powers ontologists think what grounds this possibility is powers you had, namely certain properties you *actually* had (e.g., *being infected with flu virus*). This is the first fundamental claim concerning physical modality: powers ground physical modality in concrete reality.[2] In other words, a group of powers instantiated at a spatiotemporal

[1]While there are two fundamental claims, there are a variety of powers ontology: *Pandispositionalism* such as Bird (2007a) and Mumford and Anjum (2011) claims that all (fundamental sparse) properties are powers; *dualism* such as Ellis (2012) claims that while some of properties are powers, others are categorical; *the powerful qualities view* such as Heil (2003), Martin (2007), Jacobs (2011), and Ingthorsson (2013) claims that all properties are powers *and* qualities; *Aristotelian hylomorphism*, such as Rea (2011), Marmodoro (2013), and Koons (2014) deals with power within the hylomorphist framework of matter and form.

[2]This approach is sometimes called 'the property-based theory' of modality. See Jubien (2007), Borghini and Williams (2008), Whittle (2009), Jacobs (2010), Vetter (2013).

region have their manifestation in virtue of their natures alone (without any external factors to the region).[3] But, why can powers ground physical modality in concrete reality? This is because powers have *modal natures*. This is the second fundamental claim concerning the nature of properties.

If so, why do powers have modal natures? They have modal natures because powers are individuated by things to which they are related. In other words, if we want to know what a power is, we need to look at things to which it is related. There are basically two different things to which a power is related: one is a stimulus or a manifestation partner and the other is a manifestation.[4] This idea is usually called the stimulus-manifestation model or the mutual-manifestation model.[5] Consider a power, *mass*. It is characterized as follows: it manifests in *acceleration* as its manifestation when it is stimulated by or it co-works with, *force*. In other words, the power, mass, is individuated by acceleration (its manifestation) and force (its stimulus or manifestation partner).[6] Keeping this in mind, let us look at the operations of powers in acceleration: when a certain force is exerted on an object with a mass, the object with the mass gets accelerated. Here, mass and force got manifested in acceleration. Is it *contingent* that the object got accelerated when the force was exerted on the object with the mass? According to powers ontologists, it is *not* contingent but *modally constrained* because things that determine what mass is are those to which it is related, i.e. force (as a

[3]For example, a famous external factor is a global pattern of property instantiations across the spacetime in its rival theory, Humean metaphysics. Unlike powers ontologists, advocates of Humean metaphysics usually take 'the possible-worlds approach' to modality: the closest worlds where you are also infected with the same viruses are also worlds where more patients get infected. One famous advocate is, of course, (Lewis, 1986b, pp. ix-x). See also Esfeld (2010) for a helpful comparison between powers ontology and Humean metaphysics.

[4]There is also a view according to which a power is individuated by its manifestation alone. See Lowe (2011) and Vetter (2014, 2015).

[5]For the stimulus-manifestation model, see (Bird, 2007b, p. 530). For the mutual-manifestation model, see (Heil, 2003, p. 83) and (Martin, 2007, p. 50).

[6]If we take this view to powers in general, it seems that we have to take a holistic view on the individuation of powers. Therefore, strictly speaking, in their cases, the nature of a power is determined in terms of its relation to the whole network. See (Mumford, 2004, pp. 182-4), (Bird, 2007b, pp. 532-3), and (Martin, 2007, pp. 29-30, p. 47). For criticism about this idea, see Barker (2013).

stimulus or manifestation partner) and acceleration (a manifestation). That is, mass, force, and acceleration are by their natures related. This is the idea of powers ontology that physical modality is grounded by powers (alone).

4.1.1 A Dynamic World with Powers

Is there any connection between powers and dynamicity? While some powers ontologists are sceptical about such a connection,[7] other powers ontologists think '[t]he real world is essentially active and interactive. It is (...) dynamic. And, its dynamism stems from the existence of genuine causal powers in things'.[8] These '[p]owers theorists believe in a world containing continuous, dynamic, natural processes involving active particulars'.[9] That is, according to them, in a dynamic world, there are 'active particulars' possessing powers and the dynamicity of the world consists in the powers of the active particulars. Therefore, state theorists might think that persistence is a dynamic phenomenon because of persisting objects as 'active particulars'. In order to evaluate this claim, in what follows, let us start with making clear the idea of active particulars.

Some powers ontologists, such as Brian Ellis and Mumford & Anjum, compare a 'dynamic' world with powers with a 'static' world without powers.[10] What do they mean by 'the dynamic world with powers'? Let us take as an example a repelling process in which two particles a and b with like charges, say two electrons, repel each other. In a static world without powers, this repelling process is reduced to a *contingent* sequence of 3-D stages. Let us denote these stages as S_i and two electrons a and b included in S_i as a_i and b_i. For example, at a stage S_1 of this repelling process, a_1 and b_1 with like charges have certain velocities and are in a certain distance d_1. Then, in the static world, the repelling process is reduced to a contingent

[7] For example, (Bird, 2013, p. 44) says '[t]his use of "active" may be a helpful metaphor in articulating the powers view. But that heuristic work is not metaphysical work'.

[8] (Ellis, 2014, p. 62).

[9] (Mumford, 2009, p. 228)

[10] For example, see (Ellis, 2001, pp. 1-8).

sequence of these stages S_i at each of which a_i and b_i with like charges are in a certain distance d_i, and so on. One part of this contingent sequence is like this: S_i where a_i and b_i are in a distance d_i is followed by S_j where a_j and b_j are in a distance d_j (where $d_i < d_j$). The sequence of the stages in this world is contingent for the following reasons:

1. The identity of an object (e.g. an electron) is not connected with what it causually does in processes (e.g., repelling).

2. The first point holds because properties have no modal natures.

These properties that have no modal natures are called *quiddities*: their identities are primitive or purely structural.[11] These quiddities are not responsible for what particulars (the possessors of quidditistic properties) causally do. Therefore, in the static world, when two electrons with like charges repel, this repelling itself is not determined by like charges themselves. We need something more such as laws of nature.

By contrast, in a dynamic world with powers, this repelling process is irreducible to a *contingent* sequence of these 3-D stages S_i as in the static world. This is because of the following claims:

1. The identity of an object (e.g. an electron) is connected with what it causually does in processes (e.g., repelling).

2. The first point holds because properties have modal natures.

As we saw above, since powers are by their natures related to a certain manifestation, the possessor of them must causally behave in a certain way. Therefore, the development of stages S_i is not contingent but *modally constrained*. For example, when two close enough electrons have a manifestation, there is no possibility that the manifestation is not repelling because like charges (powers) and repelling (a manifestation) are by their natures

[11] See Black (2000).

related. In other words, the operation of powers, which resides in dispositions to bring about various kinds of manifestations are determined by the nature of powers alone without any external factors such as laws of nature.

There are two characteristic features of the dynamic world where particulars (the possessors of powers) are said to be active. First, the identity of an object with powers is connected with what it causally *does* in a process in virtue of the powers. That is, its identity is related to its causal *activities*. For example, what an electron causally does in processes (e.g., repelling and attraction) is in its nature or identity. Let us call this feature the activity-based identity. Second, the causal activity of the object is *intrinsic* in that the object does its causal activity by the powers possessed by it (and their manifestation partners) without any external factor. For example, when two electrons repel each other, they do their causal work (repelling) by the powers they possess alone without any external help such as laws of nature. Let us call this feature intrinsic powerfulness. To sum up, a dynamic world with powers is the world where particulars are active because they have activity-based identities and are intrinsically powerful to have a manifestation. Let us call these particulars only available in a dynamic world with powers as *active particulars*.[12]

When we understand persistence in terms of active particulars, this means we understand persisting objects as active particulars. For example, when persisting objects do some causal work, what they causally do is in their identities and they do the causal work by the powers they have without any external factors. Someone might think we can defend persistence as a dynamic phenomenon by this idea of active particulars. However, the idea does not work for the same reason as we saw in Ch.3. Whether persisting objects are active particulars or not, the persistence of objects itself

[12]Some powers ontologists might say *powers* (not the possessor of powers) are active. Even in this case of particulars with active powers, the argument against active particulars below can be also applied because the point of the argument is that just ascribing certain properties is not enough to build a connection between persistence and powers.

is understood independently from the activity-based identity and intrinsic powerfulness of objects. Indeed, when we assume eternalism or the moving-spotlight theory, we just have the standard tenseless definition. For example, consider the persistence of an electron E from t_1 to t_2. This is defined as follows: E persists from t_1 to t_2 iff e_1 is at t_1 and e_2 is at t_2 and there is an appropriate trans-temporal relation between e_1 and e_2. When we assume some A-theories such as the minimal A-theory or the growing block theory, we have a tensed definition as we saw in Ch.3. But here we have the tensed definition because of a dynamic process such as transient filling and successive addition, *not* the activeness of persisting objects. Thus, we conclude the activeness of persisting objects has nothing to do with persistence.

4.1.2 A Global Process Through the Operations of Powers

Is there any way to defend persistence as a dynamic phenomenon in the combination of state theories with powers ontology? It is useful to look at why the idea of active particular failed. It does not work because persistence is still understood by objects being located at different times, whether persisting objects are active particulars or not. After all, objects can persist without producing any causal effect if they exist at different times. It is meaningless to look at the operations of powers in *local* causations in which objects with powers (e.g., two electrons) produce certain causal effects (e.g., repelling). Rather, we should look at the operations of powers in a *global* dynamic process. Remember the minimal A-theory and the growing-block theory in Ch.3. In these theories, persistence itself cannot be separated from global dynamic processes (transient filling and successive addition) because objects' being located or existing at times itself cannot be separated from these processes. This connection is captured by the tensed definition of persistence. Therefore, if objects' being located or existing at times itself cannot be separated from the operations of powers, persistence cannot be separated from the operations of powers. How can we attain this? The one

and only way will be to apply the operations of powers to a global dynamic changing process of the block universe itself. That is, if the dynamic process itself occurs by the operations of powers, persistence cannot be separated from powers.

How can we understand the occurrence of the dynamic process in terms of the operations of powers? As we saw in Ch.3, global dynamic processes such as transient filling and successive addition are metaphysically fundamental in that they are irreducible to a higher-order (5-D) sequence of 4-D states on a higher-order time (supertime). Therefore, there is no answer to what is the filling or addition itself from a higher-dimensional point of view. However, this does not mean there is no explanation about how these processes occur. The definition of a process is one thing, and how or why it occurs is another.[13] Here, let us take as an example successive addition in the growing-block theory. The basic idea of successive addition through the operations of powers is this: powers at the present edge have manifestations altogether forming a new spacetime segment that gets added to the present edge. Suppose that t_1 is now the present edge of the universe as in Fig.4.1 below:

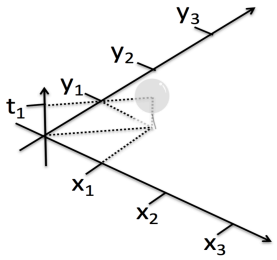


Fig. 4.1:

Powers at t_1 will have manifestations altogether forming a new spacetime segment (t_2) that gets added to the present edge (t_1). Here, we cannot ask what is this addition of the new spacetime segment. It is metaphysi-

[13]For example, the definition of a disease is one thing, and how or why it occurs is another.

cally fundamental and irreducible to a higher-order sequence. By successive addition, t_2 is now the present edge of the universe as in Fig.4.2:

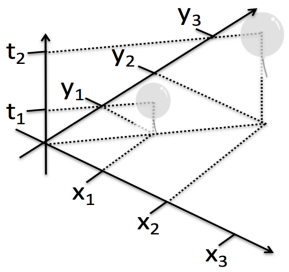


Fig. 4.2:

Powers at t_2 will have manifestations altogether forming a new spacetime segment (t_3) that gets added to the present edge (t_2), and so on. This is the basic idea of successive addition through the operations of powers.

Let us examine the operations of powers in more detail. There are two possible ways for powers at the present edge to have their manifestations. The first possibility is that a new spacetime segment (t_2) is composed of all the local manifestations of local groups of powers at t_1. For example, one group of powers at a space region r_1 of t_1 have a manifestation m_1, and another group of powers at another region r_2 of t_1 have a manifestation m_2, and so on. Then, all the local manifestations (m_1, ..., m_n) of all the groups of local powers at t_1 altogether form a new spacetime segment (t_2). The second possibility is that a new spacetime segment (t_2) is just one global manifestation of local powers at t_1. In other words, all the powers at t_1 are the members of the one group of powers that somehow co-work to have a new spacetime segment (t_2) as their manifestation. Therefore, the difference between these two views is this: in the first view, a new spacetime segment is composed by local manifestations; in the second view, it is a global manifestation. As we will see below, the idea of a dynamic process through the operations of powers faces several serious problems, in addition to the problems of infinite candidates and reduction in Ch.3.

Let us examine the first idea.[14] When we think a new spacetime segment is composed by local manifestations, we have a problem, which might be called as *the patch-work problem*. Suppose that m_1 is at r'_1 at t_2, ..., m_n is at r'_n at t_2. Obviously, m_1, ..., m_n altogether fall short of a global spacetime segment (t_2) itself simply because not all regions of t_2 are filled with manifestations. That is, some regions are occupied by manifestations, but other regions are not. All we have by the composition of location manifestations is scattered local spacetime segments. Then, we have no explanation about why we have a global spacetime segment (t_2) that is more than the composition of location manifestations. Another problem is, what we might call, *the unification problem*. In order for the manifestations m_1, ..., m_n to form a global spacetime segment (t_2), each group of powers at t_1 that has a manifestation must operate simultaneously; otherwise, there would be no global spacetime segment (t_2). However, here is the problem. The occurrence of m_i is determined by a group of powers at r_i at t_1. This is the consequence of intrinsic powerfulness. If so, the occurrence of m_i by the group of powers at r_i at t_1 is independent from the occurrence of m_j by a different group of powers at r_j at t_1. Therefore, in order for m_1, ..., m_n to occur simultaneously, there must be something that is metaphysically prior to the operations of powers and unifies the operations of powers at t_1 simultaneously. We might think of the following law-like thing: there is a law such that groups of powers at a global spacetime segment t_i operate simultaneously. This law must be global in that it is concerned with a global spacetime segment, not a local region of it. However, if there is such a law, it is in virtue of the natures of powers *plus* this law that a group of powers have their manifestation. This is simply the denial of Intrinsic Powerfulness, and so unacceptable for powers ontologists.

This is where the second way comes in. The one and only way to over-

[14]The argument in this paragraph and the next paragraph against the operations of powers in a global dynamic process is based on Aoyama and Barker (unpublishedc).

come these two problems will be to give up explaining a new global spacetime segment in terms of the composition of local manifestations of powers and instead think that the powers at t_1 as a whole have a new spacetime segment (t_2) as their manifestation. If all the powers at the present edge somehow have a new spacetime segment as their global manifestation, there is neither the patch-work nor the unification problem. However, there are other problems. One problem of this idea is *the co-ordination problem* which is similar to the unification problem. In the first possibility, the unification was among groups of powers. In this case, the co-ordination problem is among powers in one global group. If the second possibility is true, then the following must be true. A power at one galaxy and another power at another galaxy are in the same one global group of powers that together operate to have a global manifestation. However, how is it possible for these powers scattered throughout the universe to operate together or co-work? There must be something like a law that guarantees the simultaneous operation of these powers within the group. Then, we have the same problem above. Another problem is, what we might call, *the preemption problem*. Suppose that powers at t_1 as a whole have a global manifestation as a new global spacetime segment. This global spacetime segment includes all the local manifestations such as sugar-solution at a local region r_1' at t_2. If this is true, even if there are powers of sugar and water at r_1 at t_1, there is no room for them to locally operate to have their manifestation, i.e. sugar-solution at r_1' at t_2 because such a local operation is preempted by the global manifestation. This is bad news for powers ontologists because they have to give up local production or causation.

4.2 Process Ontology

We have examined the combination of state theories with powers ontology and shown that the combination is not viable. How about another dynamic

ontology, process ontology? When we combine state theories with process ontology, we have to give up a substance-based state theory and move to a process-based state theory in which temporally extended 4-D entities are fundamental as concrete reality instead of 3-D substances. This is because process ontology is designed to replace the ontology of substance with the ontology of process. Of course, this itself is not a big obstacle to having a process-based theory of persistence within the state-theoretic framework. Roughly speaking, what we need to do is to introduce a fourth dimension as time and locate temporally extended 4-D entities as irreducible at spatiotemporal regions. Indeed, a process ontologist, Johanna Seibt has offered a process-based state theory of persistence in which what persists is a process, not a 3-D object.[15] Since in process ontology processes are metaphysically fundamental and dynamic, it is natural to think that the theory might defend persistence as a dynamic phenomenon. In the following, let us first look at Seibt's idea of persistence as recurrence, and then examine her view on dynamicity.

4.2.1 Persistence As Reccurence

Johanna Seibt has offered *General Process theory* that is composed of the two basic parts: ontology and mereology. The ontological part is to specify what truth-makers are correlated with statements of a language. As expected, general processes play a crucial role as truth makers in this theory. General-Process theory is 'a *monocategorical ontology* in the sense that *general processes* are the ontological counterparts not only of statements about subject-less activities but also of statements about things, stuffs, events, properties, actions, relations, persons, etc.'[16] General Process theory is designed to offer an alternative to the idea that individual particulars (substances) are

[15]See Seibt (2008). Other recent process-oriented philosophers are, for example, Campbell (2009), Simons (2013) and Bapteste and Dupré (2013).

[16](Seibt, 2010, p. 49). Also, the task of the theory is 'to show that the truth-makers of English and its translation equivalents consist of nothing else but free processes.'(Seibt, 2004, p. 36).

ontologically fundamental (what Seibt calls 'the myth of substance').

What are these truth makers, i.e. general processes? They can be classified into two kinds. Some of them are non-subjectless processes (e.g., running, swimming); others are subjectless processes (e.g., raining, snowing). These general processes have the following features: they are independent, individual, concrete, spatiotemporally extended, non-particular, non-countable, determinable, and dynamic.[17] Let us consider a subjectless process, *raining*. According to Seibt, raining occurs in a *concrete* space and time without a putative possessor like a bare particular. When we have several occurrences of raining at different locations at the same time, each occurrence of raining is concrete but *itself* has *no particularity*. In other words, raining can be multiply located at different places *simultaneously*. In this sense, raining is a multiply-locatable *determinable*, not a determinate particular being located in a specific spacetime region. Moreover, raining is *temporally extended* and *non-countable*, while it will be measurable in portions. Also, raining is *individual* because it is fundamental and not something we get from other basic parts in this ontology. And, finally, raining is a *dynamic* process.

How can we understand persistence in terms of these general processes? Seibt offers the idea of persistence as recurrence.[18] Consider a general process, raining that is located at some spatiotemporal region R. For example, raining occurring in your vicinity for 30 minutes from 5 to 5:30 p.m. The crucial point here is that when we look at any *temporal* subregion of R, we also have the occurrence of raining (where raining here is functionally defined). For example, when we look at a temporal subregion tr (5 minutes from 5:10 to 5:15), the occurrence of raining is also at tr. That is, raining qua activity occurring at R contains itself as part. This mereological feature of self-containment is called *automerity*.[19] In our raining case, this

[17](Seibt, 2009, p. 486).
[18]See (Seibt, 2008, pp. 157-8).
[19]Seibt distinguishes the following two different mereological conditions: homoeomerity

mereological relation, automerity, holds between *any* temporal region of R and R itself because raining occurs at R and also raining occurs at *any* temporal region of R. This mereological feature is called *maximal* automerity. Therefore, raining occurring at R is said to be maximally automeric: raining occurring at any temporal region of R as well as at R. Then, persistence as recurrence is defined based on maximal automerity as follows:

> A process persists over time iff it is maximally automeric during that duration.

For example, raining in your vicinity persists from 5 to 5:30 p.m. because maximal automerity holds for raining in your vicinity for 30 minutes.

You might wonder how we can defend persistence as a dynamic phenomenon by this persistence as recurrence because mereology itself is not intrinsically connected with the dynamicity of a process. For example, even if raining (qua activity) at R contains itself (i.e. raining) at any temporal region tr_i at R, it does not follow from this that raining at R is a *dynamic* process. All we can say is that raining at R satisfies a certain mereological feature, and nothing more. Therefore, *if* we understand the dynamicity of a dynamic process in terms of this mereological feature, that understanding will be totally reductive. If it is reductive, state theorists simply cannot defend persistence as an irreducibly dynamic phenomenon by accepting process ontology. Therefore, in order for process-based state theories to be viable, the reductive suggestion cannot be accepted. What we need to do is to explain that automerity is the unique mereological feature of dynamic processes, but what makes processes dynamic is not the mereological feature itself but something else. If so, what is that something else? In the

(likepartedness) and automerity (selfpartedness). According to her, we use homoeomerity when we talk about the spatial or spatiotemporal amount of entities: an entity of kind K is homoeomerous iff all of its spatial or temporal parts are of kind K. For example, any spoon of a puddle of water is like the whole; any minute of an hour of snowing is like the whole. By contrast, we only can use automerity when we talk about activities themselves, not the amount of them: An entity E is automerous iff for any spatiotemporal region R in which all of E occurs it holds that any smallest region r of R is also a region in which all of E occurs. See (Seibt, 2008, pp. 152-3).

following, let us examine Seibt's recent attempt to connect a mereological feature with dynamicity.

4.2.2 A Dynamic Process of Self-Expression

Seibt recently has offered a view on dynamicity based on ongoingness and self-expression in Aristotle.[20] According to the view, dynamicity is 'ongoingness by self-expression'. What is this self-expression? Self-expression of a dynamic entity is for it to 'generate' self-similar patterns within itself. Not surprisingly, this self-similar pattern is the mereological feature of maximal automerity. Now, why is the mereological feature related to dynamicity? This is because self-expression is *mereologically reflected* in maximal automerity. In other words, a certain mereological feature is produced by a dynamic self-expressing process, and the mereological reflection of the process is maximal automerity. This means no matter how closely we examine the mereological feature, we never find dynamicity because maximal automerity itself is the *production* of a dynamic self-expressing process. While the mereological feature, maximal automerity, is the unique feature of dynamic processes, what makes them dynamic is not the mereological feature but self expression.

Therefore, for our purpose in this chapter, what we need to focus is self-expression, i.e. the *generation* of self-similar patterns, not the mereological feature. Now, how can we understand what it is for there to be self-expression in concrete reality? Just as transient filling in the minimal A-theory and successive addition in the growing-block theory are metaphysically fundamental, so is this self-expression. Therefore, it is irreducible to a higher-order 5-D pattern of 4-D states as we saw in Ch.3. If we are not allowed to go up to a higher-order time, we only have two choices in the state-theoretic framework: (i) we accept spacetime that itself never changes just as eternalists and the moving-spotlighters do; (ii) we accept spacetime

[20]See Seibt (2015).

that itself changes just as minimal A-theorists and growing-block theorists do. As we will see below, both options do not work.

Let us start with spacetime that itself does not change, i.e. the block universe in eternalism and the moving-spotlight theory. Let us call this block universe the *unchanging block*.[21] How can we accommodate a dynamic self-expressing process in the unchanging block? It seems we cannot. As we saw above, the dynamic process of self-expression itself is distinguished from what is generated by the process, i.e. the mereological feature of maximal automerity. Therefore, accommodating a dynamic self-expressing process is at least different from including the mereological feature in the unchanging block because the mereological feature is the production of self-expression, not itself. However, if we accept the unchanging block, we have to start with the block universe in which temporally extended processes are located at spatiotemporal regions and eternally have the mereological feature of maximal automerity. In other words, the required distinction does not make sense in the unchanging block because we just start with temporally extended processes that already and eternally have the mereological feature. Then, where is a dynamic self-expressing process? The answer is nowhere simply because we start from the putative mereological reflection of the process. But, if the unchanging block exhausts concrete reality, we have to conclude there is not such a thing as self-expression.

Let us move to spacetime that itself changes, what we might call, the *changing block*. As we saw in Ch.3, if we are in the state-theoretic framework, self-expression is also conceptualized as a one-after-another process. Indeed, one plausible idea will be to understand self-expression as a version of successive addition in the growing-block theory. Consider a process, raining, that is temporally extended 4-D entity E (expressed as a blue block) located at a spatiotemporal region R in the block universe and whose latest

[21]Seibt herself seems to take this unchanging block, although Seibt (2015) is sceptical about the dynamicity-talk within the current debates on time between A-theories and B-theories.

temporal region s_1 is a part of the present edge t_1 of the block universe as in Fig.4.3. The idea here is that just as t_1 is the present edge of the changing block, so is s_1 the latest temporal region of raining E that is expressing itself.

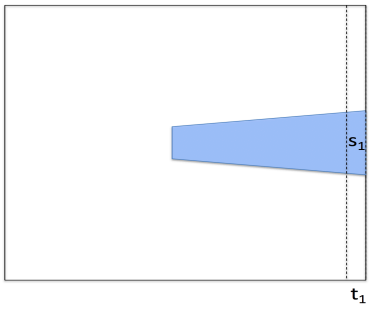


Fig. 4.3:

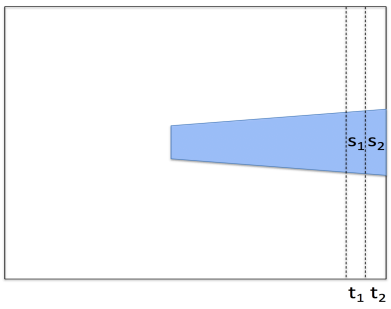


Fig. 4.4:

Since the raining process has not yet completed, E is still expressing itself as the changing block is growing by successive addition. To see how, consider the growth of the block universe. Suppose a new spacetime segment (t_2) that includes a new temporal region s_2 of E gets added to t_1 and becomes the present edge of the block universe as in Fig.4.4. This means in terms of E that a new temporal region s_2 gets added to s_1 and becomes the latest temporal region of E. When the changing block is growing by successive addition, a process is also growing by self-expression. When the self-expression of raining has completed, we have the whole raining process E as in Fig.4.5:

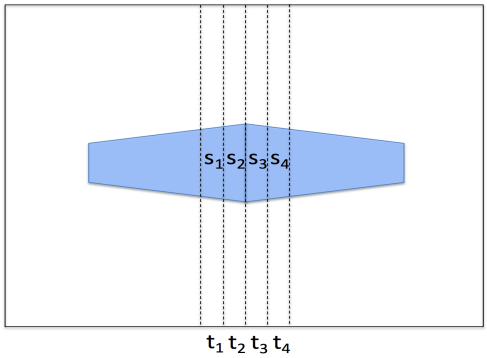


Fig. 4.5:

E is located at a spatiotemporal region and satisfies the mereological feature of automerity that is the mereological reflection or trace of self-expression. This is a way to articulate how self-expression occurs in concrete reality.

When we understand the self-expression of raining in this way, the persistence of raining is an irreducibly dynamic phenomenon because persistence as recurrence occurs through self-expression and self-expression is irreducibly dynamic in the sense of one-after-another-succession. However, as we saw in Ch.3, if we conceptualize a dynamic process as a one-after-another process, we face the problems of infinite candidates and reduction that cannot be solved within the state-theoretic framework. In process ontology, process is fundamental as a concrete reality and has non-zero spatiotemporal extension. Therefore, it especially faces the problem of reduction.

Conclusion

In this chapter, we have examined the combination of state theories with powers ontology and process ontology. In a dynamic world with powers, we have active particulars that have activity-based identities and intrinsic powerfulness. Therefore, in this combination, we have persisting objects as active particulars. However, this idea does not work because persistence itself is just understood independently from the activity-based identity and intrinsic powerfulness of objects. When we think a global dynamic process such as transient filling and successive addition occurs through the operations powers, persistence cannot be separated from the operations of powers. However, this idea faces several serious problems in addition to the problems of infinite candidates and reduction. When we combine state-theories with process ontology, we give up a substance-based state theory and move to a process-based state theory. One way to understand the persistence of processes is persistence as recurrence: a process persists over time iff it is maximally automeric during that duration. According to Seibt, this mereo-

logical feature of (maximal) automerity is the one all dynamic entities fulfill. This is because a process is dynamic by expressing itself and the mereological reflection or trace of this self-expression is (maximal) automerity. We have examined two possible ways to accommodate this dynamic self-expressing process in concrete reality. When we accept the unchanging block universe, since we have to start from the mereological reflection, there is no place for the putative reflected process, self-expression. When we accept the changing block universe, we can conceptualize self-expression as a one-after-another process. While this understanding makes persistence as recurrence an irreducibly dynamic phenomenon, it faces the problem of reduction. As we saw in Ch.3, there is no way out of this problem as long as we stick to the state-theoretic framework of introducing a fourth dimension as time and locating objects at spatiotemporal regions.

Part II

The Transition-Theoretic Framework

Chapter 5

Transition Theories of Persistence

Introduction

We have so far examined B-theoretic state theories in Ch.1-2 and A-theoretic state theories in Ch.3. On the one hand, while B-theoretic state theories themselves are consistent, since they are reductionist about transition, they can only offer the idea of persistence as a static phenomenon. On the other hand, while A-theoretic state theories have some ways to introduce dynamicity into concrete realities, since they face the problems of infinite candidates and reduction, it turns out that they are inconsistent. We have also considered the combination of state theories with dynamic ontologies such as powers ontologies and process ontology in Ch.4. Although both ontologies also offer ways to introduce dynamicity into concrete realities, again, since they face other serious problems in addition to the problems of infinite candidates and reduction, they are inconsistent.

Judging from these results, the best partner for state theories is the B-theory of time, i.e. eternalism, because A-theories of time or dynamic ontologies just make them inconsistent. As we saw in Ch.3, in state theories, the only way to conceptualize a dynamic process is to think of it as a one-

after-another process. Unfortunately, once we accept this idea of a dynamic process, we cannot avoid the problems of infinite candidates and reduction. Therefore, if we want to defend the idea of persistence as an irreducibly dynamic phenomenon, we have to give up the state-theoretic framework and find an alternative framework.

It's time to consider an alternative framework, the transition-theoretic framework which is based on the Flux-first view proposed by Stephen Barker. In this framework, persistence is not connected with objects' being located at or existing at times. Instead, persistence is connected with irreducible transition along a fourth dimension. In order to understand this alternative framework, we first need to understand the following two things: (i) transition as irreducible to states and (ii) 4-D transition. About (i), transition itself is accepted by the state-theoretic framework as well as the transition-theoretic framework. What is critical here is whether transition is irreducible to states or not. As we saw in Ch.2, in the state-theoretic framework, transition is only accepted as reducible because it is understood in terms of a higher-order sequence of states. By contrast, transition theorists take transition as irreducible to such a higher-order sequence of states. About (ii), we often experience 3-D transition such as your walking through a park in our daily life. However, we need to invoke transition through a higher dimension to explain persistence. That is, if we want to connect persistence with transition, we need to go up to a higher dimension and think of this transition along a fourth dimension. In what follows, let us start with the core idea of transition which contrasts with the idea of being located at or existing at certain regions or spaces. We look at some examples of 3-D transition and consider some characteristic features we find in our experience of transition. Then, we offer two metaphysical views on transition: taking transition as reducible or irreducible.

5.1 Transition

The term 'transition' is not a technical term only used in transition theories. Indeed, transition is something state theorists also accept as a part of concrete reality, although these theorists differ in whether transition is reducible or not. Before we consider transition as irreducible or reducible, let us first look at an example of transition. Fortunately, we have plenty of examples of 3-D transition in our daily life. For example, consider a case where a ball B is transiting or moving through 3-D space as in Fig.5.1-5.3 (3-D space is expressed as 2-D in Fig.5.1-5.3):

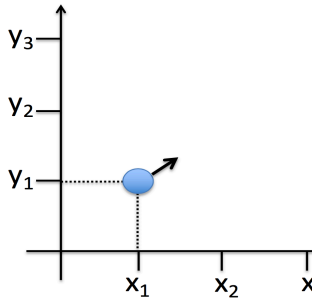


Fig. 5.1:

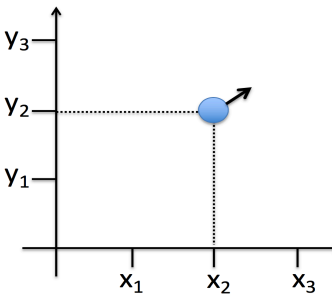


Fig. 5.2:

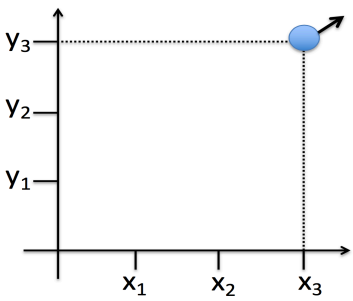


Fig. 5.3:

In Fig.5.1-5.3, as we saw in introduction, the black arrow expresses that B is transiting through 3-D space *without being located or stationary at* any 3-D points, although they give us static images. Therefore, while Fig.5.1-5.3 are static and so, for example, B in Fig.5.1 looks like being stationary at (x_1, y_1), B is in fact passing the point without being located at it. I'm not claiming here that reductionists about transition accept this feature after they analyze 3-D transition by introducing a fourth dimension. As we will see, they analyze 3-D transition in terms of a 3-D object being located at different spatial points at different times. What I'm assuming here is that we experience the transition or motion of a 3-D object through a 3-D space in this way. What we are concerned with here is not how we analyze 3-D transition but how we experience 3-D transition in our daily life. I think

reductionists about transition do not deny that in our experience a marathon runner is transiting through a marathon course without being stationary at any 3-D points on the course, although they reject this after they analyze the transition of the runner by introducing a fourth dimension. Also, we are not claiming here that B cannot be located at a spatial location and so always in transit with respect to a 3-D space. Obviously, it can be at rest with respect to the 3-D space. For example, the marathon runner can be at rest with respect to the marathon course. What we are claiming here is just that in our experience when the runner is transiting through the course, the runner is not located at any point on the course and never at rest with respect to the course.

We can find several characteristic features of transition we experience in our daily life. Let us take a closer look at the 3-D transition of a ball B in Fig.5.1-5.3, leaving aside the question about whether they are reducible or not.[1] First, B is transiting through 3-D space *without being located or stationary at* any 3-D points (x_i, y_i). If B were located at (x_i, y_i), B would not be transiting. Thus, being in transit though 3-D space is incompatible with being located at 3-D points or regions. I'm not denying here that it is passing these 3-D points. What is denied is that it is located or stationary at these points when it is transiting. Let us call this feature of a transiting ball *non-locatability*. This is related to the second feature. A transiting ball in 3-D transition is *dynamic* because a non-locatable thing is transiting through 3-D space *without being located or stationary at* any 3-D points. That is, what makes it dynamic is the feature of transiting through space without being located at any points in space.[2] This is the second feature, *dynam-*

[1]Here, again, I'm not claiming that these features are accepted as they are by reductionists about transition even after they analyze it by introducing time as a fourth dimension. My claim here is only that we can talk about some characteristic features of transition in our experience before we start analyzing transition.

[2]As we will see below, if we reduce 3-D transition to a higher-order 4-D sequence of 3-D states (b_i at a spatial location l_i at t_i) and remove the feature of transiting through space without being located at any points in space, a transiting ball B is *static* or *stationary* because each b_i is just located at l_i at t_i.

icity. The third feature is that transition has non-zero duration. This is because transition occurs within non-zero distance or interval. For example, if a runner is located at the starting point but another point is never chosen, the transition of the runner never occurs. In other words, if the transition of the runner is occurring, it is transiting through non-zero distance. If it transits through non-zero distance, it occurs with non-zero duration. Let us call this third feature *non-zero duration*. Let us move to the fourth feature. When there is a transition, the transition is always *directed*. Consider possible transitions of a ball B through 3-D space as many as possible. Is there any transition which has no direction? The answer is no. Transition requires a certain direction, and indeed transition without a direction is not possible. This is the fourth feature of *directionality*. The last feature is that we cannot describe the transition of B through the 3-D space without tense. For example, the transition of B in Fig 5.2 is described only with tense in the following way (we will talk about how tense is dealt with in transition theories in more detail in Ch.7):

(i) B is now passing through (x_2, y_2).

(ii) B was transiting toward (x_2, y_2).

(iii) B will be transiting away from (x_2, y_2).

In this way, we can find five characteristic features: non-locatability, dynamicity, non-zero duration, directionality, and tense.

5.2 3-D Transition as Reducible/Irreducible

We have specified several characteristic features of transition, leaving aside the question about whether they are irreducible features or not. As we said above, while state theorists take transition as reducible, transition theorists accept it as irreducible. Therefore, the next step is to make clear the difference between taking transition as reducible and irreducible.

Let us start from taking transition as reducible. Fortunately, we are already quite familiar with this idea because state theorists are reductionists about transition as we saw in Ch.2. As we saw in Ch.1, when state theories understand the persistence of B when it transits through 3-D space by introducing a fourth dimension as time and locating 3-D balls b_i at different times t_i as in Fig.5.4:

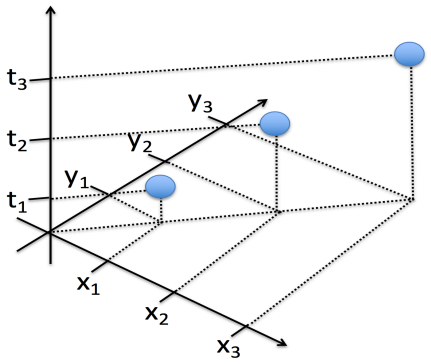


Fig. 5.4:

In this way, in the state-theoretic framework, the 3-D transition of B is understood as a higher-order 4-D sequence of 3-D states (b_i at (x_i, y_i) at t_i). In Fig.5.4, there are no black arrows because they are reducible and so non-fundamental features.

Taking transition as irreducible requires fewer steps than taking it as reducible. We do not introduce a higher dimension (a fourth dimension) because we reject the reduction of 3-D transition to a higher-order 4-D sequence. When we accept 3-D transition as irreducible, then the five characteristic features above also become irreducible features. For example, consider non-zero duration as an irreducible feature of transition. Since there is no fourth dimension as time, duration cannot be reduced to a temporal distance between two times on a fourth dimension. It is metaphysically primitive.[3] This means if we want to explain what is duration, all we can do is to point at duration in a demonstrative way. For example, if you want to show the duration of an athlete's running a 100-meter dash, all you can do is

[3]The idea of duration as metaphysically primitive is based on Barker (unpublished).

to point at the actually happening running (from the start to the goal) in a demonstrative way. Of course, in this idea, we have temporal concepts such as 1 sec. and 1 day.[4] However, they are not metaphysically prior to this duration: it is the other way around. This is analogous to spatial extension as metaphysically primitive. If we want to explain what is spatial extension, all we can do is to point at some spatial extension in a demonstrative way. For example, if you want to show the spatial extension of a desk, all you can do is to point at the desk in a demonstrative way. In this idea, we have spatial concepts such as 1 cm and 1 km. However, they are not metaphysically prior to spatial extension: it is the other way around.

While transition theorists take transition as irreducible in order to understand persistence, what they take as irreducible is *not* 3-D transition. If we want to connect transition with persistence, we need to go up to a higher dimension and think of transition along a fourth dimension. We need to do so because concrete objects do persist even if they are at rest with respect to the three dimensions. For example, when a marathon runner is at the start line waiting for the start, the runner is persisting (without transiting a marathon course). Therefore, it is not possible to connect persistence with 3-D transition as irreducible. Of course, this fact itself is not problematic for transition theorists who understand persistence in terms of transition along a fourth dimension. As we will see, if the object is persisting and so transiting along a fourth dimension, it does not mean that it is also transiting through the other dimensions. It might be at rest with respect to the other dimensions. This holds despite the fact that it's not at rest with respect to any point on the fourth dimension.

Before going up to a higher dimension and considering transition along a fourth dimension, let us examine how reductionsts about transition understand or analyze the characteristic features we find in our experience of 3-D

[4]As we will see in Ch.7, 1 minute and 1 hour are regarded as relative duration and they are not primitive.

transition. As we saw in the previous chapters, if we reduce 3-D transition to a higher-order 4-D sequence, the 3-D transition of B from (x_1, y_1) to (x_2, y_2) is understood as follows: b_1 is located at (x_1, y_1) at t_1 and b_2 is located at (x_2, y_2) at t_2 (where there is an appropriate trans-temporal relation between b_1 and b_2), and t_1 is earlier than t_2.

Let us start with non-locatability. In our experience of 3-D transition, we have a non-locatable object B transiting through a 3-D space. What is it to understand this non-locatable object reductively in terms of a higher-order sequence of 3-D states? As we saw above, in reductive transition, the 3-D transition of B is understood by 3-D balls b_i being located at different spatial locations l_i at different times. That is, *a* non-locatable transiting object B in our experience of transition is analyzed as object*s* b_i located at different times t_i as in Fig.5.4.[5]

What about non-zero duration? In our experience of 3-D transition, the transition of a non-locatable object B through a 3-D space has non-zero duration because it transits through non-zero distance without being located at any points in the space. If we analyze a non-locatable transiting object in terms of object*s* b_i located at different spatial points l_i at different times t_i, the duration of the transition is understood in terms of a temporal distance, i.e. an extension on the fourth dimension. For example, if the 3-D transition of B is from (x_1, y_1) at t_1 to (x_2, y_2) at t_2, the duration is the temporal distance from t_1 to t_2.

What about directionality? As we saw above, what is directed in our experience of 3-D transition is the transition of a non-locatable ball. If we reduce a non-locatable transiting ball to balls located at times, how can we understand the direction of 3-D transition? If we reduce 3-D transition to a higher-order sequence of 3-D states, the transition of B is directed because t_1 (at which b_1 is located at (x_1, y_1)) is earlier than t_1 (at which b_2 is located

[5]We skip the reductive understanding of dynamicity because we already looked at it in Ch.3.

at (x_2, y_2)). That is, the direction of transition is understood in terms of the temporal priority relation between times.

Finally, what about tense? In our experience of 3-D transition, we need to use tense to describe the 3-D transition of a non-locatable object. For example, when a marathon runner *is now* passing through the turning point, we need to say the runner *was* transiting toward the point and cannot ignore tense here. If we reduce 3-D transition to a higher-order sequence, what should we say about tense? There is no unique answer to this question. Suppose state theorists reduce 3-D transition to a higher-order 4-D sequence of 3-D states. If they are A-theoretic state theorists, they will claim reductive 3-D transition is irreducibly tensed in that its tense is irreducible to the B-series time order. For example, consider the moving-spotlight theory and suppose that b_2 is located at (x_2, y_2) at t_2 and the NOW *is* at t_2. State theorists who accept the moving-spotlight theory can say B *is now* (reductively) transiting from (x_1, y_1) to (x_3, y_3) and *is now* at (x_2, y_2), *was* at (x_1, y_1) at t_1 and *will* be (x_3, y_3) at t_3. These tenses are irreducible in the above sense because the dynamic process of the moving NOW is irreducible to a higher-order sequence. If they are B-theoretic state theorists, they claim reductive 3-D transition is reducibly tensed. Suppose, for example, we say B *is now* (reductively) transiting from (x_1, y_1) to (x_3, y_3) and *is now* at (x_2, y_2). This only means b_1 is at (x_1, y_1) at t_1, b_2 is at (x_2, y_2) at t_2, b_3 is at (x_3, y_3) at t_3, and $t_1 < t_2 < t_3$.

5.3 4-D Transition as Reducible/Irreducible

As we did in 3-D transition, let us consider transition along a fourth dimension with the five characteristic features, leaving aside the question about whether they are irreducible features. All we need to do is to introduce a fourth dimension in Fig.5.1-5.3 and let B also transit along the fourth dimension as in Fig.5.5-5.7 below (although again they falsely give us static

images):

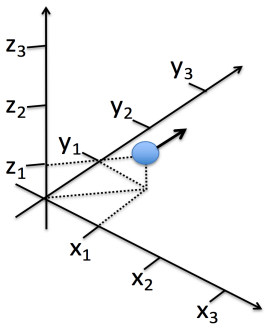


Fig. 5.5:

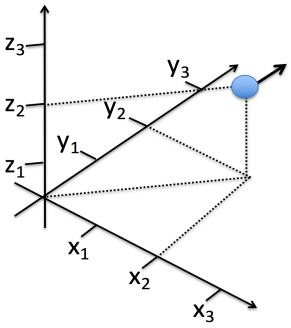


Fig. 5.6:

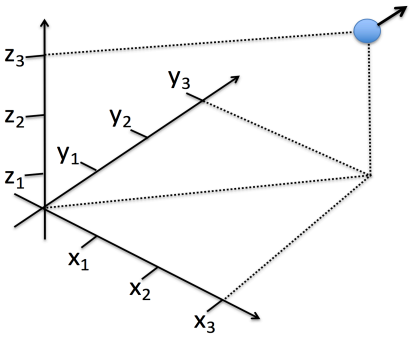


Fig. 5.7:

In Fig.5.5-5.7, the black arrows mean that B is transiting through 4-D space *without being located at* 4-D points in the space. This transition of B through 4-D space also has the five features of transition: non-locatability, dynamicity, non-zero distance, directionality, and tense. As we saw in the 3-D case, there are basically two ways to deal with this transition along a fourth dimension: transition as reducible and irreducible. In the following, as we did in the 3-D case, let us first look at transition along a fourth dimension as reducible.

Just as 3-D transition can be reductively understood in terms of a higher-order 4-D sequence of 3-D states, so can 4-D transition be understood in terms of a higher-order 5-D sequence of 4-D states. When we reductively understand 3-D transition, we introduce time as the fourth dimension and locate 3-D objects at times t_i. In the same way, when we reductively understand 4-D transition, we introduce a fifth dimension as a higher-order time called supertime and locate 4-D objects at supertimes T_i. That is, in the case of 3-D transition, we locate 3-D states, i.e. 3-D balls b_i at times t_i as in Fig.5.4; in the case of 4-D transition, we locate 4-D objects at supertimes T_i. Let us make clear what are these 4-D objects located at supertimes T_i. In the case of 3-D transition, a 3-D ball b_i with properties is located at t_i. In the case of 4-D transition, a 4-D object we locate at a supertime T_i is

4-D spacetime in which a 3-D ball b_i is located at (x_i, y_i, t_i). Let us call this as 4-D$_i$. For example, in 4-D$_1$, a 3-D ball b_1 is located at (x_1, y_1, t_1) as in Fig.5.8. In the same way, 4-D$_2$ (4-D$_3$) is depicted by Fig.5.9 (Fig.5.10) below:

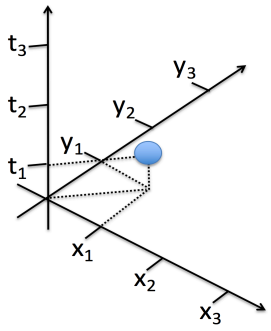


Fig. 5.8:

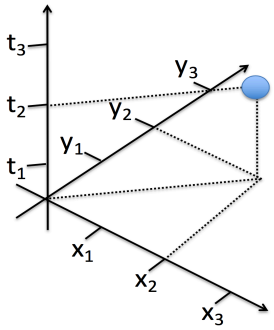


Fig. 5.9:

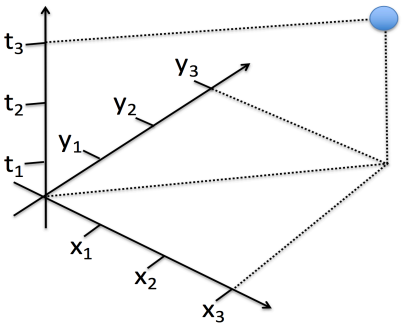


Fig. 5.10:

Once we have 4-D$_i$, all we need to do is to introduce a fifth dimension as supertime and locate 4-D$_i$ at points (T$_i$) on the fifth dimension as in Fig.5.11 below:

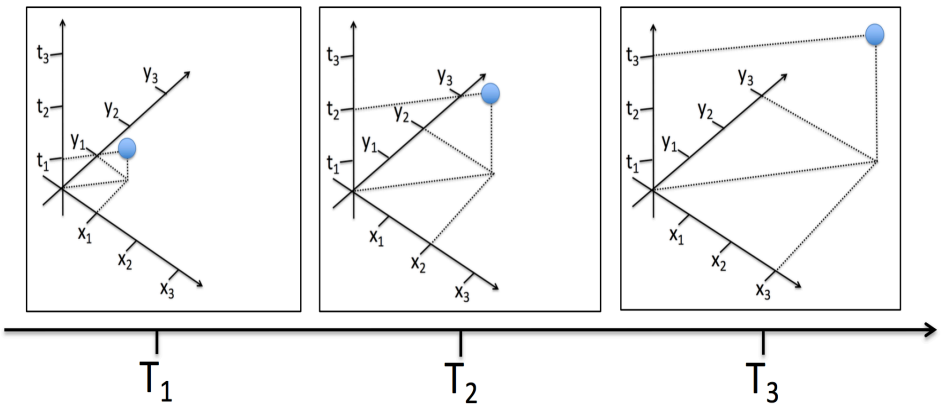


Fig. 5.11:

The point here is that if we introduce a fifth dimension as supertime and locate 4-D objects at T_i, we can get a higher-order 5-D sequence of 4-D states each of which has b_i being stationary at a point *without the black arrow*. Then, the 4-D transition of B is defined in terms of this 5-D sequence in

the following way: 4-D$_1$ (in which b_1 is located at (x_1, y_1, t_1)) is located at T_1 and 4-D$_2$ (in which b_2 is located at (x_2, y_2, t_2)) is located at T_2, and T_1 is prior to T_2, and so on. This is the basic idea of reducing 4-D transition to a higher-order sequence. Obviously, this is the state-theoretic framework because 4-D transition is understood in terms of states, 4-D$_i$ at T_i.

Of course, this is not the only way to understand 4-D transition. If we do not stick to the state-theoretic framework, we do not need to introduce a higher dimension and carry out the reduction of 4-D transition to a higher-order 5-D sequence. One way is to accept 4-D transition as *irreducible* and understand persistence in terms of this irreducible transition along a fourth dimension. In order to take 4-D transition as irreducible, all we need to do is to take no step to introduce a fifth dimension. This is the way transition theorists of persistence actually take. That is, they offer the following claim about persistence:

> The persistence of a concrete object is understood in terms of irreducible transition along a fourth dimension.

According to this idea, persistence should not be connected with location along a fourth dimension but with irreducible transition along a fourth dimension.

This is surely a defence of persistence as a dynamic phenomenon in an irreducible sense. To see the point, it is helpful to look at the two of the five characteristic features of transition as irreducible, non-locatability and irreducible dynamicity. First, if non-locatability is an irreducible feature of a transiting object, *any* persisting objects are irreducibly transiting along the fourth dimension without being located or stationary at any 4-D points as in Fig.5.5-5.7. That is, there is no concrete persisting object that is not connected with irreducible transition along the fourth dimension. As long as a concrete object persists, it is never at rest with respect to the fourth dimension and so always in transit along the fourth dimension, although it might be at rest with respect to the other three dimensions. Second,

if dynamicity is an irreducible feature of a transiting object, any persisting objects are irreducibly dynamic because they are irreducibly transiting along the fourth dimension, compared to static persistence in state theories in which persisting objects are located along the fourth dimension. Therefore, the idea of persistence as transition along a fourth dimension can successfully defend persistence as an irreducibly dynamic phenomenon.

It is helpful to compare the two different understandings of persistence in state theories and transition theories. In the state-theoretic framework, persistence is understood by objects being located along a fourth dimension.[6] Usually, persistence is understood by 3-D objects being located at more than one time. In endurantism, the same object exists at different times; in perdurantism, temporal parts of a spacetime worm exist at different times; in exdurantism, an object and its temporal counterpart exist at different times. Thus, persistence in this framework can be called *persistence as location* along a fourth dimension. By contrast, in transition theories, persistence has nothing to do with location. It is understood by irreducible transition along a fourth dimension (without being located at any 4-D points) as in Fig.5.5-5.7. So, persistence in this framework can be called *persistence as transition* along a fourth dimension.

Conclusion

Transition itself is neither something only transition theorists accept nor something we cannot experience in our daily life. Indeed, everyday we often experience 3-D transition such as your walking through a room and a car's speeding down the street. These 3-D transitions we experience have several characteristic features. First, a transiting object is non-locatable at any 3-

[6]Some state theorists do not locate 3-D objects along a fourth dimension as time because (i) they do not accept time instants or (i) they are process ontologists and so do not accept 3-D objects themselves. However, they still as state theorists locate objects at spatiotemporal regions in order to understand persistence.

D points. If it were at a point, it would not be transiting. As the Zeno's paradox about the movement of an arrow says, if we understood the movement of the arrow in the air in terms of the arrow being located at a certain spatial location at each instant of time, the motion of the arrow would be lost because instead of moving in the air, the arrow would be located or stationary at a position in the air at each instant of time. Second, a transiting object is dynamic because it irreducibly transits through 3-D space without being located at any 3-D points. Third, transition has non-zero duration because it is through non-zero distance. Fourth, it has a direction because it is through 3-D space in a certain direction. Fifth, transition cannot be described without tense.

Whether these five features are reducible features or not depends on whether we take transition as reducible to states or not. If we take 3-D transition as reducible, we reduce 3-D transition to a higher-order 4-D sequence of 3-D states. Therefore, some of the five features are also reconsidered based on the higher-order sequence. If we take 3-D transition as irreducible, we just accept the 3-D transition with the five characteristic features as it is. As we saw above, we cannot take 3-D transition as irreducible because many concrete objects persist without three-dimensionally transiting.[7] If we want to understand persistence in terms of transition, we need to go up to a higher dimension and consider transition along a fourth dimension. Indeed, when we take this transition along a fourth dimension as irreducible, we have a way to defend the idea of persistence as an irreducibly dynamic phenomenon. This is because, in transition theories, a persisting object is irreducibly dynamic because it is irreducibly transiting along a fourth dimension without being located at any points along the dimension.

[7]Here, we assume we are thinking of the persistence of 3-D objects. However, if we do not assume this, we need a more general statement: if we want to understand the persistence of an n-D object, we need one more dimension for the object to irreducibly transit. For example, if we focus on the persistence of a 2-D object, we need one more dimension for the 2-D object to transit but the dimension will not be a fourth one.

Chapter 6

Transition from Persistence to Concrete Reality

Introduction

In this chapter, we will explore the following interrelated two topics. The first one is concerned with variations of transition theories. Transition theories of persistence claim that transition is irreducible to states and that persistence is understood in terms of irreducible transition along a fourth dimension. When we understand the transition of an object O through 4-D space S, we have so far assumed that a transiting O and S through which O transits are already concrete in themselves prior to the transition of O through R. That is, we have assumed that a *concrete* object transits through a *concrete* 4-D space. However, this assumption itself does not follow from the two fundamental claims of transition theories. We will explore some possible variations of transition theories and evaluate which one is the best or better than the others. As we will see, in order to defend the claim that persistence is understood in terms of transition along a fourth dimension, one and the only one variation will be left for transition theories. The second one is concerned with the concrete/abstract distinction. When transition theorists say an transiting object (a transited 4-D space) is concrete or the

transition is concrete, what do they mean by 'concrete'? Are they concrete because they have spatiotemporal locations or are causally efficacious? As we will see below, no traditional or famous concrete/abstract distinctions in state theories work in transition theories. If so, what is the marker of concreteness in transition theories? Transition theorists suggest what makes something concrete is that it involves irreducible change. That is, concrete objects are concrete because they involve irreducible change, and abstract objects are abstract because they do not involve change in any sense. We will consider this suggestion by comparing it with other famous ideas of concreteness in state theories. In the following, let us first look at four possible variations of transition theories and classify them into two general categories.

6.1 Monism and Dualism in Transition Theories

In Ch.5, we have defined transition theories of persistence in terms of the following two fundamental claims: (I) persistence is understood in terms of irreducible transition along a fourth dimension and (II) transition is irreducible to states (objects being located at times). This general definition of transition theories seem to allow some variations, just as state theories have three standard variations, i.e. endurantism, perdurantism and exdurantism. In the case of state theories, we have these three variations because each theorist has a different answer to what trans-temporal relation holds between 3-D objects located at times. In the case of transition theories, we have some variations because transition theorists might have different answers to what are a transiting object O and 4-D space S through which O transits. Some theorists think O and S are already concrete in themselves independently from the transition of O through S. While this may be the most natural choice, others might think one of O and S is concrete in itself

independently from the transition but the other is not concrete in itself. Yet others might think neither of O nor S is concrete independently from the transition. Therefore, we have the following possible variations in terms of whether O and S are concrete/abstract:

(a) O and S are concrete in themselves.

(b) O is concrete in itself but S is not.

(c) S is concrete in itself but O is not.

(d) Neither O nor S is concrete in itself.

Here, if $O(S)$ is not concrete in itself independently from the transition of O through S, it is derivatively concrete because of the involvement in the transition or just abstract.

Once we have four possible variations, we need to examine which one is the best theory or better than the others, just as we do in the case of state theories. Maybe, you might wonder why we need to do this because it seems (a) is the only option. After all, we are thinking about the persistence of a concrete object in a concrete 4-D space. Therefore, if we accept a transition theory and understand persistence in terms of transition, what we get is this: the persistence of a concrete object in a concrete 4-D space is understood as the transition of the concrete object through the concrete 4-D space. While this may be the most natural option among the four variations above, the two fundamental claims (I) and (II) themselves do not rule out the possibilities of (b)-(d). This is because they just require that the persistence of a concrete object is understood in terms of a transiting object and 4-D space through which it transits. Although it may be natural to think that the persistence of a concrete object is understood in terms of the transition of the object itself through a concrete 4-D space, this itself is not implied by (I) and (II). Therefore, if we want to claim that (a) is better than the others, we need

to examine these four options and offer an argument to show that (a) is actually better than the others.

For our purpose of finding the best option, it is useful to classify these four possible variations in a general way in terms of whether transition theorists think O and S are concrete in themselves independently from the transition of O through S or not. As we will see, any transition theorists think the transition of O through S is in itself an irreducible concrete phenomenon whose concreteness is given independently from O and S (whether O and S are concrete or not) (see Sec.3). Therefore, we have the following two different variations. First, some transition theorists think (i) O and(or) S are(is) concrete in themselves (itself) independently from the transition of O through S *and* (ii) the transition of O through S is concrete in itself independently from O and S. Let us call this *state-transition dualism* since these theorists accept O and(or) S as concrete in themselves(itself) as well as transition as concrete in itself. Second, others think (i) O and S are not concrete independently from the transition or just abstract and (ii) the transition of O through S is concrete in itself independently from O and S. Let us call this *transition monism* since these transition theorists only accept transition as concrete in itself and other concrete realities are understood in terms of transition.

6.2 State-Transition Dualism

State-transition dualists in general think (i) O and(or) S are(is) concrete in themselves(itself) and (ii) the transition of O through S is also concrete in itself, although it may be natural to think that both O *and* S are concrete in themselves. That is, it may be natural to think the persistence of a concrete object O is understood in terms of O itself being in transit through a concrete 4-D space S.

What does this state-transition dualism look like? Let us take (a), i.e.

the idea that O and S are concrete, and build a dualist theory, what we might call *dynamic* endurantism, compared to *static* endurantism in state theories. Consider the persistence of a concrete balloon B. According to this dynamic endurantism, the persistence of B is understood in terms of the transition of the concrete balloon B itself through a concrete 4-D space. That is, unlike static endurantists, dynamic endurantists understand persistence not in terms of location but in terms of transition along a fourth dimension. Nevertheless, they are still endurantists because they keep the trans-temporal identity relation holding between things at stages of transition. For example, they think B *is now* transiting and *has* a round shape and the *same* B *will* be transiting and *will* have a oval shape. This idea of dynamic endurantism is captured by Fig.6.1-6.3 below (although they falsely give us static images of irreducible transition). In Fig.6.1, a concrete balloon B itself *is now* transiting through a 4-D concrete space S and *has* a certain shape s_1, and the *same* B *will* be transiting and will have a different shape s_2. In Fig.6.2, the same B *is now* transiting through S and *has* a shape s_2, and *had* s_1 and *will* have a different shape s_3, and so on.

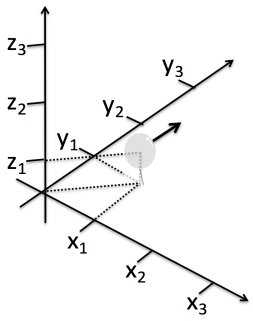


Fig. 6.1:

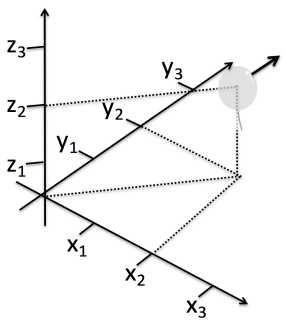


Fig. 6.2:

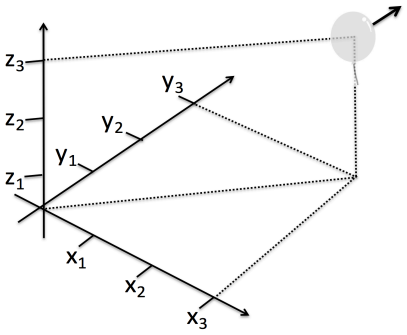


Fig. 6.3:

As we said above, unlike static endurantism, this dynamic endurantism is regarded as a transition theory because dynamic endurantists think persistence is understood in terms of irreducible transition, not location, along the fourth dimension. This is one of the two fundamental claims of transition theories. However, if we think a transiting object, say the balloon, is

in itself, separate from its transiting, a concrete object, we face a serious problem. Indeed, we have to give up the claim that persistence is understood in terms of transition. The point here is this: how do we understand the relation between the object's transiting through the 4-D space and the object's possessing properties. We usually think the instantiation of properties by a concrete object is independent from its transiting through space, whether space here is 3-D or 4-D. For example, let us first consider a 3-D case and suppose there is a concrete balloon B in front of us. We think this B is a concrete object and instantiates properties such as being round independently from its transiting through 3-D space. That is, we think the concreteness and instantiation of properties by B has nothing to do with the transition of B through 3-D space. Rather, prior to the 3-D transition, B is already concrete and instantiates properties. Therefore, we also think the intrinsic change of B such as change in shape is independent from its transiting through 3-D space: the intrinsic change of B in shape has nothing to do with its transiting through 3-D space. Indeed, B is concrete and instantiates properties when it is located at a spatial point, and B changes its shape whether it is transiting through 3-D space or not. For example, consider a balloon transiting in the air. While the transiting balloon has a certain shape and size, we do not think its shape and size depend on its transiting in the air.

Let us move to the transition of B through 4-D space S. Suppose we still think the relation between instantiating properties and transition in the same way. That is, we think B is a concrete object and instantiates properties such as being round independently from its transiting through S: the concreteness and instantiation of properties by B has nothing to do with the transition of B through S. Rather, prior to the 4-D transition, B is already concrete and instantiates properties. Now, consider a balloon B instantiating a shape-property of *being round* and the change of B in its shape from being round and being oval. This change of B in its shape is

defined in terms of instantiating different properties, *being round* and *being oval*. Since the instantiation of being round and that of being oval are understood independently from the 4-D transition of B, the change of B in its shape is understood independently from the 4-D transition of B.

Someone might think the change of B in shape has something to do with its transiting through S because the change might causally occur because of the 4-D transition. That is, the intrinsic change of B in shape has an external causal factor to make it happen. Therefore, the occurrence of the change of B in shape causually depends on the 4-D transition. We do not deny that B's intrinsic change defined in this way might causally occur because of the transition of B along the fourth dimension. However, what we are discussing here is not whether the change of B in shape is causally dependent on 4-D transition but whether the real definition of the change of B in shape has to refer 4-D transition. That is, what we are examining is the constitutional relation between change and 4-D transition in the definition of change, not whether the occurrence of the change of B might have the 4-D transition as an external causal factor. Therefore, we claim that the real definition of the change of B in shape is independent from the 4-D transition, although the occurrence of the change might be causally connected with the 4-D transition.

If this is true, we have the following problem. Suppose the change of B in shape is understood independently from its transiting through 4-D space S. For example, the change of B in its shape from being round to being oval in the expansion and shrinking process is understood by instantiating these two different properties independently from the 4-D transition. Here, obviously, the intrinsic change of B in shape does involve the persistence of B. If B would not persist and be an instantaneous object, it could not have different shape properties, being round and being oval. Therefore, since the intrinsic change of B that does involve persistence is independent from the 4-D transition, the persistence of B that is involved in intrinsic change must

be understood independently from the 4-D transition. This consequence is quite problematic for state-transition dualists. Any transition theorists claim that persistence is understood in terms of transition along the fourth dimension. In other words, persistence must be connected with transition in our understanding of persistence. Therefore, if persistence is understood independently from transition, state-transition dualists have to have the conception of persistence that is different from persistence as transition along the fourth dimension. This amounts to dismissing the fundamental claim of transition theories that persistence is understood in terms of transition. Therefore, if we want to be transition theorists, we cannot think that what is transiting is a concrete object itself that instantiates properties. Let us call this difficulty the problem of *losing persistence-transition connection*. We will see how this problem is avoided when we discuss transition monism later (see Sec.6.3.8).

What about thinking of 4-D space S as concrete in itself independently from the transition of O through S? What we first have in mind as a concrete 4-D space S maybe something like the block universe, i.e., a 4-D spacetime manifold with property instantiations. If we accept this concrete 4-D spacetime S, we have no reason to reject that 3-D balloons b_i are located at times t_i because property instantiations (i.e. objects instantiating properties) are located at times. Therefore, we have no reason to reject that a spatiotemporal region of S is captured by Fig.6.4:

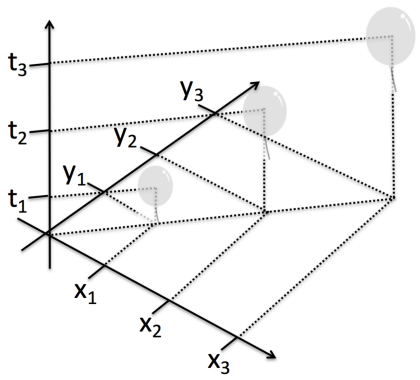


Fig. 6.4:

As we saw in Ch.1, in Fig.6.4, a 3-D balloon b_1 with a size s_1 is located at t_1, a 3-D balloon b_2 with another size s_2 is located at t_2, and so on.

If we accept the concrete 4-D spacetime in which 3-D balloons b_i are located at times t_i in this way, how should we understand the persistence of a balloon B? According to state theorists, persistence is understood in terms of location. For example, a balloon B persists from t_1 to t_2 iff b_1 is at t_1 and b_2 is at t_2, and there is an appropriate relation holding between them. Obviously, this definition of persistence makes sense in Fig.6.4, and, more importantly, there is no reason for state-transition dualists to reject this sense of persistence. This is because if they accept a concrete 4-D spacetime with property instantiations, they have no reason to reject 3-D concrete balloons b_i located at times. They have to accept that at least one way for concrete objects to persist is understood in terms of location as state theorists say: a concrete balloon B persists from t_1 to t_2 iff b_1 is at t_1 and b_2 is at t_2, and there is an appropriate relation holding between them. Of course, this itself does not mean that persistence as location is the only way for concrete objects for persist. Therefore, state-transition theorists might suggest that there is another way of persistence, i.e. persistence as transition. For example, they might think as follows. There is an order of property instantiations in S: b_1 with a shape s_1 is at t_1 and b_2 with a shape s_2 is at t_2. One way to talk about a concrete balloon is in terms of persistence as location. However, if we introduce a bare particular that instantiates properties by transiting through the order of property instantiations, we can talk about the persistence of a bare particular instantiating properties in terms of transition.

Someone might worry that in this case we have to talk about two distinct concrete persisting objects each of which persists in a different way, based on the same order of property instantiations. While it is quite weird, it

seems at least consistent even if there are two different concrete objects that persist differently based on the same order of property instantiations. If so, is there anything problematic here? What's wrong with dualism about two different persisting objects (one of which is given in terms of persistence as location and the other of which is given in terms of persistence as transition)? We do not claim that the idea of such dualism itself is inconsistent. There might be a theory of persistence according to which we accept two different persisting objects based on two different ways of persistence. However, here, we are not discussing variations of theories of persistence *in general*. Rather, we are examining variations of *transition* theories of persistence according to which persistence should not be connected with location but with transition. Therefore, even if dualism about two different persisting objects might be a weird but consistent theory of persistence, it is surely *not* a transition theory. In short, that dualism is inconsistent with transition theories. Let us call this difficulty the problem of *accepting two different persisting objects*.

Let us consider how we can reply to this problem if we still accept the idea of a concrete 4-D space S with property instantiations. It is clear why we have this problem: it is because the fourth dimension is time. Once time as a fourth dimension is introduced and property instantiations are located at times, there is no way to reject the idea of persistence as being located at times. Therefore, we might avoid this problem by accepting a concrete 4-D space S whose fourth dimension is *not* time. That is, S is a concrete 4-D space any sub-region of which is *a*temporal in that the concept of temporality cannot be applied. Is this idea that S is a concrete atemporal 4-D space S with property instantiations a viable option? Consider two things in S, the dropping a vase at a 4-D region r_1 and the breaking of the vase at another region r_2. First, they cannot be *events* because S is atemporal and so they are not located at times (or spatiotemporal regions). That is, S has property instantiations but does not include any events. Second, since S is atemporal and there is no event within S, there is no causation holding between events

such as the dropping a vase at r_1 and the breaking of the vase at r_2. There will be some relations or connections between them, but causation is not included in these relations. If so, it is quite dubious that an atemporal 4-D space S without events and causation is still regarded as concrete. We should not confuse accepting this atemporal 4-D space S with rejecting some traditional suggestions for the marker of concreteness. Accepting the former is much stronger than the latter.

To see the point, let us look at some traditional and famous suggestions for the concrete/abstract distinction. One famous and traditional distinction is connected with spatial/temporal locations as follows[1]:

> An object is concrete (abstract) iff it has (lacks) a spatial and/or temporal location.

This concreteness as location looks nice as long as we just look at some typical examples of concrete and abstract objects. Indeed, even opponents agree that concrete objects usually have spatiotemporal locations, although some of them do not. That is, no opponent would claim that any concrete objects have no spatiotemporal locations. Another famous distinction is in terms of causal efficiency:

> An object is concrete (abstract) iff it is (is not) causally efficacious.

The basic idea is that concrete objects can cause certain effects, but abstract objects cannot have causal effects. Again, this concreteness as causal efficiency looks not so bad insofar as we look at some typical examples of concrete and abstract objects. Indeed, no opponents would want to claim that no concrete objects are causally efficacious. Why they oppose this distinction is that some few concrete objects are indeed not causally efficacious.

Now, if we accept a concrete atemporal 4-D space S without events and causation, we have to claim something much stronger than just rejecting these two famous suggestions for the marker of concreteness. What we

[1]See (Katz, 1998, Ch.5).

need to accept is that any objects or things in S are concrete but lack spatiotemporal locations and causal efficiency because any sub 4-D region of S is atemporal and causation does not make sense. I think no one would want to accept this much stronger claim, although quite a few may oppose the two traditional suggestions above for the concrete/abstract distinction. Thus, if we take a concrete atemporal 4-D space with property instantiations, we have to accept this implausible consequence. Let us call this the problem of *accepting atemporal-non-causal concreteness*.

At this stage, you might give up thinking of a concrete atemporal 4-D space S as having property instantiations. In other words, you might think of S as an unpropertied global substratum or something without any property instantiation.[2] That is, in this view, an object transits through 4-D space S that is void of any property instantiation. However, this totally 'naked' global substratum is quite problematic because the idea of an unpropertied substratum itself seems inconsistent. If 4-D space itself is a global substratum itself and so is void of *any* property instantiation, it should have no geometrical and temporal properties, let alone any physical properties. Therefore, we have no ground for thinking of this global substratum as 4-D or its fourth dimension as time. Here, we should not confuse this global substratum void of any property instantiation with spacetime in spacetime substantivalism. While in the former case a global substratum literally has no property instantiation, spacetime in the latter is full of physical properties such as physical-field properties assigned by physical equations. Therefore, we'd be better off thinking that a concrete 4-D space S is propertied and has property instantiations. However, this just brings us back to the starting point.

Let us sum up the points in this section. Our first question was whether a transiting object O is concrete in itself independently from the transition

[2]The argument against the concept of a metaphysical substratum is based on Aoyama and Barker (unpublisheda).

of O through 4-D space S. If we think it is concrete in itself, we have the problem of losing persistence-transition connection. Therefore, we cannot think that O is concrete in itself prior to transition. This is bad news for (a) and (b). Next, we consider whether a 4-D space through which O transits is concrete in itself independently from transition. If we think it is a concrete spacetime manifold with property instantiations (e.g., the block universe), we have the problem of accepting two different persisting objects. If we think it is a concrete 4-D space whose fourth dimension is not time (i.e. a concrete atemporal 4-D space with property instantiations), we face the problem of accepting atemporal-non-causal concreteness. Therefore, we cannot think that S is concrete in itself prior to transition. This is bad news for (b) and (c). Consequently, none of these three options are acceptable for transition theorists. Is this the end of transition theories? Is there any transition theory that avoids these problems? The answer is yes and no. The answer is no if we stick to transition theories as theories of *persistence* and do not extend the transition-theoretic idea to concrete reality. The answer is yes if we extend the transition-theoretic idea to concrete reality in general and build transition theories of concrete reality, not just persistence. However, what are these transition theories of concrete reality? This is the next idea we are going to discuss, transition monism.

6.3 Transition Monism

We have shown in the last section that if we accept transition theories of persistence, we cannot take the options (a)-(c). This means only (d) is left. According to (d), a transiting object O and 4-D space S through which O transits are not concrete in itself independently from transition. Thus, if we accept (d), we have to build a theory in which the concrete nature of a persisting object is explained in terms of the concreteness of transition. In other words, we need a theory in which concrete reality such as persisting

objects as well as persistence are understood in terms of transition. This is a theory proposed by transition monists who think transition is the fundamental concrete reality and all the other concrete realities are understood in terms of transition.[3] In the following, let us start with answering the following two questions. First, if transition is the fundamental concrete reality, why is transition concrete in itself (independently from a transiting object O and 4-D space S)? Second, if all the other concrete realities such as persisting objects are defined in terms of transition and so only concrete derivatively, how should we understand a transiting object O and 4-D space S? Are they also derivatively concrete or just abstract?

According to transition monists (as well as state-transition dualists), transition is concrete in itself independently from O and S. This means concreteness in transition monism is understood differently from any suggestions in state theories. If so, how should we understand the concreteness of transition? Transition theorists have a clear answer to this question: transition is concrete because it does involve *irreducible change*. For example, consider the transition of O through S. This transition is an irreducible continuous extrinsic change of how O and S are spatially related. That is, transition monists accept the concrete is defined in terms of transition (irreducible change) as follows:

> Something is concrete (abstract) iff it cannot (can) be separated from, or is (is not) intrinsically connected with, transition.[4]

Let us call this idea *concreteness as transition*. There are two related points here. First, obviously, according to this distinction, there is no concrete object that can be separated from change. That is, the concrete realm is the realm of beings that are essentially changing intrinsically or extrinsically. Second, this does not rule out the involvement of abstract objects in concrete

[3]Therefore, transition monism should not be confused with a certain version of process ontology according to which there is the one and only one concrete reality, process.

[4]See (Barker, unpublished, Ch.3).

objects or even in change because abstract objects are those whose real definitions involve no essential reference to transition/irreducible change.

Let us next make clear what it is to understand the concrete natures of other concrete realities such as a balloon in terms of transition. This leads us to the answer to how we should understand a transiting object O and 4-D space S in transition monism. If we think other concrete realities are defined in terms of transition, something, say a balloon B, is concrete but its concreteness is only derived from or depends on the involvement in transition. Here, we try to explain the concreteness of B *relationally* in terms of the involvement in transition that is concrete in itself. We often do this kind of defining something relationally in terms of something else. One example is this: a passenger is a person insofar as it moves through space. That is, we have a passenger when a person moves through space. Here, a passenger is defined relationally in terms of a person and its involvement in moving through 3-D space. There are two things that, although obvious, are worth noting here. First, in the definition, a person is not identical with a passenger. If it were so, a person would be essentially connected with moving through 3-D space but this is false. Second, in order to define a passenger, we cannot use a passenger itself instead of a person in the following way: a passenger is a passenger insofar as it moves through space. If we did so, the definition would be just circular.

Keeping this in mind, let us define a concrete balloon B relationally in terms of the involvement in transition. As a first approximation, the definition is that there is a concrete balloon when X transits through S. You might think X here is B itself. That is, we have a concrete balloon B when B transits through S. However, as we saw above, this is just circular. If we want to explain the concrete nature of B *relationally* in terms of the involvement in transition, X cannot be B that is already concrete, just as we cannot explain a passenger in terms of something that is already a passenger. Therefore, X must be something else. Is this X concrete or not?

Suppose that X is concrete and think we have a concrete balloon B when X transits through S. Since X is something that transits through S, X itself is not transition. Therefore, if X is concrete, it is not concrete in itself because in transition monism only transition is concrete in itself. That is, its concreteness must be derived from or depend on the involvement in transition. Therefore, we need to explain the concrete nature of X relationally in terms of the involvement in transition. As a first approximation, the definition is that there is a concrete X when Z transits through S. As we can easily tell, thinking of X as concrete leads us to an infinite regress because we in turn have to explain the concrete nature of X relationally in terms of the involvement in transition. This implies that we want to avoid the circularity and the infinite regress, we need to think of X as an abstract entity. Especially, since we are trying to explain the concrete nature of a 3-D concrete object, X is a 3-D abstract entity. That is, a concrete object is something we have when a 3-D abstract entity transits through S.

Obviously, this also applies to 4-D space S through which O transits if we think there is a concrete 4-D space CS whose concrete nature is only derivative. So, let us try to define a concrete 4-D space relationally in terms of the involvement in transition. As a first approximation, there is a concrete 4-D space CS when O transits through a 4-D manifold S. As we saw above, if S is CS itself, the definition is circular; if S is not CS but still a concrete 4-D manifold, the definition faces an infinite regress. Therefore, a 4-D manifold S through which O transits must be abstract. There is a concrete 4-D space CS whose concreteness is only derivative, but this should not be confused with 4-D space S through which O transits. Since the concrete nature of CS is defined in terms of S and a transiting O, CS cannot be S. We only have a concrete 4-D manifold CS when O transits through S. This is the view of concreteness as transition.

If this is true, transition monists claim that concrete reality including persistence is defined in terms of the transition of an *abstract* 3-D entity

through an *abstract* 4-D space. However, how is it possible for concrete reality to be defined in terms of the transition of an abstract entity through an abstract space? It should be noted that transition monists *do not* claim that concrete reality is just something *abstract*. Rather, concrete reality is defined in terms of the fundamental concrete reality, i.e. *transition*. Therefore, concrete reality is defined *not* in terms of something abstract, but something concrete. i.e. transition. However, if transition is not that of an concrete 3-D object through a concrete 4-D space but that of an abstract 3-D entity through an abstract 4-D space, how is it possible for other concrete realities such as a concrete balloon to be defined in terms of such transition? In the following, let us consider this question by comparing two different theories of objects, a concrete theory and an abstract theory of objects. A concrete theory (e.g., the substratum theory) explains concrete objects in terms of a concrete base (usually called a *bare particular*) with properties.[5] An abstract theory (e.g. the bundle theory) explains concrete objects in terms of properties alone without any concrete base.[6] As we saw above, only a certain abstract theory can be compatible with transition theories (if there is). However, it is helpful to compare two different theories of objects in order to understand what transition monists try to do to explain concrete reality in terms of transition.

6.3.1 Abstract Theories of Objects

For a comparison, let us start with a concrete theory, the substratum theory. According to this theory, we have a concrete object, say a blue round ball B when a bare particular b instantiates properties such as being blue and being round. This bare particular b itself without any instantiation relation to properties has no qualitative natures, although it has properties when it instantiates them. Therefore, the claim here is *not* that a concrete object is

[5]For example, see Sider (2006), Moreland (2013), and Connolly (2015).
[6]Some bundle theorists are Simons (1994), Paul (2002), Robb (2005).

a bare particular b itself. This is just wrong because a concrete object such as our blue round ball B has properties but the bare particular itself has no qualitative natures. Rather, there is a concrete object when b instantiates properties. Unfortunately, as we saw above, in transition monism, a transiting object O can be neither concrete in itself independently from transition nor derivatively concrete because of its involvement in transition. Therefore, we cannot take concrete theories of objects here.

What about accepting abstract theories (e.g., the bundle theory) that explain concrete objects in terms of abstract entities and a certain relation among them *without* any concrete base? In abstract theories, a certain relation among abstract entities plays the following metaphysical role: it makes them as a whole concrete but leaves each abstract. Concreteness emerges at the level of the related whole, although each member in the whole itself is abstract. That is, the general idea of abstract theories of objects is captured in the following way: we have a concrete object when abstract entities are in a certain relation. It should be noted that abstract theorists never say that a concrete object is just properties, i.e. abstract objects because this is a contradiction, just as concrete theorists never say that a concrete object is just a bare particular b. Rather, they think while properties are abstract, we have a concrete object *when* they are in a certain relation, just as concrete theorists think while a bare particular itself is not a concrete object, we have a concrete object *when* it instantiates properties.

The general idea of abstract theories is characterized above, but we have different abstract theories relative to what relation holds between abstract entities. Let us start with the bundle theory according to which the relation holding between properties is bundle or compresence. In this theory, a concrete object such as a balloon is defined in terms of abstract entities, i.e. properties such as being blue and being round: we have a concrete object when properties are bundled. Again, we should not confuse this suggestion with the claim that a concrete object is just a plurality of properties (ab-

stract entities) or the claim that the bundle relation makes them concrete. Each is just a contradiction. In the bundle theory, a concrete object is not a plural of abstract objects (properties) themselves, and abstract objects (properties) obviously do not become concrete. Rather, there is a concrete object when properties are bundled as the related whole. Here, the bundling relation plays a specific metaphysical role of making the bundle of properties as a whole concrete but leaving each property in the bundle abstract. In this way, unlike the substratum theorists, the bundle theorists do not secure the concreteness of a concrete object by postulating a bare particular in addition to properties. Rather, they think that concreteness emerges at the level of the bundled whole, although while each element of a concrete object (i.e. a property) is abstract.

6.3.2 The Transit Theory

If we accept the general idea of abstract theories in transition monism, we have an abstract theory that is different from this bundle theory. On the one hand, according to transition monism, since concrete reality consists in transition, concrete objects such as a ball consist in transition: we have a concrete object when X it transits through 4-D space S. One the other hand, according to abstract theories of objects, X is an abstract entity. Therefore, if we combine these two views, we replace X with an abstract entity so that we have a concrete object when an abstract entity transits through 4-D space S.[7] Let us call this combination the *transit theory* of objects. Again, we should not confuse this idea with the claim that a concrete object is an abstract entity itself or the one that when an abstract entity transits through 4-D space, it becomes concrete. Each of these claims is just a contradiction. In the transit theory, a concrete object is not an abstract entity itself, and a transiting abstract entity does not become concrete. Rather, concreteness

[7]Of course, in transition monism, 4-D space S here is also abstract. We will explain it later.

emerges at the level of the related whole (i.e the transition of X through S), just as in the bundle theory concreteness emerges at the level of the related whole (i.e the bundle of properties). Here, the transition relation plays the metaphysical role of making the transition of an abstract entity through 4-D space as a whole concrete, leaving a transiting entity (and 4-D space) abstract. As we saw above, this is because, in the idea of concreteness as transition, transition is concrete because it involves irreducible change but abstract entities are abstract because they have nothing to do with change.

Let us take a closer look at this abstract theory of objects, the transit theory. If an abstract 3-D entity transits through an abstract 4-D space, this transiting abstract entity must be *spatially extended*. Otherwise, 4-D transition would not make sense. However, the combination of abstract entities and spatial extendedness is not familiar. How can we understand these spatially extended *abstract* entities?

At first, we do not need to claim that *all* abstract entities are spatially extended. That claim is obviously wrong. Rather, the claim here is that *some* abstract entities are spatially extended, although others are not. We have clear paradigmatic examples of non-spatially extended abstract entities: numbers, pure sets, and propositions. How about abstract objects that are spatially extended? It is true that there are some purported examples: the equator and impure sets (sets whose members are concrete objects). But, these examples are not what transition theorists have in mind when they think of spatially extended abstract entities. Rather, they think of geometrical structures as transiting abstract entities. These structures are called *structured forms*.[8] They are geometrical but not purely geometrical because they also have non-spatial physical values at each point within their geometrical structures. While what physical values are assigned will be an empirical matter, the idea of assigning physical values can be understood based on what physicists do when they think of physical fields. For exam-

[8]See (Barker, unpublished, Ch.3).

ple, when they talk of an electromagnetic field, they think of an infinitely extending 3-D abstract space and assign physical values to each point in the space by, say, Maxwell's equations. These assigned values are physical because these equations are not purely mathematical but have physical constants and coefficients (e.g., electric constant ϵ_0) in them. In the same way, when transition monists talk of a structured form, they think of a spatially extended 3-D geometrical structure in an abstract 4-D abstract space and assign physical values to each point in the 3-D structure by physical equations with physical constants and coefficients. From this perspective of assigning physical values to points in an abstract space, these physicists and transition monists just do the same thing. Of course, there is the following crucial difference between them. On the one hand, physicists think an abstract space with physical fields is an abstract *representation* or *model* of concrete reality. On the other hand, for transition monists, structured forms are not representations or models of concrete reality: they do not represent anything concrete. Rather, we have concrete reality as transition when a structured form transits through an abstract 4-D space.

Let us make clear the idea that there is a concrete object when a structured form transits through 4-D abstract space. Consider a concrete balloon. According to the transit theory, there is a concrete balloon because a spatially extended structured form, what is called a *balloon-form*, is in transit four-dimensionally. What is this balloon-form? Suppose we are repeating the following process: we blow up a balloon and then release air a bit from the balloon. In this process, a balloon changes its shape and size continuously. For example, when we start to blow up a balloon, its shape is relatively oval. But it becomes more and more round as it gets inflated more and more. By observing this expanding and shrinking process of a balloon, we realize that some features of the balloon such as being round do not remain constant but other features remain constant. The latter features are those that underlie the identity of the balloon during the change. Transition

theorists think a balloon-form is the abstract summation of these features that remain constant through the changing process.

We can consider these two different kinds of features in terms of the determinable/determinate distinction.[9] A determinable property is a property that can be determined in more specific ways, and determinates of a determinable are the determinable in more specific ways. For example, being a triangle can be determined in more specific ways, and being an equilateral triangle and being an isosceles triangle are more specific ways of being a triangle. Here, being a triangle is a determinable of determinates, being an equilateral triangle and being an isosceles triangle. Now, consider two different features of the balloon. A balloon-form, the abstract summation of the constantly remaining features of the balloon through the changing process, is considered as a determinable. In other words, a concrete balloon keeps its identity throughout the process because a balloon-form remains constant during the process, i.e. it transits through 4-D space. Also, we have determinates of this balloon-form, i.e. more specific ways of a balloon-form. For example, a round-balloon-form is the abstract summation of some features that only remain constant through some section of the process; an oval-balloon-form is the abstract summation of other features that only remain constant through another section of the process. This round-balloon-form and oval-balloon-form are considered as determinates of a determinable, a balloon-form.

6.3.3 Spatially Extended Abstract Entities

If this is true, we have to accept a spatially extended determinable that itself has no determinate size and shape. Here, we will have two questions, general and specific, to this idea. The first one is general: is it consistent to connect spatial extendedness with abstract entities? The second one is specifically about *determinable* structured forms: is it consistent to think

[9]See, for example, Yablo (1992), Funkhouser (2006) and Wilson (2009).

of spatially extended determinable forms that have no determinate size and shape? Let us start with the first general question about the idea of spatially extended abstract entities.[10] There might be several arguments against this idea. Someone might straightforwardly claim that what makes objects concrete is spatial extendedness. That is, the marker of concreteness is spatial extendedness. If this is true, the idea of spatially extended abstract entities is inconsistent. However, this claim itself is controversial. For example, Descartes rejects this claim because he thinks there are two different fundamental concrete realities, a physical being and a thinking being. He thinks spatial extendedness is the marker of physical beings but not the marker of concrete beings. How can we dismiss Descartes' idea? We might try to support our claim by enumerating concrete objects surrounding us and check whether they are spatially extended. However, this does not work because this enumeration never rules out the possibility that there is a non-spatially extended thinking being.

Pace Descartes, let us make a concession and accept that all concrete objects are spatially extended. Of course, this claim itself does not imply that no abstract entity is spatially extended. Is there any way to bridge the these two claims? Someone might argue that spatial extendedness is the marker of concreteness because spatial extendedness is essentially connected with *solidity* or *impenetrability*. For example, an apple cannot penetrate your body because concrete objects have impenetrability due to their spatial extension. If this is true and there are spatially extended abstract entities, we have to accept that abstract entities themselves (without any relation such as bundle or transition) have solidity or impenetrability. This seems absurd. At least abstract theorists do not want to accept this because they also say concrete objects have impenetrability, not abstract entities themselves. Fortunately, there is no essential connection between spatial extendedness

[10]The argument in this paragraph and the next paragraph is my reconstruction of the argument for spatially extended abstract entities in (Barker, unpublished, Ch.4).

and impenetrability. At least, spatial extendedness is not a sufficient condition for impenetrability. For example, while an apple cannot penetrate your body, plenty of other objects can penetrate your body. Indeed, some spatially extended concrete objects such as neutrinos can penetrate almost all other spatially extended concrete objects including your body. This is enough to show that spatial extendedness *alone* does not imply solidity or impenetrability, although there is solidity or impenetrability.

Someone might distinguish two kinds of entities in the physical realm, matter (material) and properties, and claim that impenetrability only belongs to the former. If this is true, we cannot explain the impenetrability of a concrete object in abstract theories. For example, it is true that neutrinos can penetrate almost everything, but they sometimes collide with other elemental particles such as electrons. That is, neutrinos fail to transit through, i.e. penetrate, electrons. If impenetrability is only available when we accept matter, we cannot explain this impenetrability of electrons in the transit theory. However, this objection does not work. First, when we consider concrete objects in terms of matter, we should be careful about ambiguity in matter: (i) propertied matter and (ii) non-propertied matter itself. In this objection, neutrinos and electrons must be propertied matter simply because they have a number of properties. However, if so, the objection here is not persuasive because it might be true that electrons have impenetrability because matter are propertied in a certain way. Therefore, if we want to dismiss abstract theories in terms of impenetrable matter, we have to show that non-propertied matter itself has impenetrability. Unfortunately, this is implausible. Consider what this non-propertied matter looks like. Since this is non-propertied, it has no geometrical features such as spatial extension, shape, and size; otherwise, it would be geometrically propertied. In the same way, we can even show that it is atemporal because it has no temporal features. However, in order for non-propertied matter to have impenetrability, at least it must be spatially extended because it

is understood dispositionally in terms of the failure of one thing's transiting through another thing. For example, a concrete wall is impenetrable for you because you cannot transit through the wall, but penetrable for a neutrino because it can transit through it. However, as we saw above, in order to understand transition, we need spatial extendedness. That is, only *propertied* matter might have impenetrability. If so, it seems this is not an objection but possibly an argument for abstract theories because we cannot understand impenetrability in terms of un-propertied matter itself.

Let us move to the second doubt on spatially extended determinable forms. How can we understand them if they have no determinate shape and size? Let us start with shape. It seems whenever we conceive of something spatially extended, it has a determinate shape. For example, let us imagine a balloon in our mind. It is quite likely that it has an oval shape because it is a typical determinate shape of it. Anyway, whatever shape your imagined balloon has, at least it would not be indeterminate in shape. Therefore, it seems we never find something spatially extended but indeterminate in shape. However, transition monists think the reason why we do not find something indeterminate in shape is not that there is not such thing but that we are looking in the wrong place. Remember where a spatially extended determinable form F comes from. F is the abstract summation of the features of an object that remain constant through change. In the case of the expanding and shrinking of a balloon, a determinable structured form is the abstract summation of the features that remain constant during the changing process. We look at the balloon in the process and realize that the balloon never lose the feature of having a balloon shape, although its determinate shape continuously changed. That is, we have an experience that the balloon keeps having the feature of having a balloon shape. As this example tells us, transition theorists think that a determinable feature of having a balloon shape becomes accessible only against the background

of continuous change in determinate shapes.[11] How about size? Since the size of an object is in general a relative matter, it is strange to say that a balloon has a determinate or absolute size, unlike the case of shape. Of course, we can compare the size of a balloon and the size of a volleyball and conclude that they have different sizes and the former is smaller than the latter. Therefore, we can say they have comparable sizes, although they do not have determinate or absolute sizes. It seems whenever we conceive of something spatially extended, it has a comparable size. Therefore, it seems we never find something spatially extended but lacking even a comparable size. However, again, the reason why we do not find something lacking a comparable size is not that there is not such thing but that we are looking in the wrong place. We look at the balloon in the changing process and realize that the balloon has never lost the feature of having a size, although its comparable size changes. That is, we experience that the balloon keeps having the feature of having a size. A determinable feature of having a size (but not having a comparable size) becomes accessible only against the background of change in comparable sizes.

6.3.4 A Spatially Extended 4-D Structured Form

We have focused on the determinable features of the balloon in the changing process and defended the idea of spatially extended determinable forms. This determinable form is the abstract summation of the determinable features that remain constant through and so survive the changes the ball undergoes. How about the determinate features of the balloon in the process? Since a concrete balloon has determinate features, if we want the transit theory to be a theory of concrete objects, we also have to explain how the determinate features of the balloon are understood. As we saw above, in this theory, there is a concrete object when a determinable structured form

[11]This argument that a determinable feature is only available in our experience of continuous change is based on (Barker, unpublished, Ch.4).

transits through 4-D space. In our balloon case, there is a concrete balloon when a determinable ball-form transits through 4-D space. While this idea does explain how the concrete balloon persists in terms of the form's transiting along a fourth dimension, this does not explain the intrinsic changes of the balloon. For example, the persistence of the balloon in terms of a determinable balloon-form's four-dimensional transiting. However, the balloon continuously has different determinate shapes in the changing process. How can we understand these determinate features of the balloon in the process?

As we considered above, when the balloon changes in various respects (e.g, shape and size), there are determinate features of the balloon that do not remain constant throughout the process. Just as we think of a determinable balloon-form as determinable features that remain constant throughout the change, we can think of determinate balloon-forms as these determinate features that do not remain constant throughout the change. Unlike a determinable balloon-form, determinate balloon-forms have determinate shapes and comparable sizes. If we put these determinate balloon-forms in a certain order in a 4-D abstract space, we have a spatially extended 4-D structured form, what we called a 4-D *manifold* (M), as in Fig.6.5:

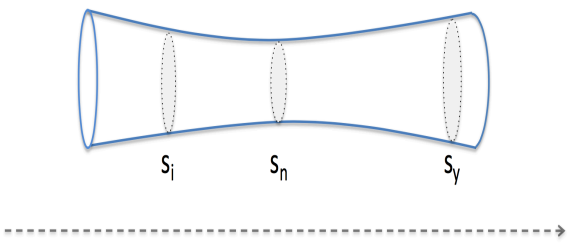


Fig. 6.5:

In Fig.6.5, each 3-D slice or hyperplane s_i of the spatially extended 4-D manifold is a determinate balloon-form that has a determinate shape and a comparable size. This idea of a four-dimensionally extended manifold itself is

quite similar to the idea of a 4-D spacetime worm in perdurantism, although a 4-D manifold in transition theories is abstract but that in perdurantism is concrete.

Let us take a closer look at this spatially extended 4-D manifold M. While the 3-D slices of M have distinct shapes from and comparable sizes to one another, since they are determinate balloon-forms, each 3-D slice s_i is a determinate of a determinable balloon-form. In other words, all the 3-D slices share a determinable balloon-form. Also, since the determinable/determinate relation itself is relative, the situation here is a little bit more complicated. To see the point, let us divide the 4-D manifold into three sections, M_1 (the first 1/3), M_2 (the middle 1/3), and M_3 (the last 1/3): M_1 includes s_i as one of its 3-D slices, M_2 includes s_n as one of its 3-D slices, and M_3 includes s_y as one of its 3-D slices. Suppose each 3-D slice of M_1 (M_3) is a determinate of a determinable round-balloon-form, although they have distinct shapes and comparable sizes. In other words, all the 3-D slices of M_1 (M_3) share a determinable round-balloon-form. Suppose further that each 3-D slice of M_2 is a determinate of a determinable oval-balloon-form, although they have distinct shapes and comparable sizes. In other words, all the 3-D slices of M_2 share a determinable oval-ball-form. Therefore, we can sum up the situation here as follows: (i) each 3-D slice s_i of M is a determinate of a determinable balloon-form; (ii) each 3-D slice s_i of M_1 (M_3) is also a determinate of a determinable round-balloon-form; (iii) each 3-D slice s_i of M_2 is a determinate of a determinable oval-balloon-form.

6.3.5 Intrinsic Changes of Concrete Objects

How can we connect this idea of a spatially extended 4-D structured manifold with the transit theory of objects in order to explain the intrinsic change of a balloon during the change? Remember how a concrete object is understood in the transit theory. We have a concrete object such as a balloon when a determinable balloon-form S transits through 4-D space. When we consid-

ered the determinate features of the balloon, we thought of a 4-D abstract space in which a 4-D structured manifold M is located along a fourth dimension. Thus, the suggestion is to combine these two ideas as follows: there is a concrete balloon when a determinable balloon-form F transits through a 4-D manifold M each 3-D slice s_i of which is a determinate of F.[12] This idea is captured by the Fig.6.6-7 below. In Fig.6.6, a determinable balloon-form F (expressed by a blue oval) is transiting through M_1 and will be transiting through M_2 and M_3; In Fig.6.7, S is transiting through M_2, was transiting through M_1, and will be transiting through M_3.

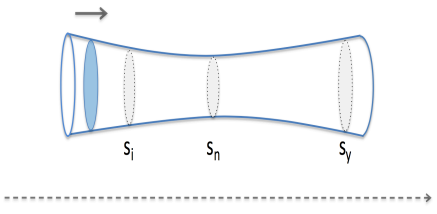


Fig. 6.6:

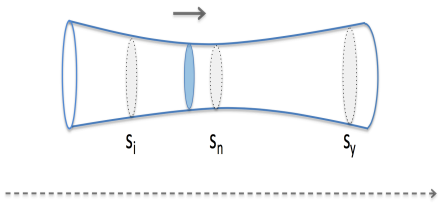


Fig. 6.7:

Let us connect the transition of F through M with the persistence of and the intrinsic continuous change of the balloon. The persistence of the balloon through the change is understood in terms of F's being in transit through M. The ball persists throughout the change because certain determinable features that are concerned with the identity of the balloon remain constant in the changing process and this constancy of the features is captured by the transition of F through M. Here, of course, F can transit through M because each 3-D slice of M is a determinate of F. The intrinsic change of the balloon is also understood in terms of F's being in transit through M, but in this case the point is rather that F transits through M whose 3-D slices have distinct shapes from and comparable sizes to one another. The balloon continuously changes in size and shape in the process because

[12]See (Barker, unpublished, Ch.3).

F transits through M whose 3-D slices have distinct shapes and comparable sizes one another. For example, the balloon continuously changes in shape from being round to being oval because F transits first through M_1 and then through M_2 as in Fig.6.6-7.

6.3.6 What is Concrete and What is Transiting

In the transit theory, we have a concrete persisting balloon not because what is transiting is concrete in itself independently from the transition but because a determinable form F *transits through* a 4-D manifold M. As we saw above, in this theory, concreteness comes at the level of the related whole, i.e. the transition of F through M. Transition is concrete in itself because, in transition monism, concreteness is understood in terms of change: the marker of concreteness is whether it involves change. Consequently, a concrete persisting balloon is concrete but only derivatively in that a determinable balloon-form is involved in transition. In this sense, in Fig.6.6-7, it is wrong to think something *concrete* is transiting through the 4-D manifold. This is just smuggling the idea of state-transition dualism into transition monism. Rather, something *abstract* (a determinable balloon-form F) is transiting through an abstract 4-D manifold, but we have a concrete persisting object because F is involved in transition at the level of which concreteness emerges.

It is helpful to compare two different abstract theories of objects, the bundle theory in state theories and the transit theory in transition monism. As we saw above, in the bundle theory, concreteness comes at the level of the bundle. This relation makes the bundle of properties as a whole concrete but leaves each property in the bundle abstract. Let us look at a 4-D structured manifold in Fig.6.5. In the bundle theory, since each 3-D slice s_i of the 4-D manifold M is a *bundle* of properties, it is a concrete 3-D balloon b_i. Therefore, the 4-D manifold M itself is also concrete. This is because concreteness is introduced by bundle. This understanding of concrete reality is

within the state-theoretic framework because each concrete ball b_i is located at times. Therefore, endurantist bundle theorists understand the persistence of a balloon B by introducing the trans-temporal identity holding between b_i at times; perdurantist bundle theorists understand the persistence of B by introducing the trans-temporal part-whole relation holding between B (i.e. M) and its temporal parts (i.e. b_i at times); exdurantist bundle theorists understand the persistence of B by introducing the temporal counterpart relation holding between b_i at times. By contrast, in the transit theory in transition monism, a 4-D structured manifold in Fig.6.5 is abstract and so each 3-D slice of it is also a spatially extended abstract form. What makes transit theorists different from bundle theorists is to consider the transition relation holding between a determinable form F and a 4-D manifold M, instead of considering the bundle relation holding between properties. There is a (derivatively) concrete object when F transits through M and the concrete objects persists when F transits along the fourth dimension.

6.3.7 Non-reductionism about Persistence, Change and Transition

Now, we have the transition theory, transition monism, which is a theory of concrete reality not only a concrete phenomenon, persistence. It is useful to consider this theory in terms of whether it is reductionist about persistence, change, and transition by comparing this with the state-theoretic framework that is reductionist about these phenomena.

Let us start with non-reductionism about persistence. As we saw in Ch.2, reductionism about persistence is defined as follows:

Persistence Reductionism: Persistence is understood in terms of (more basic entities) X and Y that do not ontologically depend on persistence.

In other words, in a reductionist theory, persistence is understood in terms of more basic entities X and Y each of which does not depend for its existence

on persistence. In transition monism, persistence is understood in terms of irreducible transition along a fourth dimension. As we saw in Ch.5, this transition has non-zero duration because an object transits through non-zero distance without being located at any points. This means an object cannot transit without persisting because transition has non-zero duration. For example, consider a case where you get into your room through a door. It is not possible for you to transit through the door and get into your room without your persisting because your transition occurs with non-zero duration. Therefore, since there is no transition without persistence, transition theorists are not reductionists about persistence.

In transition monism, a concrete object is understood in terms of a determinable form F transiting through a 4-D manifold M. This is the idea of defining the concrete nature of a concrete object relationally in terms of the involvement in transition. In other words, since a concrete object is defined in terms of transition, we cannot have a concrete object that is separated from transition: transition is essential to the concrete object. This is the idea of concreteness as transition. Now, transition monists also understand persistence in terms of transiting along the fourth dimension. If a concrete object cannot be separated from transition, since persistence is understood as transition along the fourth dimension, a concrete object cannot be also separated from persistence. That is, persistence is essential to concrete objects. Obviously, this does not hold in state theories in which persistence is not a fundamental feature of concrete reality. As we saw in Ch.2, persistence is not essential feature of a concrete 3-D ball b_1 being located at t_1. It might or might not persist, depending on whether there is an appropriate relation between b_1 and other concrete objects at different times.

This non-reductionism about persistence is related to non-reductionism about change. In Ch.2, reductionism about change is defined as follows:

Change Reductionism: Change is understood in terms of more basic entities X and Y that do not ontologically depend on change.

As we saw above, transition monism understands concrete reality such as concrete persisting objects in terms of transition, i.e. irreducible extrinsic change. Here, obviously, transition monism is not reductionist about change because transition, i.e. irreducible change, comes at the fundamental level of concrete reality.

As we saw in Ch.2, in the state-theoretic framework, change is understood in terms of persisting objects possessing incompatible properties at different times. That is, persistence is a more basic feature of concrete reality than change, although persistence is in turn understood by being located at or existence at times. Therefore, persistence can be separated from change: a concrete reality might persist without change. By contrast, in transition monism, transition along a fourth dimension does involve irreducible change. Since persistence is connected with transition along a fourth dimension, persistence also does involve change. Therefore, persistence cannot be separated from change.

It is obvious that transition monists are not reductionists about transition and so not reductionists about the dynamicity of a persisting object. Let us just check the metaphysical status of dynamicity (that is understood in terms of transition) in the state-theoretic framework and transition monism. Some endurantists might talk about the moving through time of a persisting object, i.e. 4-D transition. In the state-theoretic framework, since the persistence of the object is understood by locating the same object at different times, moving through time only means that the same object is temporally multiply located at different times. Therefore, as we saw in Ch.2, 4-D transition is after all reduced to the temporal multi-location of a persisting object, and dynamicity is also reduced to a 4-D sequence of 3-D states. That is, dynamicity here is just a reducible feature of a persisting object. By contrast, in transition monism, a concrete persisting object is irreducibly dynamic because it is understood in terms of a determinable form F being irreducibly transiting through a 4-D manifold M. As we saw above,

irreducible transition is essential to a concrete object, this dynamicity is also essential to the concrete object. That is, a concrete persisting object is essentially irreducibly dynamic.

6.3.8 Why Transition Monism Can Solve the Dualist Problems

Let us finish this chapter by making clear why transition monists can avoid the problems that arise in state-transition dualism. In state-transition dualism, the problem of losing persistence-transition connection arises for the following reason. If a concrete object itself transits through 4-D space S, since the concrete object has properties prior to its transiting through S, the instantiation of properties by the object is also prior to transition. This implies the instantiation of different properties by the object, i.e. the change of the object, is also prior to transition. Since change does involve persistence, persistence is also prior to transition. If so, one fundamental claim of transition theories that persistence is understood in terms of transition is rejected. Therefore, the problem is that if we think of a transiting object as concrete prior to transition, then the intrinsic change of the object that does involve persistence also comes prior to transition. By contrast, in transition monism, a transiting object is a spatially extended abstract form F. Therefore, the problem of losing persistence-transition connection never occurs. For if we think of a transiting object as abstract, the intrinsic change of the object never happens simply because F as an abstract entity does not change intrinsically. As we saw above, a concrete object itself is understood in terms of the transition of an abstract determinable form F through an abstract 4-D manifold M. Moreover, the intrinsic change of a concrete object is also understood in terms of the transition of F through M. Therefore, since intrinsic change is understood in terms of transition, there is no implication that persistence and transition is separated.

Also, in state-transition dualism, the problem of two different persisting objects and the problem of atemporal-non-causal concreteness arise because

these dualists think 4-D space S is concrete in itself (independently from transition). When we think of S as 4-D spacetime with property instantiations, since there is no reason to reject persistence as location, state-transition dualists have to accept two different ways of persistence. While there will be a theory of persistence that might accept two different ways of persistence, that theory is not a transition theory because transition theorists think persistence should not be connected with location but with transition. This is the problem of two different persisting objects. When we think of S as 4-D space whose fourth dimension is not time, any sub-regions of S become atemporal. Therefore, any things located in S cannot be regarded as events, and so there is no causation holding between things located at atemporal regions. Therefore, we have to accept the implausible consequence that any concrete objects or things in S are atemporal and non-causal. This is the problem of atemporal-non-causal concreteness. In transition monism, these two problems do not arise simply because 4-D space S and a 4-D local manifold M are abstract. In other words, if S is abstract, there is no room in transition monism for these problems that are concerned with a *concrete* 4-D space(time).

Conclusion

Transition theories have the two fundamental claims: (I) persistence is understood in terms of transition and (II) transition is irreducible to states (objects being located at times). These two claims seem to leave us four variations: (a) O and S are concrete in themselves; (b) O is concrete in itself but S is not; (c) R is concrete in itself but O is not; (d) neither O nor S is concrete in itself. We classified these four options into two general views: state-transition dualism and transition monism. The former theorists think (i) O and(or) S are(is) concrete in themselves(itself) independently from the transition of O through S *and* (ii) the transition of O through S is concrete in itself independently from O and S. The latter theorists think (i) tran-

sition is the fundamental concrete reality and other concrete realities are defined in terms of transition.

As we saw in Sec.2, state-transition dualism faces three serious problems. The first one is the problem of losing persistence-transition connection. This problem arises when we think of a transiting object as concrete in itself independently from transition. Transition monists can avoid this problem because they think of a transiting object as abstract. The second one is the problem of two different persisting objects. This problem occurs when we think of 4-D space as a concrete 4-D spacetime with property instantiations. The third one is the problem of atemporal-non-causal concreteness. This problem happens when we think of 4-D space as a concrete 4-D space whose fourth dimension is not time. Transition monists can avoid these two problems because they do not think 4-D space is concrete. Rather, 4-D space through which an object transits is abstract.

Chapter 7

Concrete Reality in Transition Monism I

Introduction

In Ch.6, we have articulated the picture of concrete reality in transition monism especially in terms of a theory of concrete objects. In this view, transition is the fundamental concrete reality and other concrete realities are understood in terms of transition. When we accept this view, transition is not that of a concrete object through a concrete 4-D space but that of an abstract determinable through an abstract 4-D structured form. The reason why the transition of an abstract entity through an abstract space itself is *concrete* is because transition qua a concrete event is an irreducible extrinsic change. In other words, transition monists understand the marker of concreteness in terms of transition that is irreducible change. Since other concrete realities are defined in terms of transition, concrete reality in general is intrinsically connected with change. For example, a concrete object such as a balloon is understood in terms of a determinable balloon-form F being in transit through an abstract 4-D manifold M.

When we accept transition monism, in addition to these consequences, we have to understand the fourth dimension and time differently from the state-

theoretic framework. On the one hand, in the state-theoretic framework, the fourth dimension is introduced to offer temporal locations for objects. That is, time is understood as a dimension whose metaphysical role is to offer (temporal) locations for objects. On the other hand, in the transition-monist framework, a fourth dimension is introduced for a determinable form F to transit along the dimension with respect to which F is never at rest, although F also transits through the other dimensions but can be at rest with respect to them. As we will see, this fourth dimension is neither concrete nor abstract time. It has nothing to do with time. Since this understanding of the fourth dimension is new, we need to take a closer look at this fourth dimension and its metaphysical role.

When time is not introduced as a fourth dimension, how is it introduced in the transition-monist framework? In this view, transition is the fundamental concrete reality and other concrete realities are defined in terms of transition. Therefore, if time is included in concrete reality, time cannot be independent from transition. That's why a fourth dimension as time is rejected in this framework: time must be introduced through transition. Since this idea of time introduced through transition is also new, we need to look at how some temporal phenomena such as temporal durations, the direction of time (the B-series time order), and tense are treated in this framework.

7.1 A Fourth Dimension in the Transition-Monist Framework

While both state theories and transition monism introduce a fourth dimension, the fourth dimension plays different metaphysical roles in these two theories. Let us quickly look at the metaphysical role of the fourth dimension in state theories. As we saw in Ch.1-2, state theorists understand concrete reality by locating objects with properties at times. For example, when we understand the persistence of an object, we locate the same object

(in endurantism) or distinct objects (perdurantism and exdurantism) at different times. In this state-theoretic framework, time as a fourth dimension plays the metaphysical role of offering temporal locations for objects. Time together with 3-D space form 4-D spacetime for concrete objects to be located. Let us call this idea of time the *dimensional conception* of time. In this conception, a fourth dimension is the dimension of temporal location.

By contrast, in transition monism, we do not understand concrete reality by locating objects with properties at times. Rather, we understand concrete reality in terms of the transition of a determinable form F through a 4-D manifold M. As we saw in Ch.6, we have an abstract 4-D space in which 4-D structured forms are located as in Fig.7.1:

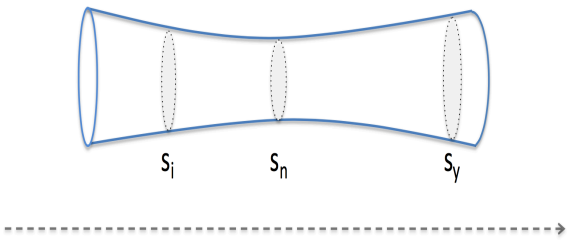


Fig. 7.1:

In a sense, the fourth dimension plays the metaphysical role of offering locations for the 4-D structured manifold M that is an ordering of 3-D determinate structures. Of course, unlike the state-theoretic framework, this metaphysical role itself has nothing to do with concrete reality because 4-D space in the transition-theoretic framework is abstract. That is, the fourth dimension offers abstract regions for 4-D structured forms, not concrete temporal locations for concrete objects.

If this were the only metaphysical role the fourth dimension plays, we would have no concrete reality in this framework. As we saw in Ch.6, this is not the only metaphysical role the fourth dimension plays. It also plays the metaphysical role of offering regions for determinable forms to transit.

Since this point can be generalized to the other three dimensions in transition monism, this leads us to the basic difference in the metaphysical roles that dimensions play in the state-theoretic framework and the transition-monist framework. In state theories, none of the four dimensions play this metaphysical role of offering regions for something to *irreducibly* transit along them. That is, the fourth dimension offers temporal locations and the other three dimensions offer spatial locations for concrete objects to be located. You might think since concrete objects transit through 3-D space also in the state-theoretic framework, they transit along the three dimensions. This is true if 3-D transition is understood *reductively*. We should remember how state-theorists understand the 3-D transition of a concrete object reductively by introducing a fourth dimension. As we saw in Ch.5, the transition of a concrete ball B through 3-D space is understood in terms of the higher-order 4-D sequence of 3-D states: b_i's being located at different spatial locations l_i at different times t_i. Therefore, there is no *irreducible* transition along any of four dimensions in state theories.

By contrast, in transition monism, any of the four dimensions play this metaphysical role of offering regions for a determinable form to irreducibly transit along them. Therefore, this metaphysical role itself is not peculiar to the fourth dimension because if the form irreducibly transits through 4-D space, it also irreducibly transits along the other three dimensions as well as the fourth dimension. However, there is something special about the fourth dimension in transition monism. What is special about it is that a transiting form is never at rest with respect to this fourth dimension and always in transit along the dimension (as long as a concrete object defined in terms the form persists), although it can be at rest with respect to the other three dimensions.[1]

Is there any relation between the fourth dimension in transition monism and the dimensional conception of time? First, if we mean concrete time

[1]The idea of dimensions is in Barker (unpublished).

here, the fourth dimension in transition monism has nothing with time in itself because the fourth dimension is just abstract. How about the idea of a fourth dimension as abstract time that offers abstract locations for objects? For example, we might say that a 4-D structured form M is located at 4-D abstract spacetime as in Fig.7.1. Each 3-D slice s_i of M is an abstract balloon stage and located at an abstract time t_i: s_n is located at t_n, s_y is located at t_y, and so on. Is this idea of abstract time consistent? It is quite dubious that the abstract fourth dimension deserves to be called *time*. For example, suppose the 4-D manifold M is located from t_1 to t_3 along this abstract time as the fourth dimension. Suppose further that the temporal extension from t_1 to t_3 is 1 minute. However, why should this temporal extension be regarded as 1 minute? Time such as 1 minute is measured by clock processes. For example, 1 minute corresponds to the clock process, i.e. the transition of a hand around the face. If so, when we claim a certain extension (from t_1 to t_3) along the abstract fourth dimension is 1 minute, what grounds our claim? Obviously, this 1 minute is not something measured by the concrete clock process. If so, why is this 4-D extension deserves to be called 1 minute? I think there is no ground. Moreover, even if there is the concrete clock process, the status of the abstract fourth dimension as time cannot depend on this clock process; otherwise, the abstract fourth dimension *in itself* would not be time.

Here is the another way of putting the same problem. Suppose the abstract fourth dimension is time and consider an abstract 4-D entity along this fourth dimension. Since the fourth dimension is time, this 4-D entity is regarded as an event of a certain kind, rather than just an abstract 4-D entity. If so, why is this abstract 4-D entity worthy of the name 'event'? For example, what makes it possible to distinguish this abstract 4-D entity with the status of event from another abstract 4-D entity without the status of event in a different abstract 4-D space whose fourth dimension is not time? Here, it seems the only difference is whether we call the fourth dimension

time or not. Obviously, however, calling the fourth dimension as time does not make the dimension as time or an abstract 4-D entity along the dimension an event. There must be something which allows us to distinguish the former 4-D entity as an event from the latter 4-D event without the status of event. If we cannot find any substantial difference in these two abstract 4-D spaces, there must be certain kinds of concrete entities that ground the meaning of the term 'events' here. That is, there must be concrete counterparts of events that ground the status of the former 4-D entity as an event. What are these concrete counterparts of events? One straightforward case is that 4-D abstract entities are regarded as events because when they are concretized, they are regarded as events. Another slightly different case is that 4-D abstract entities are regarded as events because when 3-D slices of them are concretized successively one after another, the sequences of successively concretized slices are regarded as events. In any case, what is crucial here is that we need concrete counterparts of events that ground the status of abstract 4-D entities as events. Otherwise, we have no ground for claiming that the abstract fourth dimension is time and an abstract 4-D entity along the dimension is an event.

However, as we saw in Ch.6, this kind of concrete counterparts are not available in transition monism. In this theory, concrete reality is understood in terms of the transition of an abstract determinable form F through an abstract 4-D manifold M. Here, neither this abstract 4-D manifold nor its 3-D slices are concretized. In transition monism, concrete reality is not something we get from concretization of abstract entities but is defined in terms of the transition of F through M. Of course, we do not deny there is such a way of understanding concrete reality in terms of concretization. But, that way of understanding is just the state-theoretic one, especially the one in the passage theory. Since we are now thinking about whether the abstract fourth dimension is time or not in the transition-monistic framework, we should conclude we have no relevant concrete counterparts of events that

ground the status of an abstract 4-D entity as an event.

This leads us to another related question concerning time. If time is not as a fourth dimension, how can we understand time in the transition-theoretic framework?

7.2 Time in Transition Monism

If concrete reality is defined in terms of transition and time is part of concrete reality, time must be understood in terms of transition. However, what is time that is defined in terms of transition? In this section, we consider this question in terms of temporal duration or quantity, tense, and the direction of time in the transition-theoretic framework. As usual, the best way to do this is through comparing state theories and transition monism.

7.2.1 Temporal Duration

Let us start with a simpler idea of temporal duration in the state-theoretic framework. As we saw in Ch.2, when we consider the combination of the state theories with a theory of time (whether it is a A-theory or B-theory), time is introduced as a fourth dimension (except for the combination with presentism). This means time is considered analogous to space. Just as space has three dimensions and offers spatial locations for objects, time has a dimension and offers temporal locations for objects. If we accept this analogy, then we also accept temporal quantities are analogous to spatial quantities. Just as spatial quantities such as 1m and 1km are understood by extension in 3-D space, temporal quantities such as 1 day and 1 year are understood by extension on time dimension.[2] For example, consider the changing process

[2]Of course, this does not mean space and time are not perfectly analogous. For example, it seems inconsistent that a particular can be spatially multiply located at different 3-D locations: If someone is at Rome, the person cannot be located at Tokyo at the same time. However, it is consistent that a particular can be temporally multiply located at different times: someone is at Rome at a time, and the same person is at Tokyo at another time.

of a balloon's first shrinking and then expanding. This temporally extended process is captured by a *concrete* 4-D manifold in Fig.7.1:

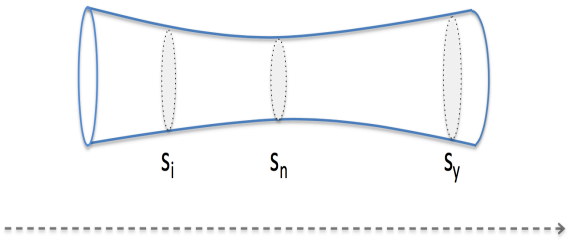


Fig. 7.1:

Each 3-D slice of the 4-D manifold is a concrete balloon with a determinate shape and comparable size. Now, what is the temporal duration of this process? The temporal duration is just the temporal extension of this 4-D manifold. The answer is simple because a fourth dimension is time.

In transition monism, there is also a fourth dimension along which a 4-D *abstract* manifold is located as in Fig.7.1. In this case, each 3-D slice of the 4-D manifold is a spatially extended determinate form that has a determinate shape and comparable size. Since the abstract fourth dimension has nothing to do with time in itself, a four-dimensional extension itself cannot be a temporal duration. Indeed, the 4-D manifold located along the fourth dimension in Fig.7.1 tells us nothing temporal. If so, what is the temporal duration of the concrete shrinking and expanding of the balloon? Suppose that the shrinking and expansion process of a concrete balloon corresponds to the transition of a determinable balloon-form F through a 4-D manifold M as in Fig.7.2-3 below. If the concrete process has a certain temporal duration, it is because F transits through M that has a certain length along the fourth dimension.[3] In other words, what duration a concrete process has depends on the length of a 4-D manifold through

[3]See (Barker, unpublished, Ch.5).

which F transits. Therefore, if F transits through a 4-D manifold M' that has a longer length along the fourth dimension, the corresponding concrete process has a longer temporal duration.

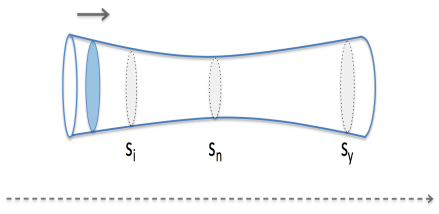


Fig. 7.2:

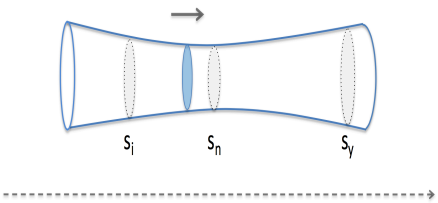


Fig. 7.3:

It should be noted that while the temporal duration of a concrete process depends on a length of M, the temporal duration itself is not the length of M. For example, consider the clock process, i.e. the concrete movement of a hand around the face. As we explained, this concrete process corresponds to the transition of a determinable form F through a 4-D manifold that has a certain length along the fourth dimension. Therefore, when we say the clock process is 1 minute, the temporal duration of 1 minute depends on the certain length of the 4-D manifold. However, the temporal duration, 1 minute, is not the length of M. For this 1 minute clock process, we need the *transition* of F through M that has the certain length. In this sense, unlike temporal duration in the state-theoretic framework, there is no temporal duration without transition in transition monism.

7.2.2 Tense

As we saw in Ch.2, we have two different ways to deal with tense in the state-theoretic framework, i.e. A-theories and B-theories. According to B-theories, tense is not a fundamental feature of concrete reality. For example, consider the following absolute tensed facts (or sentences) that I *was* born, I *am* now alive, and I *will* die. According to B-theories, these tensed facts

(sentences) are reduced to relative tenseless facts (sentences): I am born at t_α, I am alive at t_μ, I die at t_ω and $t_\alpha < t_\mu < t_\omega$. By contrast, according to A-theories, tense is a fundamental feature of concrete reality. In general, irreducible tense is introduced in concrete reality by a dynamic one-after-another process in A-theories (except for presentism). In other words, there is the following general consensus: if we only have spacetime called the block universe without any dynamic process, there is no irreducible tense. That's why A-theorists (except for presentists) talk about metaphysically fundamental processes. For example, let us look at a dynamic process of successive addition in the growing-block theory. In this theory, as we saw in Ch.3, new space-time segments get added one after another to the present edge of the block universe. This successive addition is captured by Fig.3.5-7 (on p. 70). In Fig.3.6, a new space-time segment t_2 (where a 3-D balloon b_2 is located at (x_2, y_2)) got added to the previous present edge t_1 (where a 3-D balloon b_1 is located at (x_1, y_1)) and becomes the present edge of the block universe. In Fig.3.7, a new space-time segment t_3 (where a 3-D balloon b_3 is located at (x_3, y_3)) got added to the previous present edge t_2 and becomes the present edge of the block universe, and so on.

How about tense in transition monism? As we saw in Ch.6, a concrete object such as a balloon is understood in terms of transition: we have a balloon when a determinable balloon-form F transits through M. Consequently, a concrete object's having a property is also understood in terms of transition.[4] For example, consider a 4-D manifold M each 3-D slice of which is a determinate of a determinable balloon-form F in Fig.7.1. In Ch.6, we divide M into three sub-sections M_1, M_2, and M_3. M_1 (M_3) is the 4-D manifold each 3-D slice of which is a determinate of a determinable, being round. Let us call a 4-D manifold each 3-D slice of which has a determinable X as a *X-type* 4-D manifold. For example, M_1 (M_3) is a round-type 4-D

[4]Properties possessed by concrete objects are called *possessable properties* in the Flux-first view. See (Barker, unpublished, Ch.8).

manifold. Also, M_2 is the 4-D manifold each 3-D slice of which is a determinate of a determinable, being oval. Therefore, M_2 is an oval-type 4-D manifold. Based on types of manifolds, a concrete object having a property X is defined in terms of transition as follows:

> A concrete object has or is X iff a determinable form F transits through an X-type 4-D manifold.

Therefore, that a concrete balloon has a round shape means that a balloon-form F transits through a round-type 4-D manifold M_1 (M_3).

Now, we are ready to understand tensed facts in transition monism. Look at Fig.7.2 in which a determinable ball-form F *is now* transiting through a round-type 4-D manifold M_1, i.e. the first 1/3 section of M that includes s_i. In transition monism, this present continuous tense is primitive and so not something we can explain. Rather, transition monists explain past and future tense in terms of this primitive tense of present continuous. In Fig.7.2, we can also talk about a present-tensed fact about a concrete persisting balloon: a balloon B *now has* a round shape. This is because a concrete balloon's having a round shape is defined in terms of F's transiting through a round-type 4-D manifold. Since F *is now* transiting *toward* a oval-type 4-D manifold M_2 (i.e. the middle 1/3 section of M that includes s_n), F *will* be transiting through M_2. Here, we can also talk about a future-tensed fact about the concrete persisting balloon: the balloon B *will* have an oval shape. This is because a concrete oval balloon is defined in terms of F's transiting through a oval-type 4-D manifold. Next, let us look at Fig.7.3 in which F *is now* transiting through an oval-type 4-D manifold M_2. Since F *is now* transiting *away from* M_1, F *was* transiting *through* M_1. Here, we can also talk about a past-tensed fact about the concrete persisting balloon: the balloon B *had* a round shape.

7.2.3 The Direction of Time

How about the direction of time or the B-series time order? let us first make clear what a *global* direction of time means here. Suppose we find a temporal priority relation between two events. For example, our seeing lightning is temporally priori to (i.e. earlier than) our hearing thunder. Of course, this itself is a local temporal priority relation between two local events, but as a matter of fact the direction of this temporal priority relation itself holds globally throughout spacetime (although they might be some local exceptions). In other words, if the temporal direction between t_1 and t_2 is $t_1 \rightarrow t_2$, this direction '$\rightarrow$' itself holds globally throughout spacetime. For example, if t_0 is the other adjacent time to t_1, then the temporal direction between t_0 to t_1 is $t_0 \rightarrow t_1$, not $t_1 \rightarrow t_0$; if t_3 is the other adjacent time to t_2, then the temporal direction between t_2 to t_3 is $t_2 \rightarrow t_3$, not $t_3 \rightarrow t_2$. Therefore, there is the following global direction of time, $\cdots \rightarrow t_0 \rightarrow t_1 \rightarrow t_2 \rightarrow t_3 \rightarrow \cdots$.

Now, why is there this global direction of time? There are basically two ideas for B-theorists. One idea is to explain the direction of time in terms of other directed asymmetries in the universe such as causation, counterfactual dependency, thermodynamic asymmetry, and increasing entropy.[5] For example, B-theorists with powers ontology might try to explain the direction of time in terms of the direction of the manifestation of powers.[6] Another idea is to accept the direction of time as a fundamental feature of spacetime and explain the other asymmetries in terms of this primitive direction of time.[7] There is yet another idea for A-theorists who bring irreducible tense into concrete reality by a dynamic process. This is because they might explain the direction of time in terms of the direction of the dynamic process that is metaphysically primitive, although we have already argued that such

[5]See, for example, Lewis (1979), Price (1996), Callender (2011).
[6]See Aoyama and Barker (unpublisheda).
[7]See Maudlin (2002).

one-after-another processes are dubious in Ch.3.

How can transition monists understand the direction of time (the B-series time order)? In this idea, since a fourth dimension is not time, there is no temporal location. Therefore, unlike in the state-theoretic framework, there are no times (t_i) to which we can apply the temporal priority relation. Therefore, in this framework, a fourth dimension itself has no direction, and so the 4-D manifold M in Fig.7.1 itself says nothing about how the change develops. For example, M does not tell us whether the direction of the change is from s_i to s_y or from s_y to s_n. If so, how can we understand the B-series time order? As you might expect, in transition monism, the direction of time is understood in terms of the direction of transition. Consider the transition of S through M captured by Fig.7.2-3. In Fig.7.2-3, a balloon's having a round shape is earlier than the balloon's having an oval shape because S first transits through M_1 (as in Fig.7.2) and then transits through M_2 (as in Fig7.3). By contrast, suppose there is the same 4-D manifold M as in Fig.1, but the transition of S through M has the opposite direction: S first transits through M_2 (as in Fig.7.3) and then transits through M_1 (as in Fig7.2). Then, the direction of time (or the B-series time order) is the other way around: a balloon's having an oval shape is earlier than the balloon's having a round shape.

7.2.4 Four Options for Time

It is useful to classify and summarize four options offered above for time. The first option is that the nature of time is exhausted by dimension and nothing more. That is, time is just a dimension. Tense and the direction of time (if there are) are not a fundamental feature of concrete reality: tensed facts are reduced to tenseless facts and the direction of time is explained in terms of another asymmetric phenomenon. The second option is to think that the nature of time is exhausted by dimension and its direction. That is, time is dimensional and the direction of time is an irreducible feature of

spacetime. In this option, tense is still not a fundamental feature. Therefore, in these two options, there is no (dynamic) process that brings irreducible tense into concrete reality. These are the ways B-theorists usually take. The third option is that the dimensional conception does not exhaust the nature of time because concrete reality is irreducibly tensed. That is, there are temporal locations for objects but concrete reality is also irreducibly tensed because of a certain dynamic process. This is the way A-theorists take (except for presentists). The fourth option is that concrete reality is irreducibly tensed but dimension has nothing to do with time. That is, irreducible tense is accepted, but the dimensional conception is rejected. There are no temporal locations for objects but concrete reality is irreducibly tensed. One famous example for this view is presentism. Presentists reject not only time as a fourth dimension but also the fourth dimension itself: concrete reality is three-dimensional. Presentists think concrete reality is irreducibly tensed because only the present is real.[8] Some presentists also introduce a dynamic changing process about what is the present, i.e. ephemeral becoming in Ch.3. Another example is transition monism. Unlike presentists, transition monists accept a fourth dimension. However, the fourth dimension itself has nothing to do with time in itself and does not offer temporal locations for objects as we explained above. Since transition is fundamental as concrete reality in this framework, concrete reality concerning time (temporal duration, the direction of time, tense) is explained in terms of transition.

Summary

If transition is the fundamental concrete reality and other concrete realities are understood in terms of transition, we have a different understanding of dimensions in general. In the state-theoretic framework, the fourth dimension offers temporal locations and the other three dimensions offer spatial

[8]Here, I mean by 'irreducibly tensed' that tense is irreducible to the B-series time order.

locations for concrete objects. Concrete objects never irreducibly transit through the three dimensions as well as time as the fourth dimension. By contrast, in transition monism, a determinable form F irreducibly transits any of four dimensions. What is special about the fourth dimension is that F is never at rest with respect to the fourth dimension, although it can be at rest with respect to the other three dimensions. As we saw above, the fourth dimension in transition monism is neither a concrete nor an abstract dimension of time. If we think of the abstract fourth dimension is time in transition monism, we have no ground for explaining why the fourth dimension is time.

This leads us to the following question: how can we understand time in transition monism? We have considered this in terms of temporal duration, the direction of time (the B-series time order), and tense. Unlike in state theories, temporal duration is not just an extension on the fourth dimension simply because the fourth dimension is not time. Rather, temporal duration such as 1 minute depends on the length of a 4-D manifold through which a determinable form transits. Here, unlike in the state-theoretic framework, temporal duration is not a 4-D extension along the fourth dimension because there is no temporal duration without transition. Another temporal feature is tense. In transition monism, the present continuous tense is primitive. For example, in Fig.7.2, a determinable form F *is now* transiting through M_1, and that's it. This present continuous tense cannot be explained. What transition monists do is to explain past and future tense in terms of this present continuous tense (and transition). Also, the direction of time is understood in terms of transition in transition monism. While the temporal priority relation among times is available in the state-theoretic framework, there is no application of the priority relation simply because the fourth dimension does not offer temporal locations in transition monism. Rather, the B-series time order is understood in terms of the direction of transition. For example, a balloon's having a round shape is earlier than the balloon's

having an oval shape because S first transits through M_1 and then M_2 as in Fig.7.2-3 above.

Chapter 8

Concrete Reality in Transition Monism II

Introduction

In Ch.6-7, we have made clear the picture of concrete reality in transition monism. In this view, transition is the fundamental concrete reality and other concrete realities are defined in terms of transition. Concrete objects such as balloons are understood in terms of transition: there is a concrete object when a determinable form F transits through a 4-D manifold M. While there is a fourth dimension in this view, it is not the dimension of temporal location. Time is not understood as a dimension but introduced through transition. Temporal duration, the direction of time (the B-series time order), and are defined through transition. About tense, past and future tense are defined in terms of transition and the present continuous tense.

Now, someone might think how transition monists can talk about trans-temporal relations between concrete objects. For example, as we saw above, transition theorists say a balloon's having a round shape is earlier than *the* balloon's having an oval shape. However, how is this trans-temporal relation between two balloons determined? If a round balloon is at a time

and an oval balloon is at another time as in the state-theoretic framework, it is easy to talk about a trans-temporal relation between them, whether it is numerical identity or distinctness. However, in transition monism, the fourth dimension does not offer temporal locations for concrete objects, Therefore, we cannot straightforwardly talk about a trans-temporal relation between objects *at different times* as in state theories. As we will see below, transition monists suggest a tensed trans-temporal relation, which is the counterpart of trans-temporal relations such as numerical identity in endurantism or numerical distinctness in perdurantism or exdurantism.

Someone also might think as follows. Just as a concrete balloon is understood in terms of a determinable balloon-form F's transiting through a 4-D manifold M, a concrete round thing might be understood in terms of a determinable round-form F''s transiting through a 4-D manifold M_1. If so, when we have a round ball, we also have a round thing. That is, this is a case of coincidence. However, coincidence is usually defined in terms of being in the same place at the same time (being made up of the same parts). Obviously, there is no application of coincidence in this sense in transition monism. If so, how can we understand coincidence in this view? As we will see later, transition monists think there is coincidence between concrete objects and understand it in terms of transition, just as other concrete phenomena are understood in terms of transition.

Finally, someone might wonder whether it is possible for transition monists to avoid the problems of infinite candidates and reduction that A-theorist state theorists face. As we saw in Ch.3, the former problem results from the combination of a dynamic one-after-another process with infinite divisibility; the latter problem results from the combination of a dynamic one-after-another process with finite divisibility. Do transition monists also face the same problems? As we will see below, irreducible transition in transition monism is fundamentally different from one-after-another processes in state theories. Since irreducible transition does not have the feature of

one-after-another succession, it does not face these problems.

8.1 Becoming as a Trans-temporal Relation

Transition monists offer a tensed trans-temporal relation that is the counterpart of trans-temporal relations such as numerically identity in endurantism and numerical distinctness in perdurantism and exdurantism. For a comparison, it is better to first make clear how the trans-temporal relations in state theories are introduced in the idea of genuine change and the problem of temporary intrinsics. We first consider tenseless trans-temporal relations in B-theories and some A-theories. Then, we look at tensed trans-temporal relations such as a tensed identity relation in other A-theories. Finally, we offer a tensed becoming relation in transition monism.

8.1.1 Tenseless Trans-Temporal Relations

As we saw in Ch.1, according to the idea of genuine change, one and the same thing exists before and after the change and the same thing has incompatible properties before and after the change. For example, consider the expanding process of a balloon B in which B changes its shape as in Fig.8.1:

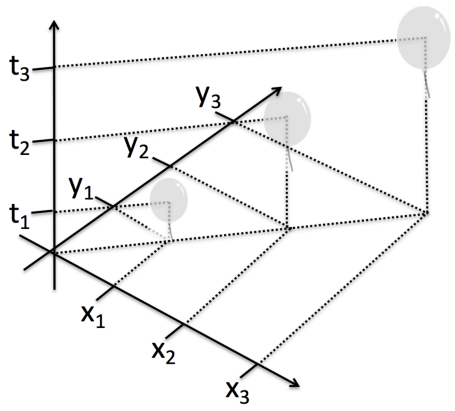


Fig. 8.1:

In Fig.8.1, a 3-D balloon b_1 is at t_1 and has a shape s_1 and a 3-D balloon b_2 is at t_2 and has another shape s_2. According to genuine change, b_1 at t_1 and b_2 at t_2 are identical with B and s_1 and s_2 are different shapes. Since no one denies that s_1 and s_2 must be different, the point here is that the trans-temporal identity between b_1 at t_1 and b_2 at t_2 is required.

As we saw in Ch.1, according to the problem of temporary intrinsics, this requirement of trans-temporal identity leads us to a contradiction: the same thing B has different shapes s_1 and s_2 at the same time. Therefore, perdurantists and exdurantists drop the requirement from the definition of change, and think b_1 at t_1 and b_2 at t_2 are numerically distinct objects. Of course, they introduce their own trans-temporal relations between them. For example, perduratists use the mereological part-whole relation in a trans-temporal way: b_1 at t_1 and b_2 at t_2 are two different temporal parts of the same 4-D spacetime worm; exdurantists introduce a temporal counterpart relation between them. The point here is that they understand change in terms of two numerically distinct objects with a trans-temporal relation that is weaker than identity.

The problem of temporary intrinsics requires the state-theoretic framework in which concrete reality is understood in terms of objects being located or existing at times. In other words, there is no application of this problem in transition monism in which the fourth dimension is the dimension of transit and persisting objects transit without being located at any 4-D points. From the transition monist point of view, change becomes a problem in the state-theoretic framework because they are reductionist about change and understand change in terms of non-changing states. If we start to understand concrete reality in terms of concreteness as transition, the problem of change disappears. However, in transition monism, it is not so clear how we can talk about trans-temporal relations if there are no objects located at different times.[1] Therefore, in the following, let us first describe this problem

[1]Of course, this problem itself is not peculiar to the transition-theoretic framework. Some A-theorists such as growing-blockers and presentists are also asked to answer the

in more detail and look at the suggestion from transition monists.

As we saw in Ch.7, the intrinsic change of a concrete object is understood in terms of transition. For example, the intrinsic change of a balloon in its shape and size is understood in terms of the transition of a determinable ball-form S through a 4-D manifold M. In other words, unlike in the state-theoretic framework, the intrinsic change of an object is not understood as 3-D objects having different properties at different times. The intrinsic change of a balloon in transition monism is captured by Fig.8.2-3 below:

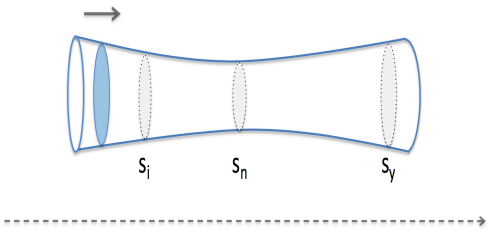


Fig. 8.2:

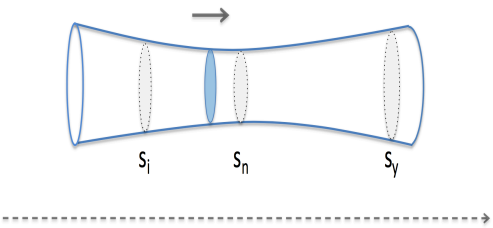


Fig. 8.3:

As we saw in Ch.6, M can be divided into three sections M_1, M_2, M_3, and M_1 (M_3) is a round-type 4-D manifold but M_2 is an oval-type 4-D manifold. As we said above, in transition monism, we cannot conceptualize change as objects having incompatible properties *at different times* simply because there are no concrete objects located at times. Rather, intrinsic change in shape and size is understood in terms of transition through certain types of 4-D manifold as in Fig.8.2-3.

Now, someone might think that when we accept the state-theoretic framework and so have objects at times, a trans-temporal relation between them is quite simple. For example, consider the persistence and the intrinsic change of a balloon in this framework captured by Fig.8.1. We have three 3-D balloons b_i at t_i. Therefore, in order to consider a trans-temporal relation such as identity, all we need to do is to choose two of them and examine whether

same problem if they do not take an ersatzist approach.

they satisfy the identity relation. However, it's not that simple in transition monism because we do not have two 3-D balloons (being located at different times) to which we apply a trans-temporal relation. Of course, this only means that the simple procedure of applying a trans-temporal relation does not make sense in transition monism. You might think we can take an ersatzist approach and talk about a trans-temporal relation between objects at different abstract times. However, as we saw in Ch.7, we should reject the idea of time as the concrete/abstract fourth dimension. Moreover, if we want to defend the idea of persistence as an irreducibly dynamic phenomenon, this ersatzist approach in which persisting objects are located at abstract times is not acceptable. If so, how do transition monists deal with trans-temporal relations?

In order to find an answer, it is helpful to consider why we can apply a trans-temporal relation in the state-theoretic framework in more detail. First, when we talk about a trans-temporal relation in this framework, what we have in mind is usually a *tenseless* relation. For example, when we say b_1 at t_1 is identical with b_2 at t_2 in endurantism, this identity relation is a *tenseless* identity that satisfies three formal features (reflexivity, transitivity, and symmetry) and the indiscernability of identicals. For state theorists that accept the block universe as in Fig.8.1, there is no perspective of making the following statements: b_1 at t_1 *was* identical with b_2 at t_2, or b_1 at t_1 *will be* identical with b_3 at t_3. These tensed identity statements simply do not make sense because if b_1 at t_1 is identical with b_2 at t_2, they are tenselessly identical.

Why can we use the tenseless identity? The answer is obvious: we can apply this tenseless identity to concrete objects at different times because these objects at times are tenselessly located at these times. You might think 3-D balls b_i at t_i are tenselessly located at t_i only in eternalism. But, this is not correct. For example, consider the moving-spotlight theory. Is s_1 tenselessly located at t_1. The answer is yes. Of course, there is the moving

NOW, but the movement of the NOW does not make the being-located-at relation between b_1 and t_1 tensed because b_1 is just located at t_1 wherever the moving NOW is. That is, the dynamic moving process of the NOW has nothing to do with whether the relation holds between them. How about the growing-block theory view? Suppose t_2 is the present edge of the growing block. Here, it is wrong to say that b_1 *was* at t_1 simply because b_1 is still located at t_1. Then, suppose t_3 is the present edge of the growing block. Again, it is wrong to say that b_1 *was* at t_1 simply because b_1 is still located at t_1. This means once a concrete object is located at a time, it is tenselessly located at the time, whether which time is the present edge of the block. That is, the dynamic process of successive addition has nothing to do with whether the being-located-at relation holds between (i) past and present objects and (ii) past and present times.

8.1.2 Tensed Trans-Temporal Relations

However, the situation gets complicated when we think of future objects at future times in the growing-block theory. Suppose that t_3 is the present edge of the block universe. According to the growing-block theory, future objects simply do not exist, although future objects *will* be located at future times. Therefore, we cannot use tenseless trans-temporal relations between a present or past object and a future object because future objects are not tenselessly located at future times. This means when we want to use a trans-temporal relation between a past or present object and a future object, the relation must be tensed. For example, if we want to talk about a trans-temporal identity between b_3 at the present (t_3) and b_4 that will be located at t_4, we have to say b_3 at t_3 *will be* identical with b_4 at t_4. The same is true of trans-temporal relations in the minimal A-theory. As we saw in Ch.2, in this theory, only one time is filled with objects. For example, suppose t_1 *is now* filled with b_1 and other objects. Then, t_2 *will be* filled with b_2 and other objects, but *is* not *now* filled with them. Therefore, if we want talk about

a trans-temporal relation, say identity, between b_1 at t_1 and b_2 at t_2 (that is, if we want to say the *same* ball at t_1 will also appear at t_2), we need the following tensed identity: b_1 at t_1 will be identical with b_2 at t_2.

Someone might think, *mutatis mutandis*, transition monists could also use this tensed trans-temporal relation. However, there is a serious problem about this tensed identity relation. As we will see, this problem is general because any theory that brings irreducible tense into concrete reality by a dynamic process faces this problem. Here, for simplicity, let us keep considering the tensed identity relation in the minimal A-theory. We have the following tensed identity relation: b_1 at t_1 will be identical with b_2 at t_2. Now, let us ask why this relation deserves to be called a tensed *identity*? The obvious answer is that the relation satisfies the tensed version of the three formal features (and the indiscernability of identicals).[2] Unfortunately, a tensed identity cannot satisfy the tensed version of symmetry: if b_1 at t_1 *will* be identical with b_2 at t_2, then b_2 at t_2 *will* be identical with b_1 at t_1.[3] Why? Remember that in any theory that brings irreducible tense into concrete reality by a dynamic process, tense is inseparably connected with the direction of the dynamic process. On the one hand, (I) if b_1 at t_1 *will* be identical with b_2 at t_2, this is because, by successive filling, t_1 *is now* filled with objects and then t_2 in turn *will be* filled with objects. On the other hand, (II) if b_2 at t_2 *will* be identical with b_1 at t_1, this is because, by successive filling, t_2 *is now* filled with objects and then t_1 in turn *will be* filled with objects. That is, (I) and (II) describe different successive filling processes. Since this consequence must be rejected, the tensed identity cannot satisfy the tensed symmetry. If so, it is quite dubious why this trans-temporal relation that does not satisfy symmetry deserves to be called identity. As it stands, we do not have enough grounds for regarding the relation as identity.

Transition monists think a tensed trans-temporal identity is not tenable

[2]A tensed version of the indiscernability of identicals will be like this: if *a will* be identical with *b*, the properties *now* possessed by *a will* be possessed also by *b*.

[3]The same argument is applied to 'was identical with'.

because of the reason above. However, they also think the holding of tenseless identity between objects (at different times) is not a correct feature of persistence. In other words, they partially agree with perdurantists and exdurantists who deny the tenseless identity between objects at different times. Nevertheless, transition theorists partially agree with endurantists who deny that persistence is about numerically distinct objects at different times. Transition monists think there is a tensed trans-temporal relation that is something in between, i.e. something neither numerical identity nor numerical distinctness.

8.1.3 Becoming as a Tensed Trans-Temporal Relation

Transition monists think the trans-temporal relation we should introduce here is not the tensed identity relation but a tensed *becoming* relation.[4] Before we define this becoming relation, let us look at how the becoming relation is used in our daily life. For example, suppose you have a cat and it was only a young female cat but *now has become* a mother cat that *now has* 5 kittens. What makes becoming elusive is that there must be something in common or something identical between a young cat and a mother cat, but the becoming relation itself cannot simply be a tenseless or tensed identity. Indeed, the becoming relation does not satisfy reflexivity and symmetry that the identity relation must satisfy. For example, in the case of symmetry, when a young female cat has become a mother cat, it does not hold that a mother cat has become a young female cat. This implies that there is a fixed direction in the becoming relation from a young female cat to a mother cat. In the case of reflexivity, it does not make sense to say a young female cat has become a young female cat because a young female cat is already a young female cat. This implies that the becoming has something to do with change. If so, does the becoming relation have nothing to do with the identity relation at all? It seems not because what we want

[4]This is suggested in (Barker, unpublished, Ch.9).

to say by the becoming relation is that something that was a young female cat now has become a mother cat. Therefore, there must be something in common or something identical in the becoming relation that itself is nevertheless not the identity relation. Therefore, there are at least three desiderata we have to meet in order to characterize the becoming relation. The first desideratum is concerned with identity: there is something in common or something identical in two concrete objects for which the becoming relation holds. The second desideratum is concerned with change: the becoming relation between two concrete objects is not just the identity relation but has something to do with change. The third desideratum is concerned with direction: the becoming relation has a fixed direction which makes it impossible for the relation to have a formal feature of symmetry. Roughly speaking, the becoming relation itself cannot be the identity relation, but at the same time it must include the identity relation as a part.

Let us consider the becoming relation between a round balloon (B_r) and an oval balloon (B_r). In transition monism, a round balloon is defined in terms of a balloon-form S_1 being transiting through a round-type 4-D manifold; an oval balloon is defined in terms of a balloon-form S_2being transiting through an oval-type 4-D manifold. Then, a future-tensed becoming relation between B_r and B_o is given as follows[5]:

B_r *will become* B_o iff

(i) S_1 and S_2 are tenselessly identical with S.

(ii) S *is now* transiting through M_1.

(iii) S *will be* transiting through M_2.

This is concrete reality captured by Fig.8.2: there *is now* a round balloon (B_r) because S *is now* transiting through M_1, and there *will be* an oval balloon B_o because S *will* be transiting through M_2. As we can tell, (i)

[5]See (Barker, unpublished, Ch.9).

meets the desideratum about identity: what is in common or identical in the becoming relation is a determinable form that transits through different segments M_1 and M_2. Also, (ii) and (iii) together meet the desideratum about change because, as we saw above, (ii) and (iii) explains the intrinsic change of a concrete balloon B. Moreover, both (ii) and (iii) explain why the becoming relation has a fixed direction: it is because the transition of a determinable has a certain direction. Unlike in the state-theoretic framework captured by Fig.8.1, an oval balloon B_o is not tenselessly located but there *will be* B_o, and so a future tense must be introduced in the becoming relation.

It is helpful to look at a becoming relation with another tense 'has now become'. This is defined as follows:

B_r *has now become* B_o iff

(i) S_1 and S_2 are tenselessly identical with S.

(ii) S *was* transiting through M_1.

(iii) S *is now* transiting through M_2.

This is concrete reality captured by Fig.8.3: there *is now* a concrete oval balloon (B_o) because S *is now* transiting through M_2, and there *was* a concrete round balloon B_r because S *was* be transiting through M_1. The becoming relation must be tensed in this way because, a round balloon B_o is not tenselessly located but there *was* B_o in transition monism. Here, again (i)-(iii) meets the three desiderata above.

Let us sum up the point. In the state-theoretic framework, when we consider the persistence of an object O, we have two different answers about whether 3-D objects o_i at different times t_i are numerically identical or not. Endurantists think that 3-D objects o_i at different times are numerically identical. Perdurantists and exdurantists claim that 3-D balls b_i at different times are numerically distinct. By contrast, in transition monism, we have a trans-temporal relation that is something in between, the becoming

relation. This becoming relation itself is not identity but at the same time has something to do with identity in that it includes the identity relation involving a determinable.

8.2 Coincidence

When we consider persistence, another important related topic is coincidence. As we saw in Ch.1, in the state-theoretic framework, coincidence is characterized as follows:

> O_1 and O_2 coincide iff they exist in the same place at the same time, being made up of the same parts.

Let us remember our snowman example. We first make two snowballs, the head-part and the body-part, and at t_1 we put the head-part on the body-part so that we get a snowman (*Snowman*) and a lump of snow (*Snow*) both of which is made up of the two snowballs. We have Snowman and Snow in the same place at the same time, being made up of the same parts. Two hours later, at t_3, Snowman melted into one big lump of snow without a snowman-shape. Therefore, it seems there is still Snow but no longer Snowman at t_3.

The debate on coincidence in this framework is mainly about whether coinciding objects are identical or not. Some endurantists accept non-identical coincidence: when Snowman and Snow coincide, they are non-identical. That is, there are numerically distinct objects in the same place at the same time. In this case, they have to explain how it is possible for numerically distinct objects to exist at the same spatial location at the same time, being composed of the same things. By contrast, other state theorists including other endurantists accept identical coincidence: when Snowman and Snow coincide, there is only one object in the same place at the same time. In this case, they have to explain the following thing: if they are identical, how

is it possible for *only* Snow to exist at t_3? For, if they are identical, and if Snow exists at t_3, also Snowman must exist at t_3.

Now, how can we understand coincidence in transition monism? Obviously, coincidence cannot be understood in terms of being located at or existing at the same place at the same time because they reject this understanding of concrete reality. Since coincidence is a concrete phenomenon and transition is the fundamental concrete reality, it must be understood in terms of transition. As we saw above, concrete objects are understood in terms of transition. We have a snowman when a determinable snowman-form S_1 transits through a 4-D manifold M (each 3-D slice of which is a determinate of S_1). We have a lump of snow when a determinable lump-form S_2 transits through a 4-D manifold M (each 3-D slice of which is a determinate of S_2). When we understand concrete objects in this way, the coincidence of two objects is understood as two determinables transiting together through the same 4-D manifold. Here, being together means being in the same 3-D space. For example, when a cat is on a mat, the cat and the mat are included in the same 3-D space and are persisting together. Of course, in this case of a cat on a mat, two different determinables included in the same 3-D space are transiting through *different* 4-D manifolds. What is special in coincidence is that two determinables included in the same 3-D space are transiting through the *same* 4-D manifold.[6]

This is the basic idea of coincidence in transition monism. Let us take a closer look at a specific case of coincidence: Snowman and Snow. Consider the following 4-D structured manifold M:

[6]The basic idea of coincidence in transition monism is already given in the old (not the current) version of Barker (unpublished), although my explanation here is not exactly the same as in the book.

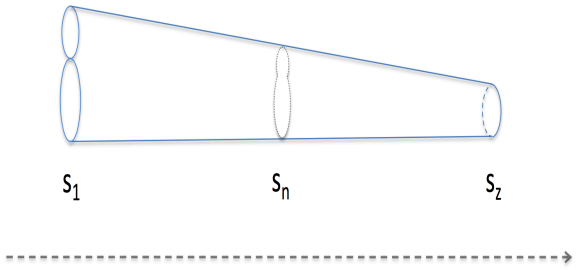


Fig. 8.4:

The 4-D manifold M is the order of 3-D structured forms each of which is a determinate of a lump-form S_2. Suppose we can divide M into two segments M_1 (the first 1/2) and M_2 (the second 1/2). The segment M_1 is the order of 3-D structured forms each of which is a determinate of a snowman-form S_1. The segment M_2 is the order of 3-D structured forms each of which is a determinate of a lump-form S_2 but not a snowman-form S_1.

Then, the coincidence of Snowman and Snow is understood as follows. Consider concrete reality captured by Fig.8.5 below:

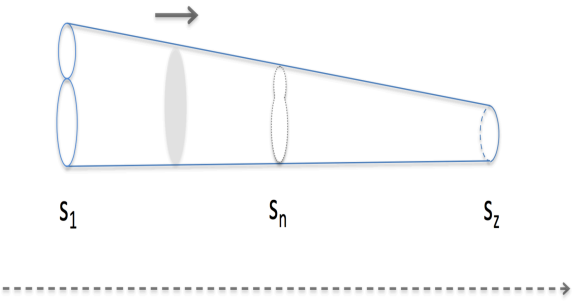


Fig. 8.5:

In Fig.8.5, two determinables (a snowman-form and a lump-form included in the same 3-D space) expressed by a gray oval are transiting together through the same segment M_1. Two different determinables can transit through the same segment M_1 because M_1 is the order of structured forms each of which

is a determinate of these two determinables. Here, we have the following tensed coincidence:

> Snowman and Snow *are now* coinciding iff a snowman-form and a lump-form *are now* together transiting through M_1.

As we saw above, since Snowman and Snow are different concrete objects because they are defined differently in terms of transition, we have non-identical coincidence in transition monism.

Let us also look at a later situation where the head-part and the body-part melted into a big lump of snow. In this situation, there *was* Snowman but there have been still Snow: a snowman-from *was* transiting through M_1 and a lump-form *was* transiting through M_1 and *is now* transiting through M_2. This is captured by Fig.8.6 below:

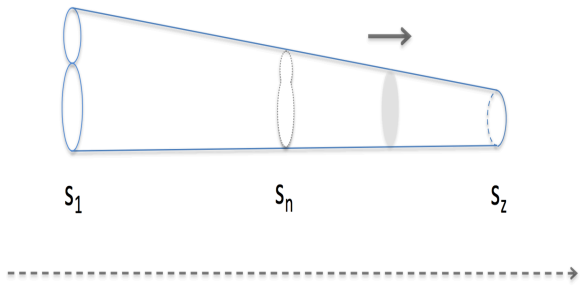


Fig. 8.6:

In Fig.8.6, only one determinable, i.e. a lump-form (expressed by a gray oval), *is now* transiting through M_2. This is because M_2 is the order of structured forms each of which is a determinate of a lump-form but not a snowman-form.

Let us sum up the points here. Transition monists think non-identical concrete objects can coincide. But coincidence here does not mean that non-identical objects are in the same place at the same time. This sense of coincidence is only available within the state-theoretic framework. Coincidence in transition monism is understood in terms of two different determinable together in transit through the same 4-D manifold.

8.3 One-After-Another Processes and Irreducible Transition

Both A-theoretic state theorists and transition monists talk about dynamic processes that are irreducible to a higher-order sequence of states. However, these dynamic processes in these two theories are fundamentally different. As we saw in Ch.3, A-theoretic state theorists talk about varieties of dynamic processes. Someone might think some of these processes might be regarded as transition. For example, the movement of the NOW in the moving-spotlight theory and transient filling in the minimal A-theory might be said to be a dynamic process of transition. In Ch.3, we called this dynamic process a *pseudo*-transition, compared to irreducible transition in transition monism. While (i) pseudo-transition in the state-theoretic framework and (ii) irreducible transition in transition monism are both irreducible in that they cannot be reduced to a higher-order 5-D sequence, they are fundamentally different. In the case of pseudo-transition, transition is characterized in terms of one-after-another succession: the NOW is first *at* a time, then it is in turn *at* another time, and so on (in the moving-spotlight theory); one and only this time is first filled with objects (i.e. concrete objects are *at* one and only this time), then another time is in turn filled with objects (i.e. concrete objects are *at* this and only this time) (in the minimal A-theory). If we want to make this feature explicit, we call this dynamic process pseudo-'at-at'-transition.[7] When we conceptualize any dynamic process in the state-theoretic framework, this one-after-another-succession is the requirement because concrete reality is understood in terms of being located at or existing at times. In the case of irreducible transition in transition monism, transition does not have this 'at-at' feature because a non-locatable determinable form S irreducibly transits through a 4-D manifold M *without*

[7]The term 'at-at' comes from Arntzenius (2000), although I used it in a different way.

being located or stationary at any 4-D points. This is the crucial difference between pseudo-transition and irreducible transition.

As we saw in Ch.3, if we conceptualize a dynamic process in terms of the one-after-another succession, we face the problems of infinite candidates and reduction. It is helpful to look at them here in order to understand why transition monists do not face these problems. Let us here take the minimal A-theory as an example. According to this theory, one and only one time is filled by objects. Also, there is a dynamic changing process about which time is filled by objects. We called this dynamic process *transient filling*. As we saw in Ch.3, if the fourth dimension as time is continuous, we have the problem of infinite candidates. Suppose t_1 (and only this time) is now filled with concrete objects. By transient filling, another time (and only this time) will get filled with concrete objects. However, which time is this another time that will get filled with objects? For example, a later time t_2? No, because there must be another time t_3 between t_1 and t_2 due to the infinite divisibility that results from the continuity of time. So, the next time is t_3? No, because there must be another time t_4 between t_1 and t_3 because of the same reason. Since this process will be repeated infinitely, there will be no answer to what is the next time that gets filled with objects. In other words, there are infinite candidates for the next time that will get filled by objects. By contrast, if we think that the fourth dimension as time is discrete, since the dimension is only finitely divisible, we do not face this problem because there is only one unique adjacent time to be filled by objects (given the direction of transient filling). However, in this case, we have another problem. If times have non-zero extension, we have to make clear whether there is an interval from one filling to another filling. If there is, we need a fifth dimension as a higher-order time to make clear the interval; if there is not, since all the fillings happen instantly, what we get is the eternalist block universe: all concrete times are filled with concrete objects.

Therefore, in order to avoid the two problems here, what transition monists have to show is the following two things: (i) the transition of a determinable form S through a 4-D manifold M is not infinitely divisible, and (ii) finite divisibility does not imply discreteness that requires a higher-order time. Let us start with (i).[8] Suppose the transition of S through M is infinitely divisible. Then, we could show that the section of M through which S is transiting converges on a 3-D slice that has an extension infinitely close to zero.[9] We first divide M through which S is transiting into half and so we get M_1 and M_2. Since S is transiting through one of M_1 and M_2, we choose the one through which S is transiting. Suppose it is M_1. Then, we divide M_1 into half and so we get M_3 and M_4. Since S is transiting through one of M_3 and M_4, we choose the one through which S is transiting. Suppose it is M_3. Then, we divide M_3 into half. If we repeat this process infinitely, the segment M_i through which S is transiting through gets infinitely closer to, i.e. converges on, a 3-D slice s_i of M because if we divide M in half infinite times, M_i is still included in M and the interval of $M_i = \frac{1}{2^\infty}$ of M. However, if M_i converges on s_i, we have to say that S is *at* M_i because M_i is a 3-D slice whose extension converges on zero and so any transition of S brings S out of M_i. However, this is inconsistent with the transition-theoretic framework in which S transits through M *without being located at* any points. Therefore, the transition of S through M must be finitely divisible.

Let us move to (ii): this finite divisibility of transition must not imply the discreteness of transition; otherwise, as we saw in the minimal A-theories above, we have to introduce a higher-order time to articulate the interval. As we will see, there is not such implication precisely because there is a non-locatable entity that continuously transits through non-zero distance.

[8]The original argument that transition does not face these two problems is in (Barker, unpublished, Ch.7). The argument here (from this paragraph to the end of Sec.3) is my own version to support the same claim.

[9]This is called the method of diminishing interval which is a popular proof-method in differential calculus and set theory.

When a 4-D manifold is finitely divisible, since numbers of finite sections do not matter, let us consider a 4-D manifold M that is finitely divisible into three subsections, M_1 (the first 1/3), M_2 (the second 1/3), and M_3 (the third 1/3). For a comparison, let us start with transient filling. Suppose transient filling is happening to M that is finitely divisible into the three subsections from M_1 to M_3[10]: M_1 and only this subsection first gets filled with objects, and then M_2 and only this subsection in turn gets filled with objects. Here, the crucial point is that when a subsection is filled with objects, the section as a whole, i.e. 1/3 of M, gets filled *all at once*. In other words, filling cannot happen gradually and continuously because that requires the infinite divisibility of M. If M_1 as a whole gets filled with objects all at once, there must be an interval from the filling of M_1 to the next filling of M_2. If there were no interval, all the fillings of subsections would occur all at once. However, if there is an interval, we have to articulate this interval in terms of a higher dimension.

How about transition in transition monism? Suppose S is continuously transiting through M that is finitely divisible into the three subsections from M_1 to M_3. When S is transiting through a subsection M_1, unlike transient filling, the transition of S through M_1 does not happen all at once because S has to continuously transit through M_1 with non-zero distance (1/3 of M) as in Fig.8.2. If S finishes transiting through M_1 then seamlessly starts to transit through M_2 because S is still continuously transiting through M as in Fig.8.3. When a non-locatable entity is continuously transiting through a 4-D manifold M, there is no interval from the transiting through M_1 to the transiting M_2 because the transition S through M as a whole is now continuously happening. While the finite divisibility of M through which S is continuously transiting allows us to look at this continuous transition in a more focused way (e.g., the transition of S through M_1 or M_2), it does not make the process itself discrete. Here, what transition as fundamental has

[10]We can think each M_i corresponds to a minimal non-zero unit of time t_i.

but transient filling lacks is a non-locatable entity that continuously transits through non-zero distance. This continuously transiting non-locatable entity is critical for rejecting that the finite divisibility of M implies the discreteness of the transition of S through M.

Since this point is crucial, it is better to give a familiar example in our daily life. Fortunately, whether transition is 3-D or 4-D does not matter for the connection between (i) finite divisibility and (ii) discreteness (and so the introduction of a higher dimension), we can consider a familiar 3-D transition. For example, consider a marathon course M that has the length of 42,195 km. Suppose we divide M into a number of subsections M_i with 10 m except for the last section with 5 m. For a comparison, again, let us start with transient filling. Suppose transient filling is happening to M that is finitely divisible into a number of subsections M_i with 10 m: M_1 and only this subsection first gets filled with objects, and then M_2 and only this subsection in turn gets filled with objects, and so on. Here, the crucial point is that when a subsection is filled with objects, the section as a whole, i.e. 10 m as a whole, gets filled all at once. If M_1 as a whole gets filled with objects all at once in this sense, there must be an interval from the filling of M_1 to the next filling of M_2. If there were no interval, all the fillings of subsections would occur all at once: the marathon event would finish all at once! However, there is an interval, we have to articulate this interval in terms of a higher dimension.[11]

Let us move to transition monism. Suppose a marathon runner R is continuously transiting (running) through M that is finitely divisible into subsections with 10 m. When R is transiting through a subsection M_1, unlike transient filling, the running of R through M_1 does not happen all at once because S has to continuously run through M_1 from 0 m to 10m. If

[11]Of course, in this case, what is introduced is a fourth dimension, and so this introduction itself is not problematic. However, that is not the point here. Rather, the point is the connection between the finite divisibility of M and the introduction of a higher dimension.

S finishes running through M_1 then seamlessly starts to run through M_2 because S is continuously running through a marathon course M. No one would want to say that since a marathon course M is divided into subsections, the running of the athlete through each subsection occurs discretely. For we actually see an athlete continuously running through these subsections. While the finite divisibility of a marathon course through which an athlete is continuously running allows us to look at the continuous running of R through M in a more focused way, it does not make R's running a marathon itself discrete. Here, again, what irreducible transition in transition monism has but transient filling in the minimal A-theory lacks is a non-locatable runner that continuously transits through non-zero distance. This continuously transiting non-locatable runner R is critical for rejecting that the finite divisibility of a marathon course M implies the discreteness of the running of R through M.

Conclusion

If transition is the fundamental concrete reality and concrete reality in general is understood in terms of transition, we cannot straightforwardly talk about a trans-temporal relation between two different things at different times. If so, what is the counterpart of trans-temporal relations (in the state-theoretic framework) that are between concrete objects at different times? Transition monists suggest a tensed trans-temporal relation that is something neither numerical identity (in endurantism) nor numerical distinctness (in perdurantism or exdurantism). They think the trans-temporal relation we should introduce is the tensed *becoming* relation. This becoming relation meets the following three desiderata: (i) there is something in common or something identical in two concrete objects for which the becoming relation holds; (ii) the becoming relation between two concrete objects is not just the identity relation but has something to do with change; (iii) the

becoming relation has a fixed direction which makes it impossible for the relation to have a formal feature of symmetry.

In the state-theoretic framework, coincidence is understood as being in the same place at the same time, being made up of the same parts. Some enduratists accept non-identical coincidence: when Snow and Snowman coincide, they are non-identical. Other state theorists including the rest of endurantists accept identical coincidence: when they coincide, they are identical. In transition monism, coincidence is understood quite differently. Obviously, transition monists cannot understand coincidence in terms of being located at the same place at the same time. Rather, coincidence is understood as transiting together through the same 4-D manifold. For example, transition theorists understand the coincidence of Snowman and Snow in the following way: Snowman and Snow *are now* coinciding iff a snowman-form and a lump-form *are now* together transiting through M_1. Since Snowman and Snow are different concrete objects, transition monists suggest non-identical coincidence.

We also have considered the transition-monistic treatment of the problems of infinite candidates and reduction. In the state-theoretic framework, the former problem results from the combination of a dynamic one-after-another process with infinite divisibility, and the latter problem results from the combination of a dynamic one-after-another process with finite divisibility. Since transition monists also deal with a dynamic process of irreducible transition, someone might think transition monism also faces the same problems. However, in this view, while a 4-D manifold M through which a determinable S is transiting is finitely divisible, this finite divisibility of M does not make the transition of S through M discrete. You might wonder why one-after-another processes in state theories imply but irreducible transition in transition monism does not imply discreteness. What transition in the latter has but one-after-another processes in the former lack is a non-locatable entity that continuously transits through non-zero distance.

This continuously transiting non-locatable entity allows us to reject that the finite divisibility of M implies the discreteness of the transition of S through M.

Conclusion

An Alternative Framework to the State-theoretic One

What is persistence? This is the most general question we tried to answer in this dissertation. According to current standard theories of persistence (i.e. endurantism, perdurantism, and exdurantism), an object persists by 3-D objects being located or existing at more than one time.[12] In endurantism, when an object persists, the same object is temporally multiply located at different times; in perdurantism, when an object (as a spacetime worm) persists, it has different temporal parts at different times; in exdurantism, when an object persists, the object at a time is in a temporal counterpart relation to another object at a different time. That is, they understand persistence in terms of *location* along a fourth dimension: they introduce a fourth dimension as time which offers temporal locations for objects and locate 3-D objects at times. We called this framework the *state-theoretic* framework. This is so popular that what is discussed in the debate on persistence is usually what are these objects being located at spatiotemporal regions, assuming this framework itself. Some theorists say numerically identical objects are located at different times; others say numerically distinct objects are located at different times. It seems no one would doubt the state-theoretic framework itself in which persistence is understood in terms of locating objects at spatiotemporal points or regions. In this dissertation, however, we put doubt on this predominant framework and tried to build a new alternative framework, the *transition-theoretic* framework, which is based on the Flux-first view proposed by Stephen Barker.[13]

Someone might ask how it is possible to understand persistence in any other way. As long as we are within the state-theoretic framework, the answer is 'no other way'. That is, understanding persistence in terms of location is the only way. Even if some endurantists might think persistence

[12]The general definition of the state-theoretic framework is to understand persistence by introducing a fourth dimension and locate objects along the fourth dimension.

[13]Barker (unpublished).

is more like 'moving through time', this is only a metaphorical or poetic expression of persistence and so there is no metaphysically substantial ground for such a seemingly dynamic phenomenon. Indeed, we have shown that any irreducibly dynamic phenomenon does not make sense or is inconsistent in the state-theoretic framework (Ch.3-4). If so, the current situation is quite daunting for someone who thinks persistence is something irreducibly dynamic, compared to the static picture given by the state-theoretic framework. For even if the person expresses the thought, either persistence as an irreducibly dynamic phenomenon is not understood or the dynamicity of persistence is understood as a *non*-fundamental feature of concrete reality. What is worse, there has been offered no alternative framework in which persistence as an irreducibly dynamic phenomenon is comprehensible.[14] That is, we are facing the following two problems: (i) if we talk about the idea of persistence as an irreducibly dynamic phenomenon, the idea is not understood in the state-theoretic framework; (ii) there has been offered no alternative framework in which the idea is comprehensible, whether it is correct or not.

The Common Ground: Transition

Of course, this does not mean there is actually no alternative framework in which persistence as an irreducibly dynamic phenomenon might be defended. Rather, even if there is such an alternative framework, it is quite a hard task to introducing it to people in the state-theoretic framework. If there is such a possible framework, how can we share the idea with others who are quite used to understanding concrete reality in the state-theoretic way? Our strategy was this: the best way is to start from a shared concrete

[14]Someone might think persistence as recurrence in process ontology has offered an alternative framework. However, as we saw in Ch.4, process ontology is still in the state-theoretic framework. Process ontologists just locate temporally extended 4-D entities called processes at spatiotemporal regions, instead of 3-D substances. Indeed, in the state-theoretic framework, endurantism and process ontology can be said to be in the same group according to which trans-temporal identity holds for a persisting entity.

phenomenon by both groups and make clear how the two groups differ in understanding the phenomenon. The concrete phenomenon we chose was *transition*. Transition itself is quite a common concrete phenomenon in our daily life. In a sense, you never start a day without transition because you have to get up from a bed and transit from your room to a kitchen or somewhere else. This transition is understood as a relation between an object O and space R as follows: O *is transiting through* R. For example, when you are walking through a park, a transiting object is you and the space through which you are transiting (walking) is a park. Obviously, this transition is a concrete phenomenon any state theorists accept as a part of concrete reality. They do regard your walking through a room as a concrete phenomenon (even if they do not think of it as an *irreducible* concrete phenomenon).

As we saw in Ch.5, transition has several characteristic features. First, when an object O is transiting through space R, the transiting object O is non-locatable at any points, although it passes through these points. That is, O is transiting through R in a certain direction without being located or stationary at any points in R. For example, when you are jogging through a park, you are transiting through the park in a certain direction without being located or stationary at any points. Of course, if you want to take a rest, you can stop and be located or stationary at a location, but, in that case, you are not jogging. This is the feature we called *non-locatability*. Second, when O is transiting through R, the transiting O is dynamic because O is transiting through R without being located at any points in R. For example, when you are running through a park, you are dynamic because you are transiting through the park without being located or stationary at any points in the park, compared to cases where you are static when you are sitting on a bench in the park. This is the feature we called *dynamicity* (that is understood in terms of transition). Third, when O is transiting through R, the transition cannot happen without duration. This is because

transition is through non-zero distance. For example, even if light transits through a distance with 1 nm, the transition has to have non-zero duration because light has to transit from 0 nm to 1nm. This is the feature we called *non-zero duration*. Fourth, when O is transiting through R, the transition must have a direction. For example, when you walk through a distance between you room and a kitchen, your walking is either from your room to the kitchen or from the kitchen to your room. This is the feature we called *directionality*. Fifth, when O is transiting through R, the transition cannot be described without tense. For example, when a marathon runner *is now* passing the turning point, then the runner *was* passing the 10 km point and will be reaching the goal. Here, we cannot ignore tense because we would have the following meaningless claim: when the runner passes the turning point, then the runner passes the 10 km point and reaches the goal. This is the feature we called *tense*.

Transition as Reducible/Irreducible

This (i.e. transition with these five characteristic features) is the common ground shared by the two different frameworks, the state-theoretic and the transition-theoretic framework. Then, the next step is to show how these two frameworks differ in understanding this common ground. While the state theorists understand them as reducible, transition theorists understand them as irreducible. Let us start from the state-theoretic framework. Consider an athlete's running a marathon. As we saw above, they introduce a fourth dimension as time and locate objects at times as in Fig.8.7 below:

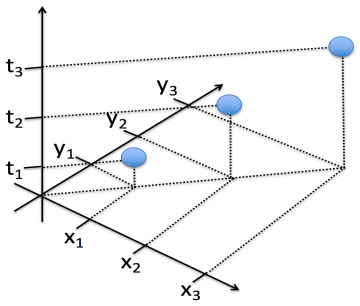


Fig. 8.7:

That is, in this framework, the running (transition) of an athlete A through a marathon course from a spatial location l_1 to another location l_2 is understood as follows (let us call an athlete at t_i as a_i): an athlete at t_1 (a_1) is located at p_1 and an athlete at t_2 (a_2) is located at p_2, and t_1 is earlier than t_2.[15]

By contrast, in order to understand the persistence of A when it runs through a marathon, if running (i.e. transition) is irreducible to states, we do not locate a_i at t_i as in Fig.8.7. Rather, we let A transit through 4-D space as in Fig.8.8-10 below:

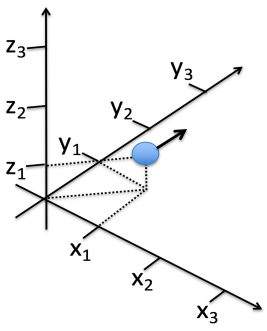


Fig. 8.8:

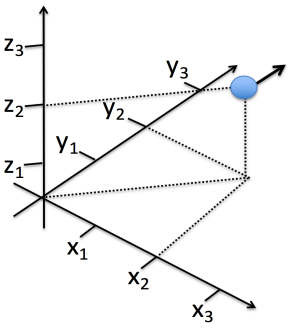


Fig. 8.9:

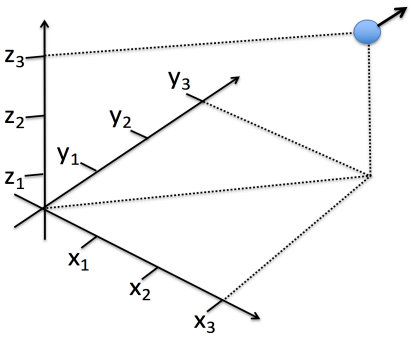


Fig. 8.10:

In Fig.8.8-10, a non-locatable ball is irreducibly transiting through 4-D space without being located at any 4-D points, although it is passing through these points.

Persistence as Transition

In this way, even if we start from the common ground (transition with its five characteristic features), we have a different picture of persistence if we

[15] In endurantism, a_1 and a_2 are identical to A; in perdurantism, a_1 and a_2 are different temporal parts of A as a spacetime worm; in exdurantism, a_1 ($=A$) is in a temporal counterpart relation to a numerically distinct a_2 ($=A'$).

understand the common ground differently. One the one hand, in the state-theoretic framework, in order to understand the persistence of an athlete A through a marathon, we locate 3-D objects a_i at different times t_i as in Fig.8.7. On the other hand, in the transition-theoretic framework, in order to understand the persistence of A through a marathon, we let a non-locatable A transit through 4-D space without being located at any points in 4-D space. That is, these two frameworks offer two different understandings of persistence. In the state-theoretic framework, persistence is understood in terms of locations along the fourth dimension. In endurantism, the same object exists at different times; in perdurantism, temporal parts of a spacetime worm exist at different times; in exdurantism, an object and its temporal counterpart exist at different times. That's why persistence in this framework is called *persistence as location* (along the fourth dimension). By contrast, In the transition-theoretic framework, persistence has nothing to do with location. It is understood in terms of irreducible transition along the fourth dimension. We called this understanding of persistence as *persistence as transition* (along the fourth dimension).

Transition theories of persistence successfully defend the idea of persistence as an irreducibly dynamic phenomenon. Consider the persistence of an athlete A through a marathon. In the transition-theoretic framework, the persistence of A is understood in terms of irreducible transition along the fourth dimension. As we saw above, a transiting object A has one characteristic feature of transition, i.e. dynamicity. Since transition is irreducible to states, dynamicity that is understood in terms of transition is also an irreducible feature of a transiting object. This means a transiting object A is *irreducibly* dynamic because it is irreducibly transiting along the fourth dimension without being located at any points on the dimension.

The crucial point here is that this dynamicity of a persisting object is not a mysterious or incomprehensible feature of concrete reality because there is a clear metaphysical basis for this dynamicity: a persisting object is

irreducibly transiting through 4-D space without being located at any 4-D points. Although we have shown that persistence as an irreducibly dynamic phenomenon can be defended by transition theories, we cannot finish our inquiry on persistence here. For we have to start the next journey to defend transition theories. Especially, we first have to make clear whether there are any varieties of transition theories, and if not, why.

State-Transition Dualism

State-transition dualists in general think (i) a transiting object O and(or) 4-D space S through which it transits are(is) concrete in themselves(itself) and (ii) the transition of O through S is also concrete in itself, although it may be natural to think that both O *and* S are concrete in themselves. As we saw in Ch.6, one possible version of state-transition dualism is dynamic endurantism. Consider the persistence of a concrete balloon B. According to this dynamic endurantism, the persistence of B is understood in terms of the transition of the concrete balloon B itself through a concrete 4-D space. That is, dynamic endurantists understand persistence not in terms of location but in terms of transition. Nevertheless, they are still endurantists because they keep the trans-temporal identity relation holding between things at stages of transition.

However, dynamic endurantists face the serious problem of losing persistence-transition connection. Consider a concrete balloon B whose concreteness is independent from its transiting through a concrete 4-D space S. Since this rubber balloon B is a concrete object independent from its transiting through S and instantiates properties such as being round, the instantiation of these properties themselves are also independent from its transiting through S. This is obvious because, according to dynamic endurantism, what transits through S is a concrete object instantiating properties. Now, if the instantiation of properties by B is independent from and so has nothing to with its transiting through S, the instantiation of different properties

such as being round and being oval by B, i.e. the change of B in its shape, is also independent from its transiting through S. However, the change of B does involve the persistence of B. Therefore, the persistence of B is also independent from the transition of B through S because the change of B that does involve the persistence of B is independent from the transition. If so, the persistence of B does not consist in (and so cannot be understood in terms of) the transition of B through S. Thus, dynamic endurantism cannot keep the fundamental claim that persistence is understood in terms of transition.

Moreover, state-transition dualists also face other serious problems. Suppose a concrete 4-D space S with property instantiations. If we think S is a concrete 4-D spacetime with property instantiations, we face the problem of two different persisting objects. If we accept this concrete 4-D spacetime S, we have no reason to reject that 3-D balloons b_i are located at times t_i because property instantiations (i.e. objects instantiating properties) are located at times. That is, a spatiotemporal region of S will be as follows: a 3-D balloon b_1 with a size s_1 is located at t_1, a 3-D balloon b_2 with another size s_2 is located at t_2, and so on. If there is an appropriate relation between b_1 and b_2, there is no reason for state-transition dualists to reject the persistence of a balloon B in a state-theoretic way. Since state-transition dualists accept another way for concrete objects to persist, i.e. persistence as transition, they have to end up with accepting two different ways of persistence, contrary to their claim that persistence should not be connected with location but transition.

If we think the fourth dimension is not time, S is a concrete 4-D space any sub-region of which is *a*temporal in that the concept of temporality cannot be applied. In this case, we face the problem of accepting atemporal-non-causal concreteness. Consider two things in S, the dropping a vase at a 4-D region r_1 and the breaking of the vase at another region r_2. First, they cannot be *events* because S is atemporal and so they are not located at times

(or spatiotemporal regions). That is, S has property instantiations but does not includes any events. Second, since S is atemporal and there is no event within S, there is no causation holding between events such as the dropping a vase at r_1 and the breaking of the vase at r_2. There will be some relations or connections between them, but causation is not included in these relations. Therefore, we have to accept the following implausible consequence that any objects or things in S are concrete but lacks spatiotemporal locations and causal efficiency.

Transition Monism

Transition monists think transition is the fundamental concrete reality and all the other concrete realities are understood in terms of transition. In other words, they think transition is fundamental but this does not rule out other concrete realities such as a balloon, although they are not fundamental but non-fundamental. According to transition monists, transition is concrete because it does involve *irreducible change*. That is, transition monists accepts the following concrete/abstract definition:

> Something is concrete (abstract) iff it cannot (can) be separated from, or is (is not) intrinsically connected with transition, i.e. irreducible change.[16]

If we accept this concrete/abstract distinction and understand concrete reality in terms of transition, how should we understand a transiting object O and 4-D space S through which it transits?

If we think other concrete realities are understood in terms of transition, something, say a balloon B, is concrete but its concreteness is only derived from or depends on the involvement in transition. Here, we try to explain the concreteness of B *relationally* in terms of the involvement in transition that is concrete in itself. As a first approximation, the definition is that

[16]See (Barker, unpublished, Ch.3).

there is a concrete balloon B when something X transits through S. As we saw in Ch.6, if we think of X as B itself, the definition becomes circular, and if we think of X as not B but still something concrete, we face an infinite regress of explaining concreteness relationally. Therefore, if we want to avoid circularity and infinite regress, we have to think of X as abstract. Obviously, this also applies to 4-D space S. If there is a concrete 4-D space CS, its concrete nature is defined in terms of an abstract 4-D space and the involvement in transition.

The Transit Theory

If so, concrete reality in general is understood in terms of the transition of an *abstract* 3-D entity through an *abstract* 4-D space. However, if so, how can we understand a concrete object such as a balloon in terms of transition? We examined this question in terms of two different theories of objects, a concrete theory and an abstract theory of objects. A concrete theory (e.g., the substratum theory) explains concrete objects in terms of a concrete base (usually called a *bare particular*) with properties. An abstract theory (e.g. the bundle theory) explains concrete objects in terms of properties alone without any concrete base. As we also saw above, if concrete reality is understood in terms of transition, only an abstract theory of objects is acceptable.

Abstract theories of objects in general explain concrete objects in terms of abstract entities and a certain relation among them *without* any concrete base such as a bare particular. This certain relation among abstract entities plays the following metaphysical role: it makes them as a related whole concrete but leaves each abstract. Therefore, if we accept the idea of abstract theories in transition monism, we have an abstract theory that is different from the bundle theory: there is a concrete object when an abstract entity transits through 4-D space. In Ch.6, we called this abstract theory the *transit theory* of objects. We should not confuse this idea with the claim

that a concrete object is an abstract entity itself. In the transit theory, a concrete object is not an abstract entity itself. Rather, the transit theorists say we have a concrete object when an abstract entity transits through 4-D space, just as the bundle theorists say we have a concrete object when properties are bundled. Here, the transition relation plays the metaphysical role above: the transition of an abstract entity S through 4-D space R is concrete, although S and R themselves are abstract. Of course, this is because transition involves irreducible change but the abstract entity itself is defined without irreducible change.

Spatially Extended Structured Forms

If an abstract object transits through an abstract 4-D space, an abstract transiting entity must be *spatially extended*. As we saw in Ch.6, transition theorists think these transiting abstract entities are geometrical structures. We called these structures *structured forms*. They are geometrical but not purely geometrical because it also has non-spatial physical-field properties. We can explain structured forms with physical-field properties in the following way. Physical-field theorists in physics and transition theorists have something in common. In the former case, physicists have an abstract 4-D model or representation of how the our concrete universe develops. In this abstract model, there are physical fields such as an electromagnetic field each point within which has physical values assigned by certain equations (e.g., Maxwell's equations). In the latter case, transition theorists think of an abstract 4-D space in which there are physical fields including 4-D structured manifolds. Since physical values are assigned by certain equations to each point in the physical fields, each point within a 4-D manifold located in the fields also has physical values. Of course, these two theorists differ in understanding concrete reality. The critical difference is this: there is a dynamic process of transition in the latter but not in the former. For physicists, since their 4-D abstract spacetime is given as a representation of how our

concrete universe develops over time, this means the development process of our universe is a temporally extended 4-D entity. By contrast, for transition theorists, a 4-D abstract space including 4-D manifolds with physical values is not a representation of the concrete developmental process of our universe. There is nothing concrete represented by the 4-D abstract space. Rather, concrete reality comes through the transition of a determinable form S through a 4-D manifold M.

When we understand there is a concrete balloon when a determinable form F transits through a 4-D manifold M, how should we think of F and M? When we look at a concrete object in a changing process, we can identify determinable and determinate features of the object. In Ch.6, we considered a balloon in the changing process of shrinking and expanding. In this process, a balloon changes its shape and size continuously. By observing this expanding and shrinking process of a balloon, we can identify some *determinable* features that remain constant throughout the change. These features are those that underlie the identity of the balloon throughout the change. A determinable form F, what we called a *balloon-form*, is the abstract summation of these features that remain constant throughout the change. In addition to these determinable features, we can also identify some features that do not remain constant through the change. For example, a balloon is round for some duration during the change but is not always round. Therefore, a round-balloon-form is the abstract summation of these features that only remain constant through some section of the process. In the same way, an oval-balloon form is the abstract summation of those features that only remain constant through another section of the process. These round-balloon form and oval-balloon form are determinates of a determinable balloon form.

The Transition of F through M

We can understand the transition of a determinable F through a 4-D manifold M based on this determinable/determinate distinction. First, we put determinate balloon-forms with determinate shapes and sizes in a certain order in a 4-D abstract space so that we have a spatially extended 4-D structured form, i.e. a 4-D manifold M as in Fig.8.11:

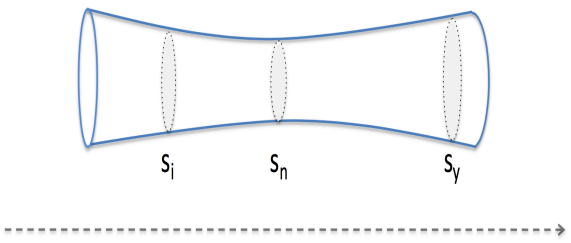


Fig. 8.11:

In Fig.8.11, each 3-D slice or hyperplane s_i of the spatially extended 4-D manifold M is a determinate balloon-form that has a determinate shape and a comparable size, although all the 3-D slices share a determinable balloon-form. The next step is to let a determinable ball-form F transit through a 4-D manifold M each hyperplane of which is a determinate of F as in Fig.8.12-13 below. Here, F can transit through M because M is the order of determinates of F. This is the idea of concrete objects such as a balloon in transition monism: there is a concrete balloon when a determinable ball-form F transits through a 4-D manifold M whose 3-D slices are determinates of F.

Property Possession and Intrinsic Change of Concrete Objects

As we saw in Ch.6, concrete objects' having properties is also understood in terms of transition. Suppose we can divide the 4-D manifold M in Fig.8.11 into three sections, M_1 (the first 1/3), M_2 (the second 1/3), and M_3 (the

last 1/3). Each 3-D slice of M_1 (M_3) is a determinate of a determinable, being round, because they have distinct round shapes. In other words, all the 3-D slices of M_1 (M_3) share a determinable, *being round*. We called this type of 4-D manifolds *round-type* 4-D manifolds. Also, each 3-D slice of M_2 is a determinate of a determinable of a determinable, being oval because they have distinct oval shapes. In other words, all the 3-D slices of M_2 share a determinable, being oval. We called this type of 4-D manifolds *oval-type* 4-D manifolds.

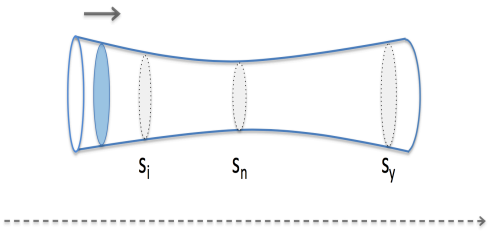


Fig. 8.12:

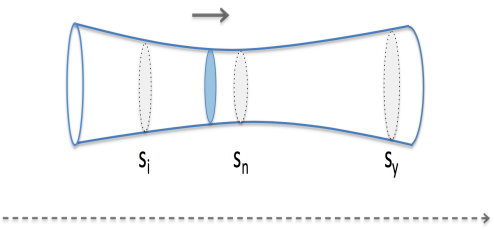


Fig. 8.13:

Then, we can understand a concrete round ball (a ball's having a round shape) as follows: there is a concrete round ball when a determinable ball form F transits through a round-type 4-D manifold. This is captured by Fig.8.12: there *is* a concrete round ball because F *is transiting* through M_1. This is closely connected with the intrinsic change of a concrete object. Consider a case where a concrete ball changes its shape from being round to being oval. This intrinsic change is understood in terms of transition as follows. Suppose that there *is* a concrete round ball (a concrete ball *now has* a round shape) because F *is transiting* through M_1 as in Fig.8.12. Here, there *will* be a concrete oval ball (a concrete ball *will* have an oval shape) because F *will* be transiting through M_2. In this way, the intrinsic change of a balloon is understood as the transition of F through M from M_1 to M_2.

A Fourth Dimension in Transition Monism

In Ch.7, we considered the basic difference in the metaphysical roles that dimensions play in the state-theoretic framework and the transition-monistic framework. In state theories, none of four dimensions play this metaphysical role of offering regions for something to *irreducibly* transit along them. That is, the fourth dimension offers temporal locations and the other three dimensions offer spatial locations for concrete objects to be located. By contrast, in transition monism, any of four dimensions play this metaphysical role of offering regions for a determinable form to irreducibly transit along them. Therefore, this metaphysical role itself is not peculiar to the fourth dimension because if the form irreducibly transits through 4-D space, it also irreducibly transits along the other three dimensions as well as the fourth dimension. However, there is something special about the fourth dimension in transition monism. What is special about it is that a transiting form is never at rest with respect to this fourth dimension and always in transit along the dimension (as long as a concrete object persists), although it can be at rest with respect to the other three dimensions.

Time in Transition Monism

If time is not a fourth dimension, how can we understand time in transition monism? We considered this question in Ch.7 in terms of temporal duration, the direction of time (the B-series time order), and tense.

What is the temporal duration of the shrinking and expanding of the balloon? Obviously, a four-dimensional extension itself cannot be a temporal duration simply because a fourth dimension is not time. Indeed, the 4-D manifold M located along the dimension of transit in Fig.8.11 tells us nothing temporal. Suppose that the shrinking and expansion process of a concrete balloon corresponds to the transition of a determinable balloon-form F through a 4-D manifold M as in Fig.8.12-3 above. If the concrete

process has a certain temporal duration, it is because F transits through M that has a certain length along the fourth dimension. In other words, what duration a concrete process has depends on the length of a 4-D manifold through which F transits. It should be noted that while the temporal duration of a concrete process depends on a length of M, the temporal duration itself is not the length of M.

How about tense in transition monism? Look at Fig.8.12 in which a determinable ball-form F *is now* transiting through a round-type 4-D manifold M_1, i.e. the first 1/3 section of M that includes s_i. In transition monism, this present continuous tense is primitive. In Fig.8.12, F *is now* transiting through M_1, and that's it. This present continuous tense is unexplained. What transition monists do is to explain past and future tense in terms of this present continuous tense and the direction of transition. For example, in Fig.8.12, F *is now* transiting toward M_2, F *will* be transiting through M_2. In Fig.8.13, F *is now* transiting away from M_1, F *was* transiting through M_1.

How can transition monists understand the direction of time (the B-series time order)? In this view, since a fourth dimension is not time, there is no temporal location. Therefore, unlike in the state-theoretic framework, there are no times (t_i) to which we can apply the temporal priority relation. In transition monism, the direction of time is understood in terms of the direction of transition. Consider the transition of F through M captured by Fig.8.12-3 again. Here, a balloon's having a round shape is earlier than the balloon's having an oval shape because F transits through M from M_1 to M_2. By contrast, suppose there is the same 4-D manifold M as in Fig.8.11, but if the transition of F through M had the opposite direction from M_2 to M_1. Then, the direction of time (or the B-series time order) is the other way round: a balloon's having an oval shape is earlier than the balloon's having a round shape.

Becoming as a Trans-temporal Relation

As we saw in Ch.8, transition monists partially agree with perdurantists and exdurantists who deny the tenseless identity between objects at different times. Nevertheless, they partially agree with endurantists who deny that persistence is about numerically distinct objects at different times. Transition monists think there is a tensed trans-temporal relation that is something in between, i.e. something neither numerical identity nor numerical distinctness: *becoming*. We considered the becoming relation between a round balloon (B_r) and an oval balloon (B_r). In transition monism, we have a round balloon when a balloon-form S_1 transits through a round-type 4-D manifold; we have an oval balloon when a balloon-form S_2 transits through an oval-type 4-D manifold. Then, a tensed becoming relation between B_r and B_o is given as follows:

B_r *has now become* B_o iff

(i) S_1 and S_2 are tenselessly identical with S.

(ii) S *was* transiting through M_1.

(iii) S *is now* transiting through M_2.

This is concrete reality captured by Fig.8.13: there *is now* a concrete oval balloon (B_o) because S *is now* transiting through M_2, and there *was* a concrete round balloon B_r because S *was* transiting through M_1. The becoming relation must be tensed in this way because a round balloon B_o is not tenselessly located at a region in 4-D space.

Coincidence in Transition Monism

We considered how transition monists understand the coincidence of Snowman and Snow in Ch.8. In transition monism, we have a snowman when a determinable snowman-form S_1 transits through a 4-D manifold M (each

3-D slice of which is a determinate of S_1). Also, we have a lump of snow when a determinable lump-form S_2 transits through a 4-D manifold M (each 3-D slice of which is a determinate of S_2). When we understand concrete objects in this way, the coincidence of two objects is understood as two determinables transiting together through the same 4-D manifold. Here, for two determinables to transit together means they are included in the same 3-D space and the space itself four-dimensionally transiting.

Based on this idea, the coincidence of Snowman and Snow is understood as follows. Consider concrete reality captured by Fig.8.14 below:

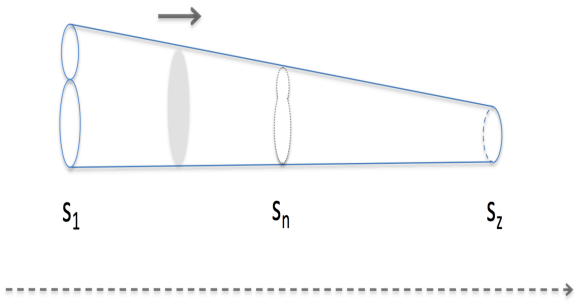


Fig. 8.14:

In Fig.8.14, two determinables (a snowman-form and a lump-form included in the same 3-D space) expressed by a gray oval are transiting together through the same segment M_1 (the first half of M). Two different determinables can transit through the same segment M_1 because M_1 is the order of structured forms each of which is a determinate of these two determinables. Here, we have the following tensed coincidence:

> Snowman and Snow *are now* coinciding iff a snowman-form and a lump-form *are now* transiting together through M_1.

As we saw above, since Snowman and Snow are different concrete objects because they are defined differently in terms of transition, we have non-identical coincidence in transition monism.

One-After-Another Process and Irreducible Transition

As we saw in Ch.3, any dynamic process in the state-theoretic framework faces the problems of infinite candidates and reduction. In this framework, any metaphysically fundamental dynamic process is at best conceptualized in terms of one-after-another succession. However, the problem of infinite candidates results from the combination of a dynamic one-after-another process with infinite divisibility; the problem of reduction results from the combination of a dynamic one-after-another process with finite divisibility. In Ch.8, we have shown that transition monism does not face these problems. While a dynamic process of transition as irreducible is finitely divisible, this does not pose the problem of reduction because transition itself is still continuously happening.

We considered why this is possible with an example of an athlete A's running a marathon course M. Suppose an athlete A is continuously transiting (running) through M that is finitely divisible into subsections with 10 m. When A is transiting through a subsection M_1, unlike one-after-another processes, the running of A through M_1 does not happen all at once because A has to continuously run through M_1 from 0 m to 10 m. If A finishes running through M_1 then seamlessly starts to run through M_2 because A is continuously running through a marathon course M. No one would want to say that since a marathon course M through which A is running is divided into subsections, the running of the athlete through each subsection M_i occurs discretely. For we actually see an athlete continuously running through these subsections. While the finite divisibility of a marathon course through which A is continuously running allows us to look at the continuous running of R through M in a more focused way, it does not make A's running a marathon itself discrete. Here, what irreducible transition has but one-after-another processes lack is a non-locatable runner A that continuously transits through non-zero distance. This continuously transiting

non-locatable runner A is critical for rejecting that the finite divisibility of a marathon course M implies the discreteness of the running of R through M.

Concluding Remarks

As we saw in Ch.1-4, defending the idea of persistence as an irreducibly dynamic phenomenon cannot be something like offering a different ontology within the state-theoretic framework. Rather, it requires us to build a new alternative framework in which concrete reality itself is understood quite differently. This is because in the first framework, dynamic processes cannot be conceptualized without one-after-another succession. However, once we accept one-after-another succession, we face the problems of infinite candidates and reduction that are insoluble in this framework. If we want to think of irreducible dynamicity in a consistent way, we have to give up understanding concrete reality in terms of objects being located at or existing at times, i.e. states.

In Ch.5-8, we tried to build a new alternative framework, transition monism, in which concrete reality is understood quite differently in terms of transition. In transition monism, not only persistence but also concrete reality in general is understood in terms of transition. Since transition has as one of its characteristic features dynamicity, if transition is the fundamental concrete reality, dynamicity becomes a fundamental feature of concrete reality. This irreducible transition can avoid the problems of infinite candidates and reduction because this is not a one-after-another process in the state-theoretic framework. The critical difference is that irreducible transition has but one-after-another processes lack a non-locatable transiting entity that continuously irreducibly transits through non-zero distance.

In this dissertation, I have tried to defend the idea of persistence as an irreducibly dynamic phenomenon by offering the transition-theoretic frame-

work that is based on the flux-first view proposed by Stephen Barker.[17] It is better to state what is shared and what is the difference between the flux-first view and transition theories in this dissertation. In transition theories, we start from the idea of persistence as an irreducibly dynamic phenomenon and reach the claim that the transition of O through a 4-D manifold M is the fundamental concrete reality and a transiting O and M through which it transits are abstract, i.e. transition monism. In the flux-first view, Barker starts from the idea of non-reductionism about change (change is fundamental) and reaches the same claim that the transition of O through M is the fundamental concrete reality and a transiting O and M are abstract. Therefore, transition theorists start from a different place (i.e. persistence, not change) but reach the same goal: a transiting entity and 4-D space through which it transits are both abstract. In this sense, what I did in this dissertation is to offer the second route to the same claim to which the flux-first view offered the first route.

[17]Barker (unpublished).

Bibliography

Aoyama, Shinya and Stephen Barker (unpublisheda) "Anti-Humeans' Big Problem with Space-Time."

——— (unpublishedb) "Is Presentism Self-Refuting?".

——— (unpublishedc) "Is There Time for Powers Ontologists?".

Arntzenius, Frank (2000) "Are There Really Instantaneous Velocities?" *The Monist*, Vol. 83, No. 2, pp. 187–208.

Arthur, Richard T.W. (2006) "Minkowski Spacetime and the Dimensions of the Present," in Dieks, D. ed. *Philosophy and Foundations of Physics Vol.1: The Ontology of Spacetime*: Elsevier B.V. pp. 129–156.

Baker, Lynne Rudder (1997) "Why Constitution is Not Identity," *The Journal of Philosophy*, Vol. 94, No. 12, pp. 599-621.

——— (2007) *The Metaphysics of Everyday Life*: Cambridge University Press.

Bapteste, Eric and John Dupré (2013) "Towards a Processual Microbial Ontology," *Biology and Philosophy*, Vol. 28, No. 2, pp. 379–404.

Barker, Stephen (2013) "The Emperor's New Metaphysics of Powers," *Mind*, Vol. 122, No. 487, pp. 605–653.

Barker, Stephen and Phil Dowe (2003) "Paradoxes of Multi-location," *Analysis*, Vol. 63, No. 2, pp. 106–114.

——— (2005) "Endurance is Paradoxical," *Analysis*, Vol. 65, No. 1, pp. 69–74.

——— (2007) "What is Endurance?" in Kanzian, Christian ed. *Persistence*: Ontos Verlag, pp. 5–18.

Barker, Stephen (unpublished) *Heraclitus's Dream – A Metaphysics of Transit for a Metaphysically Dynamic Universe –*.

Bird, Alexander (2007a) *Nature's Metaphysics: Laws and Properties*: Oxford University Press.

——— (2007b) "The Regress of Pure Powers?" *Philosophical Quarterly*, Vol. 57, No. 229, pp. 513–534.

——— (2013) "Limitations of Power," in Groff, Ruth and John Greco eds. *Powers and Capacities in Philosophy: The New Aristotelianism*: Routledge, pp. 102–142.

Black, Robert (2000) "Against Quidditism," *Australasian Journal of Philosophy*, Vol. 78, No. 1, pp. 87–104.

Block, Ned (1978) "Troubles with Functionalism," in *Consciousness, Function, and Representation*: The MIT Press, pp. 63–102.

Borghini, Andrea and Neil E. Williams (2008) "A Dispositional Theory of Possibility," *Dialectica*, Vol. 62, No. 1, pp. 21–41.

Bourne, Craig (2002) "When Am I? A Tense Time for Some Tense Theorists?" *Australasian Journal of Philosophy*, Vol. 80, No. 3, pp. 359–371.

——— (2007) *A Future for Presentism*: Oxford University Press.

Braddon-Mitchell, David (2004) "How Do We Know It Is Now Now?" *Analysis*, Vol. 64, No. 3, pp. 199–203.

Briggs, Rachael and Graeme A. Forbes (2012) "The Real Truth about the Unreal Future," *Oxford Studies in Metaphysics*, Vol. 7, pp. 257–304.

Broad, C. D. (1923) *Scientific Thought*: London: Kegan Paul.

Brogaard, Berit (2000) "Presentist Four-Dimentionalism," *The Monist*, Vol. 83, No. 3, pp. 341–356.

——— (2012) *Transient Truths*: Oxford University Press.

Brogaard, Berit and Kristian Marlow (2013) "Is the Relativity of Simultaneity a Temporal Illusion?" *Analysis*, Vol. 73, No. 4, pp. 635–642.

Burke, Michael B. (1994) "Preserving the Principle of One Object to a Place: A Novel Account of the Relations Among Objects, Sorts, Sortals, and Persistence Conditions," *Philosophy and Phenomenological Research*, Vol. 54, No. 3, pp. 591–624.

Button, Tim (2006) "There's No Time Like the Present," *Analysis*, Vol. 66, No. 2, pp. 130–135.

——— (2007) "Every Now and Then, No-Futurism Faces no Sceptical Problems," *Analysis*, Vol. 67, No. 4, pp. 325–332.

Callender, Craig (2011) "Thermodynamic Asymmetry in Time," in Zalta, Edward N. ed. *Stanford Encyclopedia of Philosophy*.

Cameron, Ross (2011) "Truthmaking for Presentists," *Oxford Studies in Metaphysics*, Vol. 6, pp. 55–100.

Campbell, Richard (2009) "A Process-Based Model for an Interactive Ontology," *Synthese*, Vol. 166, No. 3, pp. 453–77.

Casati, Roberto and Achille C. Varzi (1999) *Parts and Places. The Structures of Spatial Representation*: The Mit Press.

Connolly, Niall (2015) "Yes: Bare Particulars!," *Philosophical Studies*, Vol. 172, No. 5, pp. 1355–1370.

Crisp, Thomas M. (2003) "Presentism," in Loux, Michael J. and Dean W. Zimmerman eds. *The Oxford Handbook of Metaphysics*: Oxford University Press, pp. 211–245.

——— (2004) "On Presentism and Triviality," *Oxford Studies in Metaphysics*, Vol. 1, pp. 15–20.

Crisp, Thomas M. and Donald P. Smith (2005) "'Wholly Present' Defined," *Philosophy and Phenomenological Research*, Vol. 71, No. 2, pp. 318–344.

Deasy, Daniel (2015) "The Moving Spotlight Theory," *Philosophical Studies*, Vol. 172, No. 8, pp. 2073–2089.

Della Rocca, Michael (2011) "Primitive Persistence and the Impasse between Three-Dimensionalism and Four-Dimensionalism," *Journal of Philosophy*, Vol. 108, No. 11, pp. 591–616.

Diekemper, Joseph (2013) "The Existence of the Past," *Synthese*, Vol. 191, No. 6, pp. 1085–1104.

Dieks, Dennis (2006) "Becoming, Relativity and Locality," in Dieks, D. ed. *Philosophy and Foundations of Physics Vol.1: The Ontology of Spacetime*: Elsevier B.V. pp. 157–176.

Dolev, Yuval (2006) "How to Square a Non-Localized Present with Special Relativity," in Dieks, D. ed. *Philosophy and Foundations of Physics Vol.1: The Ontology of Spacetime*: Elsevier B.V. pp. 177–190.

Dorato, Mauro (2006) "The Irrelevance of the Presentism/Eternalist Debate for the Ontology of Minkowski Spacetime," in Dieks, D. ed. *Philosophy and Foundations of Physics Vol.1: The Ontology of Spacetime*: Elsevier B.V. pp. 93–109.

Earman, John (2008) "Reassessing the Prospects for a Growing Block Model of the Universe," *International Studies in the Philosophy of Science*, Vol. 22, No. 2, pp. 135–164.

Ellis, Brian (2001) *Scientific Essentialism*: Cambridge University Press.

——— (2012) "The Categorical Dimensions of the Causal Powers," in Bird, Alexander, Brian Ellis, and Howard Sankey eds. *Properties, Powers and Structures: Issues in the Metaphysics of Realism*: Routledge.

——— (2014) *The Philosophy of Nature: A Guide to the New Essentialism*: Routledge.

Esfeld, Michael (2010) "Humean Metaphysics Versus a Metaphysics of Powers," in Ernst, Gerhard and Andreas Hüttemann eds. *Time, Chance and Reduction: Philosophical Aspects of Statistical Mechanics*: Cambridge University Press, pp. 119-135.

Fine, Kit (2005) *Modality and Tense: philosophical papers*: Oxford: Clarendon Press.

——— (2006) "In Defense of Three-Dimensionalism," *Journal of Philosophy*, Vol. 103, No. 12, pp. 699–714.

Fiocco, M. Oreste (2007) "A Defense of Transient Presentism," *American Philosophical Quarterly*, Vol. 44, No. 3, pp. 191–212.

Forrest, Peter (2004) "The Real but Dead Past: a Reply to Braddon-Mitchell," *Analysis*, Vol. 64, No. 4, pp. 358–362.

——— (2006) "General Facts, Physical Necessity, and the Metaphysics of Time," *Oxford Studies in Metaphysics*, Vol. 2, pp. 137–152.

Funkhouser, Eric (2006) "The Determinable-Determinate Relation," *Noûs*, Vol. 40, No. 3, pp. 548–569.

Gallois, André (1998) *Occasions of Identity: A Study in the Metaphysics of Persistence, Change, and Sameness*: Clarendon Press: Oxford.

Geach, P. T. (1967) "Identity," *Review of Metaphysics*, Vol. 21, No. 1, pp. 3–12.

Gibbard, Allan (1975) "Contingent Identity," *Journal of Philosophical Logic*, Vol. 4, pp. 187–221.

Gołosz, Jerezy (2013) "Presentism, Eternalism, and the Triviality Problem," *Logic and Logical Philosophy*, Vol. 22, pp. 45–61.

Goswick, Dana Lynne (2013) "Change and Identity Over Time," in Dyke, Heather and Adrian Bardon eds. *A Companion to the Philosophy of Time*: Wiley-Blackwell, pp. 365–86.

Haslanger, Sally (2003) "Persistence Through Time," in Loux, M. J. and D. W. Zimmerman eds. *The Oxford HandBook of Metaphysics*: Oxford: Oxford University Press, pp. 315–354.

Hawley, Katherine (2001) *How Things Persist*: Oxford: Clarendon Press.

Hawthorne, John (2006) *Metaphysical Essays*: Oxford University Press.

Heathwood, Chris (2005) "The Real Price of the Dead Past: a Reply to Forrest and to Braddon-Mitchell," *Analysis*, Vol. 65, No. 3, pp. 249–251.

Heil, John (2003) "Multiply Realized Properties," in Walter, Sven and Heinz-Dieter Heckmann eds. *Physicalism and Mental Causation: The Metaphysics of Mind and Action*: Routledge, pp. 11–30.

Hestevold, H. Scott (2008) "Presentism: Through Thick and Thin," *Pacific Philosophical Quarterly*, Vol. 89, pp. 325–347.

Hestevold, H. Scott and William R. Carter (2002) "On Presentism, Endurance, and Change," *Canadian Journal of Philosophy*, Vol. 32, No. 4, pp. 491–510.

Ingram, David (2016) "The Virtues of Thisness Presentism," *Philosophical Studies*, Vol. 173, No. 11, pp. 2867–2888.

Ingthorsson, Rögnvaldur (2013) "Properties: Qualities, Powers, or Both?" *Dialectica*, Vol. 67, No. 1, pp. 55–80.

Jacobs, Jonathan D. (2010) "A Powers Theory of Modality: Or, How I Learned to Stop Worrying and Reject Possible Worlds," *Philosophical Studies*, Vol. 151, No. 2, pp. 227–248.

——— (2011) "Powerful Qualities, Not Pure Powers," *The Monist*, Vol. 94, No. 1, pp. 81–102.

Johnston, Mark (1987) "Is There a Problem About Persistence?" *Proceedings of the Aristotelian Society*, Vol. 61, pp. 107–135.

——— (1992) "Constitution is Not Identity," *Mind*, Vol. 101, No. 401, pp. 89–105.

Jubien, Michael (2007) "Analyzing Modality," *Oxford Studies in Metaphysics*, Vol. 3, pp. 99–139.

Katz, Jerrold J. (1998) *Realistic Rationalism*: Bradford.

Koons, Robert (2014) "Staunch VS. Faint-Hearted Hylomorphism: Toward an Aristotelian Account of Composition," *Res Philosophica*, Vol. 91, No. 2, pp. 151–177.

Lewis, David (1986a) *On the Plurality of Worlds*: Blackwell Publishing.

——— (1986b) *Philosophical papers Volume II*: New York Oxford: Oxford University Press.

——— (1972) "Psychophysical and theoretical identifications," *Australasian Journal of Philosophy*, Vol. 50, No. 3, pp. 249–258.

——— (1979) "Counterfactual Dependence and Time's Arrow," *Noûs*, Vol. 13, No. 4, pp. 455–476.

Lombard, Lawrence B. (2010) "Time for a Change : A Polemic Against the Presentism/Eternalism Debate," in Campbell, Joseph Keim, Michael O'Rourke, and Harry Silverstein eds. *Time and Identity*: Mit Press.

Lowe, E. Jonathan (2009) "Serious Endurantism and the Strong Unity of Human Persons," in Honnefelder, Ludger, Benedikt Schick, and Edmund Runggaldier eds. *Unity and Time in Metaphysics*: Walter de Gruyter Inc, pp. 67–82.

——— (2011) "How Not to Think of Powers," *The Monist*, Vol. 94, No. 1, pp. 19–33.

Ludlow, Peter (2004) "Presentism, Triviality, and the Varieties of Tensism," *Oxford Studies in Metaphysics*, Vol. 1, pp. 21–36.

Mackie, Penelope (2008) "Coincidence and Identity," *Royal Institute of Philosophy Supplement*, Vol. 83, No. 62, pp. 151–176.

Markosian, Ned (2004) "A Defence of Presentism," *Oxford Studies in Metaphysics*, Vol. 1, pp. 47–82.

Marmodoro, Anna (2013) "Aristotle's Hylomorphism Without Reconditioning," *Philosophical Inquiry*, Vol. 37, No. 1-2, pp. 5–22.

Martin, C.B (2007) *The Mind in Nature*: Oxford University Press.

Maudlin, Tim (2002) "Remarks on the Passing of Time," *Proceedings of the Aristotelian Society*, Vol. 102, pp. 259–274.

McCall, Storrs (1994) *A Model of the Universe*: Oxford: Clarendon Press.

McCall, Storrs and E. J. Lowe (2009) "The Definition of Endurance," *Analysis*, Vol. 69, No. 2, pp. 277–280.

Mellor, D. H. (1981) *Real Time*: Cambridge University Press.

——— (1998) *Real Time II*: Routledge.

Merricks, Trenton (1999) "Persistence, Parts, and Presentism," *NOÛS*, Vol. 33, No. 3, pp. 421–438.

——— (2006) "Goodbye Growing Block," *Oxford Studies in Metaphysics*, Vol. 2, pp. 103–110.

——— (2007) *Truth and Ontology*: Oxford University Press.

Moreland, James Porter (2013) "Exemplification and Constituent Realism: A Clarification and Modest Defense," *Axiomathes*, Vol. 23, No. 2, pp. 247–259.

Mozersky, M. Joshua (2011) "Presentism," in Callender, Craig ed. *The Oxford Handbook of the Philosophy of Time*: Oxford University Press, pp. 122–144.

Mumford, Stephen (2004) *Laws in Nature*: Routledge.

——— (2009) "Powers and Persistence," in Honnefelder, Ludger, Edmund Runggaldier, and Benedikt Schick eds. *Unity and Time in Metaphysics*: W. de Gruyter: Berlin, New York, pp. 223–236.

Mumford, Stephen and Rani Lill Anjum (2011) *Getting Causes from Powers*: Oxford University Press.

Myro, George (1997) "Identity and Time," in Rea, Michael C. ed. *Material Constitution*, pp. 148–172.

Noonan, Harold W. (1988) "Substance, Identity and Time," *Proceedings of the Aristotelian Society*, Vol. suppl. vol. 62, pp. 79–100.

——— (1993) "Constitution is Identity," *Mind*, Vol. 102, No. 405, pp. 133–146.

——— (2009) “Perdurance, Location and Classical Mereology,” *Analysis*, Vol. 69, No. 3, pp. 448–452.

——— (2013) “Presentism and Eternalism,” *Erkenntnis*, Vol. 78, No. 1, pp. 219–227.

Parsons, Josh (2007) “Theories of Location,” *Oxford Studies in Metaphysics*, Vol. 3, pp. 201–232.

Paul, L. A. (2002) “Logical Parts,” *Noûs*, Vol. 36, No. 4, pp. 578–596.

Price, Huw (1996) *Time’s Arrow & Archimedes’ Point: New Directions for the Physics of Time*: Oxford University Press.

Rea, Michael (2003) “Four-Dimensionalism,” in Loux, Michael J. and Dean W. Zimmerman eds. *The Oxford Handbook of Metaphysics*, Vol. 45: Oxford University Press, pp. 246–280.

——— (2011) “Hylomorphism Reconditioned,” *Philosophical Perspectives*, Vol. 25, No. 1, pp. 341–358.

Robb, David (2005) “Qualitative Unity and the Bundle Theory,” *The Monist*, Vol. 88, No. 4, pp. 466–92.

Sainsbury, R. M. (1988) “Tolerating Vagueness,” *Proceedings of the Aristotelian Society*, Vol. 89, No. n/a, pp. 33–48.

Savitt, Steven F. (2006) “Presentism and Eternalism in Perspective,” in Dieks, D. ed. *Philosophy and Foundations of Physics Vol.1: The Ontology of Spacetime*: Elsevier B.V. pp. 111–127.

——— (2009) “The Transient Nows,” in Myrvold, Wayne C. and Joy Christian eds. *Quantum Reality, Relativistic Causality, and Closing the Epistemic Circle*: Springer, pp. 349–362.

Seibt, Johanna (2004) “Free Process Theory: Towards a Typology of Occurrings,” *Axiomathes*, Vol. 14, No. 1-3, pp. 23–55.

——— (2008) “Beyond Endurance and Perdurance: Recurrent Dynamics,” in Kanzian, Christian ed. *Persistence*: Ontos, pp. 133–164.

——— (2009) “Forms of Emergent Interaction in General Process Theory,” *Synthese*, Vol. 166, No. 3, pp. 479–512.

——— (2010) “Particulars,” in Poli, Roberto and Johanna Seibt eds. *Theories and Applications of Ontology*: Springer, pp. 23–55.

——— (2015) “Aristotle’s ‘Completeness Test’ as Heuristics for an Account of Dynamicity,” in Petrov, V. and A. Scarfe eds. *Dynamic Being*: Cambridge Scholars, pp. 2–28.

Shoemaker, Sydney (2012) “Coincidence Through Thick and Thin,” *Oxford Studies in Metaphysics*, Vol. 7, pp. 227–253.

Sider, Theodore (2001) *Four-Dimensionalism*: Oxford: Clarendon Press.

——— (2006) “Bare Particulars,” *Philosophical Perspectives*, Vol. 20, No. 1, pp. 387–397.

——— (2011) *Writing the Book of the World*: Oxford University Press.

Simons, Peter (1994) “Particulars in Particular Clothing: Three Trope Theories of Substance,” *Philosophy and Phenomenological Research*, Vol. 54, No. 3, pp. 553–575.

——— (2013) “Continuant Causation, Fundamentality, and Freedom,” in Gibb, Sophie C. and Rögnvaldur Ingthorsson eds. *Mental Causation and Ontology*: Oxford University Press, pp. 233–247.

Simons, Peter M. (1987) *Parts: A Study in Ontology*: Oxford University Press.

Skow, Bradford (2009) “Relativity and the Moving Spotlight,” *The Journal of Philosophy*, Vol. 106, No. 12, pp. 666–678.

——— (2012) "Why Does Time Pass?" *Nous̑*, Vol. 46, No. 2, pp. 223–242.

Sullivan, Meghan (2012) "The Minimal A-Theory," *Philosophical Studies*, Vol. 158, No. 2, pp. 149–174.

——— (2016) "An A-Theory Without Tense Operators," *Canadian Journal of Philosophy*, Vol. 46, No. 4-5, pp. 735–758.

Tallant, Jonathan (2010) "A Sketch of a Presentist Theory of Passage," *Erkenntnis*, Vol. 73, No. 1, pp. 133–140.

——— (2011) "There's No Future in No-Futurism," *Erkenntnis*, Vol. 74, pp. 37–52.

——— (2014) "Defining Existence Presentism," *Erkenntnis*, Vol. 79, pp. 479–501.

Tooley, Michael (1997) *Time, Tense, and Causation*: Oxford: Clarendon Press.

van Inwagen, Peter (1990) "Four-Dimensional Objects," *Nous̑*, Vol. 42, No. 2, pp. 245–255.

Vetter, Barbara (2013) "'Can' Without Possible Worlds: Semantics for Anti-Humeans," *Philosophers' Imprint*, Vol. 13, No. 16.

——— (2014) "Dispositions Without Conditionals," *Mind*, Vol. 123, No. 489, pp. 129–156.

——— (2015) *Potentiality: From Dispositions to Modality*: Oxford University Press.

Whittle, Ann (2009) "Causal Nominalism," in Handfield, Toby ed. *Dispositions and Causes*: Oxford University Press, pp. 242–283.

Wiggins, David (1968) "On Being in the Same Place at the Same Time," *The Philosophical Review*, Vol. 77, No. 1, pp. 90–95.

——— (1980) *Sameness and Substance*: Basil Blackwell.

——— (2001) *Sameness and Substance Renewed*: Cambridge University Press.

Williamson, Timothy (1998) "Bare Possibilia," *Erkenntnis*, Vol. 48, pp. 257–273.

——— (2002) "Necessary Existents," in O'Hear, A. ed. *Logic, Thought, and Language*, Vol. 51: Cambridge University Press, pp. 269–87.

Wilson, Jessica (2009) "Determination, realization and mental causation," *Philosophical Studies*, Vol. 145, pp. 149–69.

Yablo, Stephen (1992) "Mental Causation," in *Thoughts: Papers on Mind, Meaning, and Modality*: Oxford University Press, pp. 222–248.

Zimmerman, Dean W. (2005) "The A-Theory of Time, the B-Theory of Time, and 'Taking Tense Seriously'," *Dialectica*, Vol. 59, No. 4, pp. 401–457.