

The Theory of Time as Relations

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To my genuine friends, who are killed
for their meat,
for their fur,
for fun and
for science.

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ABSTRACT

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The aim of this thesis is to analyze “The Problem of Change” and to investigate a possible solution that solves the problem. To achieve this end two rival analytical approaches, namely endurance theory and perdurance theory, are examined. It is concluded that both approaches cannot satisfactorily solve the problem because of different reasons. However endurance theory has a significant advantage, which is the ability to capture our intuitions better about change. Hence I attempted to construct a new account, namely “The Theory of Time as Relations.” This account treats time moments as relations. It maintains that a material object can have a property only by bearing a time-moment relation to that property. Then I compared it with the other solutions.

Finally, although time as relations account cannot solve the problem of change completely, it is argued that it was a fruitful account and open to become an accurate solution, at least, a support for an accurate solution.

KISA ÖZET

Bu tezin amacı "Değişim Problemi"ni çözümlmek ve problemin olası bir çözümlü araştırmaktır. Bu amaca ulaşmak için birbirlerine rakip olan iki analitik yaklaşım, "endurance teorisi" ve "perdurance teorisi" incelenmiştir. Bu iki yaklaşımın da farklı sebeplerden ötürü bir çözüm teşkil etmediği görülmüştür. Bununla birlikte "endurance" teorisinin önemli bir avantajı vardır: Söz konusu teori değişim hakkındaki sezgilerimiz ile daha uyumludur. Bundan ötürü "İlişkiler Olarak Zamanın Teorisi" isminde yeni bir yaklaşım geliştirmeye çalıştım. Bu yaklaşım, zaman sürelerini ilişkiler olarak ele almaktadır. Maddi bir nesne bir özelliğe ancak o özelliğe dair bir zaman-süresi ilişkisi taşıyarak sahip olabilir. Bunun ardından yaklaşımımı diğer çözümler ile kıyasladım.

Sonuç olarak, her ne kadar ilişkiler olarak zaman yaklaşımı değişim problemini tam olarak çözemese de verimli bir yaklaşım sunduğu ve daha hassas bir çözüme ya da böyle bir çözüm için destek teşkil etmeye açık olduğu öne sürülebilir.

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INTRODUCTION

This thesis will be on “The Problem of Change.” The problem of change is seen as a special kind of identity issue, namely identity through time. There are two main rival approaches to this problem to be referred respectively as “endurance theory” and “perdurant theory”.

In the first chapter, I will explain what the problem of change, or in other words identity through time, is. It is the only way to put the distinction between intrinsic properties and extrinsic properties in order to define the problem of change properly. Hence I will define the distinction between intrinsic properties and extrinsic properties, and demonstrate the philosophical significance with respect to the problem of change. Later I will present some well-known particular solutions in brief. The presentation of them will help us to understand the distinction between perdurant theory and endurance theory, which makes in the next chapter.

In the second chapter, I will investigate endurance theory vs. perdurant theory in order to find a criterion to distinguish endurance theory from perdurant theory. It will help to classify the particular solutions as a kind of endurance theory or perdurant theory. Lastly I will investigate each, and possible objections to each, including mine, to each, in detail. This investigation shows that none of the theories achieves to be perfectly an account for change.

In the third section, I will talk about Stage Theory, in last few years, which has become popular with the relation to the debate between endurance and

perdurant theory. Although it is not a solution of the problem of change, I will briefly talk about why it is not.

In the fourth chapter, I will attempt to construct a purely endurantist theory, namely “The Theory of Time as Relation.” To do this, firstly, I will explain my main motivation to attempt to construct such an account, which is endurantist. Then I will lay out the intuitive thought behind the idea upon which the theory is based. Later I will present the logical structure of the theory as.

Lastly, as the conclusion, I will argue that the problem of change does still survive. However the fundamental idea of endurance theory, which I will present, is fruitful. So I will claim that the theory of time as relation might be an alternative to the other endurantist theories by means of enquiring the differences and resemblances among them. Ultimately I will put the main difficulty, which endurance theory has to overcome.

CHAPTER I

THE PROBLEM OF CHANGE

In fact, The Problem of Change is an old philosophical issue, which roots back to Hindu Scripts circa 800 B.C. For instance, in Chandogya, which is one of the oldest primary Upanishads, it is uttered that it is impossible that being arises upon non-being.¹

This claim resembles Parmenides' argument that everything is, but nothing is not.² It is always an enigma how things remain the same while they qualitatively change. Parmenides prefers denying the change in order to save the being. On the other hand, Heraclitus argues that there are no persistent things in the world except change, i.e., in contrary to Parmenides' view, he denies the being in order to save change. The famous Latin word, *Ex nihilo nihil fit*, which means that nothing comes out of nothing, shows that the change is still a significant philosophical issue in Medieval Age.

This tension between being and change does not finish in modern philosophy. The problem of change, or identity through time, is a particular questioning of this old tension in analytical philosophy.

The problem of change can be expressed in various ways. As a simple way, in David Lewis' own words: "When they do, they have some of their intrinsic

¹ Swami Swahananda. *Chandogya Upanishad*. Available [online]: <http://www.geocities.com/advaitavedant/chandogya.htm>. [17 September 2006].

² Parmenides, *Way of Truth* (Princeton, N.J.: Princeton University Press, 1965)

properties temporarily. For instance shape: sometimes you sit, and then you are bent; sometimes you stand or lie, and then you are straight. How can one and the same thing have two contrary intrinsic properties? How does it help that it has them at different times?"³ Especially last two questions capture sharply to understand the problem in ordinary language.

In the same vein, Fraser MacBride formulates the problem of change in more analytical way by questioning the compatibility of the following propositions each of which is true:

1. An object exists at different times.
2. It has different properties at those times.⁴

The problem of change can be defined as how it is possible that there can be objects that satisfy simultaneously both of these two conditions.

Although these explanations are enough to understand the problem, at least as a starting point, I want to express it in a logical way in order to put the problem exactly. Thus we need to recognize a crucial distinction between numerical identity and qualitative identity.

Numerical Identity vs. Qualitative Identity

Numerical identity can be defined as the relation everything has to itself and to nothing else.⁵ However this definition is circular, because then "nothing else" must

³ David Lewis, "Tensing the Copula," *Mind* 111(2002): 1.

⁴ Fraser MacBride, "Four New Ways To Change Your Shape," *Australian Journal of Philosophy* 79 (2001): 81.

⁵ Harold Noonan. 15 December 2004. *SEP: Identity*. Available [online]: <http://plato.stanford.edu/entries/identity/>. [17 September 2006].

be defined in terms of numerical identity, e.g. “no numerically non-identical thing.” The other attempts seem not to be able to avoid circularity either.

Since it is not easy to give a definition without any circularity for numerical identity, it seems better to describe than to define it: If A and B are numerically identical, actually there is only one thing, not two things. On the other hand, qualitative identity is the relation between two things whose all properties are absolutely in common.

In the light of this distinction, change can be understood as being numerically identical but qualitatively non-identical.⁶ However, that is precisely the heart of the problem. According to “The Principle of the Indiscernibility of Identicals,” which is also called Leibniz’ Law:

$$\forall x \forall y (x = y \rightarrow (Fx \rightarrow Fy)).$$

This principle can be interpreted as saying that numerically identical things must also be qualitatively identical. Is this a genuine inconsistency, or if not, is there any way to remove this apparent inconsistency?

Intrinsic Properties vs. Extrinsic Properties

In order to understand identity through time conceptually, we need to introduce a significant distinction: Intrinsic Properties and Extrinsic Properties. There are various attempts in the literature to define intrinsic-ness but only a few of them succeed it.

⁶ Arda Denkel, *Reality & Meaning* (İstanbul: Boğaziçi University Press, 1995), 58.

One of the Davis Lewis' well-worn criteria to distinguish intrinsic properties from extrinsic properties is based upon the duplication of the objects. He says "... two things are duplicates iff (1) they have exactly the same perfectly natural properties, and (2) their parts can be put into correspondence in such a way that, corresponding parts have exactly the same perfectly natural properties, and stand in the same perfectly natural relations."⁷ The word "natural properties" in the quote refers that being non-disjunctive.⁸ He asserts, "If something has an intrinsic property, then so does any perfect duplicate of that thing; whereas duplicates situated in different surroundings will differ in their extrinsic properties."⁹ He gives not only this necessary condition but also sufficient condition for being intrinsic properties: he claims that any property with respect to which duplicates never differ is intrinsic.¹⁰ However although the property *having a duplicate* is surely extrinsic, it cannot be differed with respect to duplicates, i.e. it is intrinsic according to Lewis' criterion. Furthermore there are some debates about whether such a definition of intrinsic properties is circular.

As another attempt, Jaegwon Kim maintains that an intrinsic property is a property that could be had by something that does not coexist with any other object distinct from itself.¹¹ It entails that a property is intrinsic if and only if every object can have it when there are no other objects in the world. *Being alone in the world* satisfies the condition, but it is still extrinsic.

Stephen Yablo's description is more successful. He says "You know what an intrinsic property is: it's a property that a thing has (or lacks) regardless of what may

⁷ David Lewis, *On the Plurality of Worlds* (New York: Basil Blackwell, 1986): 61.

⁸ *Ibid.*

⁹ David Lewis, "Extrinsic Properties," *Philosophical Studies* 44 (1983): 197-200.

¹⁰ David Lewis, *On the Plurality of Worlds* (New York: Basil Blackwell, 1986): 62.

¹¹ Jaegwon Kim, "Psychophysical Supervenience," *Philosophical Studies* 41 (1982): 51-70.

be going on outside itself.”¹² In the same vein, David Lewis’ another description is similar: “A thing has its intrinsic properties in virtue of the way that thing itself, and nothing else, is.”¹³

In other words, when a thing has an extrinsic property than that object needs to coexist with, at least, one other thing. In the light of this explanation, it is easy to see that “being married” is an extrinsic property. Since, a person cannot be married (or single) regardless of the existence (or non-existence) of a second person. On the other hand “having 10g mass” is one of the simplest examples of intrinsic properties. Because “having 10g mass” is about nothing except the object, which has that property. As another example, shape seems to give rise to intrinsic properties. For, according to Gauss’ Theorema Egregium, curvature of a continuous surface can be determined independently from the three dimensional space in which it is embedded.

Now, let us try to make an intuitive definition of change: a change consists of an object’s losing the property it has. Thus, it is an alteration in an object from having a property to not having it.

Let us see a well-known example in order to recognize the importance of the distinction between intrinsic properties and extrinsic properties. After Socrates had died, his wife Xanthippe became a widow. When we focus on Socrates’ death, we realize that it affects both Socrates and Xanthippe: it makes Socrates from not having the property of deadness to having it, and Xanthippe from not having the property of widowhood to having it. It is obvious that this event causes a change in Socrates because of gaining a property of deadness. Yet although also Xanthippe gains a property, widowhood, it is intuitively clear that there is no “real” change in Xanthippe.

¹² Stephen Yablo. December 1998. *Intrinsicness*. Available [online]: <http://www.mit.edu/%7Eyablo/intrinsicness.html>. [17 September 2006].

¹³ David Lewis, “Extrinsic Properties,” *Philosophical Studies* 44 (1983): 197-200.

This is incompatible with our definition of change since, according to our definition, if a thing, e.g. Xanthippe, lose one of its properties, it entails that there is a change in that thing. The why do we reach a controversial position? For the definition is not complete; it has the necessary condition but not the sufficient one. This is a point at which the significance of the intrinsic-extrinsic distinction arises. We can talk about a real change in an object only if altering property is intrinsic. The other changes are called ‘mere Cambridge’ change by P. T. Geach. Therefore, we may say identity through time is a problem about temporary intrinsic change, and deals only with “real” changes.

Particular Solutions

Every statement can be in principle paraphrased as a combination of sub-statements of the subject-predicate form, that is ‘a is F’. The form of an atomic temporal statement is ‘a is F at t’. Then the question is how the latter can be captured in terms of the former, i.e., how a temporal sentence can be understood in terms of an atemporal one.

The statements “Descartes is straight at t_1 ” and “Descartes is bent at t_2 ” are unproblematic in our ordinary language. However there is a philosophical need to paraphrase them in terms of the subject-predicate form. To do this there are three simple ways, applying time element to either object, the copula, or property, and one relatively complicated way. Let us introduce these accounts separately.

The Theory of Time-Indexed Properties

According to this theory, the time element must be applied to properties, i.e., all properties are time indexical.¹⁴ Accordingly, to say, “Descartes is straight at t” in ordinary language is just to say, “Descartes is straight-at-t.” According to that view, there are properties like F-at-t₁, F-at-t₂, and so on.

Adverbialism (Instantiation as Relative to Times)

According to this view, the time element must be applied to the copula, i.e. An instantiation is relative to times.¹⁵ In other words, the way in which an object has a property must be characterized by means of time. This means that possessing a property is an adverbial matter. It follows, to say “Descartes is straight at t” in ordinary language is just to say “Descartes is-at- t straight” or “Descartes is t-ly straight” or more clearly “Descartes is straight in the t-way” Then there is no inconsistency between that Descartes is-t₁-ly straight and that Descartes is-t₂-ly bent.

The Theory of Temporal Parts:

According to this theory, the time element must be applied to object, i.e., there are some temporary intrinsic monadic properties,¹⁶ and it is not the case that instantiation is relative to times, but objects must be subdivided into temporal parts. Lewis says, “We are made up of temporal parts, and our temporary intrinsics are

¹⁴ Peter van Inwagen, *Ontology, Identity and Modality* (Cambridge: Cambridge University Press, 2001): 113.

¹⁵ Sally Haslanger, “Endurance and Temporary Intrinsics,” *Analysis* 49 (1989): 120.

¹⁶ We will see that the next particular solution denies all temporary intrinsic properties.

properties of these parts, wherein they differ one from another.”¹⁷ For instance, the claim that Descartes is straight at t just means, “Descartes-at- t is straight.” Thus, time is the index of an object and these indexed elements of the object are – temporal – parts of the whole object.

The Theory of Properties as Relation to Times:

This theory argues that intrinsic properties are not really monadic properties, but rather dyadic relations between objects and time.¹⁸ For instance, if Descartes is straight at t_1 and bent at t_2 , Descartes has *the relation straight-at* to t_1 and *the relation bent-at* to t_2 . The same object has two mutually exclusive relations however there is no problem because the relata of the relations are different. So it seems that such an account is a solution for the problem of change.

¹⁷ David Lewis, *On the Plurality of Worlds* (New York: Basil Blackwell, 1986): 204.

¹⁸ Peter van Inwagen, *Ontology, Identity and Modality* (Cambridge: Cambridge University Press, 2001): 113.

CHAPTER III

ENDURANCE THEORY vs. PERDURANCE THEORY

In fact, all the solutions to the problem of change discussed above can be incorporated into two main theoretical approaches: endurance theory and perdurance theory.

Let us begin by presenting the main idea behind perdurance theory: All objects occupy space by having parts. I have legs in a region of space, and arms in a different region of space, etc... All my parts might have different properties, and those properties might be inconsistent. For instance, it might be that my legs are wet, and my arms are dry. However, this application of inconsistent properties to the same object gives rise to no logical problem.

Perdurance theorists make an analogy between space and time. They argue that objects have temporal-parts just like they have spatial parts.¹⁹ So if Descartes is straight at t_1 and bent at t_2 , this means that different temporal parts of Descartes have different properties, i.e., *the temporal part of Descartes in t_1 is straight and the temporal part of Descartes in t_2 is bent.*

It is clear that there is no contradiction in such an account. For, there is nothing that is both straight and bent. Two inconsistent properties are applied to two

¹⁹ Theodore Sider, *Four Dimensionalism* (New York: Oxford University Press, 2001): 2.

separate temporal part of the very same object. So it seems that the account solves the problem of change, at least *per se*.

The line between perdurance theory and endurance theory is usually drawn as a disagreement about whether objects have temporal parts or not. However, in fact perdurance theory implies exactly that objects are temporally extended.²⁰ It does not logically entail that objects have temporal parts. This is compatible with the analogy between space and time. Being spatially extended does not entail having spatial parts either. In both case, having parts is an empirical matter.²¹

Moreover many endurantists do not totally deny the possibility of temporal parts. They are ready to admit the possibility of instantaneous objects, which exists at a single moment. They are temporal parts of themselves. Then is the possibility of proper temporal parts inconsistent with endurantism? Let us recall well-known example, a lump of clay. It become a statue for a moment, and later keeps going to be a lump of clay. Then the statue turns a proper part of the lump. These thought experiments show, at least, that the denial of temporal parts is not sufficient in order to make a sharp distinction between endurance theory and perdurance theory.

On the other hand, the standard claim of the endurance theory is also not sharp enough: objects have three dimensions and persist through time by being “wholly” present whenever they exist. Since endurance theorists admit that objects might lose (or gain) some parts, what does *wholly* present exactly mean? Theodore Sider says, “What is it for x to be ‘wholly present’ at t ? The idea is presumably that every part of x exists at t . But every part at what time? For three dimensionalists,

²⁰ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 28.

²¹ Josh Parsons, “Must A Four-Dimensionalist Believe In Temporal Parts,” *Monist* 83 (2000): p.10

parthood relation is temporally relative, and so ‘every part of x exists at t ’ is incomplete since ‘part of’ is temporally unqualified.”²²

Hawley is aware of this obscurity too. She proposes a sharper and clearer definition: “an object endures if and only if

- (i) it exists at more than one moment
- (ii) and statements about what parts the object has must be made relative to some time or other.”²³

This definition is necessary and sufficient for distinguishing endurance theory from perdurance theory properly. Especially the second condition is crucial to understand the distinction and to eliminate the obscurity of the standard definition of endurance mentioned above. Second condition entails that atemporal talk about the parts of persisting objects is incomplete for endurance theory.

This formulation is based upon the claim that both perdurance theory and endurance theory can provide an atemporal description of persisting objects. This claim allows both theories to be formulated in the same linguistic framework in order to characterize the disagreement between them. Then three-dimensionalism needs further temporal qualification in order to demonstrate that the persisting object is not temporally extended. This is the foundation of the idea of the formulation.

Let us assume that I have a computer and I bought a display adapter two days ago. The atemporal proposition that *my computer has a display adapter* is complete for perdurance theory. Then the yesterday-temporal part of my computer is a part of my computer (“my computer” worm). If the display adapter (-worm) is the part of the yesterday-temporal part of my computer, then, according to transitivity of parthood, the proposition that *my computer has a display adapter* is true, else it is false,

²² Theodore Sider, *Four Dimensionalism* (New York: Oxford University Press, 2001): 64.

²³ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 27.

but in both cases complete. This shows that the theory of temporal parts is obviously a perdurance theory.

On the other hand, for the theory of endurance, the proposition that *my computer has a display adapter* is incomplete. Although it is not true that my computer has the display adapter in 2005, it is true that my computer has the display adapter now. Thus time reference is required for the truth-value of the proposition, that is, it is not possible to decide whether it is true or not without a time reference. This fact captures the common definition that enduring objects are wholly present whenever they exist. So, Adverbialism, the theory of time-indexed properties and the theory of properties as relation to times are endurance theories.

Objections to Perdurance Theory

There are some serious objections to perdurance theory. The best known and the most injurious one is the claim that four-dimensionalism²⁴ cannot account for change, for it implies there is no change. Actually, according to four-dimensionalism, there are temporal parts and they never change. However, four-dimensionalism can account for change: a persisting object consisting of temporal parts changes when it has a sequence of different temporal parts. So change is defined by not an alteration of temporal parts but by the differences of the object's temporal extension.

Another objection is that the concept of temporal part-hood is inconsistent. Since a four-dimensional object is a – non-proper – temporal part of itself, it is

²⁴ Although four-dimensionalism is not necessarily perdurance theory, I will conventionally use them interchangeably hereafter.

obvious that temporal parts could occupy a time interval. Yet, can an instantaneous slice of an object be regarded as a temporal part?

It is not so easy to reject instantaneous slices as temporal parts. If a persisting object can have no instantaneous part, every temporal part of any persisting object must be four-dimensional. In ordinary speaking, we can talk about spherical objects, like a tennis ball. The property of being spherical can only be applied to three-dimensional objects. However if a persisting tennis ball and its temporal parts are four-dimensional, what is the property of being spherical?

This objection is tricky. Let us consider a book, especially a thin book. Although rectangularity is a property of two-dimensional “objects,” we say the book is rectangular. We know that there is no two-dimensional thing in our world. Then must we not utter properties that can be applied merely to two-dimensional objects whilst talking about something in our world. Of course, no. When we say that the book is rectangular, we do not mean that it is really rectangular, but it is rectangular when we ignore one of its dimensions. Furthermore, we may also say that every page of the book, each of which is a spatial part of the book, is also rectangular. So not only the whole but also its parts are rectangular. Since perdurance theory is based on the analogy between space and time, why do not we treat the same way to a tennis ball with respect to the property of being spherical?

Hawley has another objection that comes from a similar idea. Let us assume that our persisting tennis ball has a fixed mass of 100g. Let us divide it into two non-overlapping temporal parts. Hawley says that the mass of an object is the sum of the masses of all non-overlapping parts. Then, according to Hawley’s calculus, what is the weight of the persisting object, or what is the weight of its temporal parts? The problem can be overcome by the same way, ignoring the one dimension that is time.

It is very easy to construct a similar example in the three-dimensional world if we carelessly use the term non-overlapping as Hawley does. Is it true that the length of an object is the sum of the lengths of all non-overlapping parts? The answer is as problematic as Hawley's claim about mass. Let us consider a stick that is 10 meters long. When I divide it vertically, I may get two sticks each of which is 5 meters long. In contrast, if I divide it horizontally, I will get two sticks which are non-overlapping parts of the original stick, and each of which is 10 meters long.

It is not easier to say "yes" to the question whether an instantaneous slice of an object can be regarded as a temporal part. An instantaneous slice of a persisting object is surely three-dimensional. Yet, according to four-dimensionalism, all material objects have four dimensions. Therefore an instantaneous slice of a material object cannot be a material object. Even though, *prima facie*, this conclusion seems ambiguous, Van Inwagen's analysis of part-hood relation shows that there is no need to regard a "part" clearly as a material object.²⁵ So it is possible to say that instantaneous slices are temporal parts. But they must still be an object, because they have some properties and properties can be applied only to objects. Then what kind of objects are they?

Another objection comes from Zimmerman through an example. Let us suppose two qualitatively identical spheres made of completely homogenous material and contained no empty space. Let one of them be stationary, and the other rotate. Zimmerman maintains that these spheres at every instant, i.e. every temporal part for a particular instance, are the same. So four-dimensionalism cannot draw a distinction between the spheres one of which is stationary and the other is rotating.

²⁵ Peter Van Inwagen, *Material Objects* (New York: Cornell University Press, 1990): 18-19.

There is, however, a questionable aspect of the example:²⁶ Since rotation might cause a centrifugal force, it is not possible to suppose two qualitatively identical spheres one of which rotates and the other is stationary. If we shift the example to two spinning spheres rotating in opposite directions, the objection would be stronger. But such a shift is not sufficient either since centrifugal force is not a scalar but a vector magnitude, i.e., it has a direction. So the example of two spinning spheres rotating in opposite directions does not settle the issue.

But the existence of centrifugal forces is a contingent matter. It is not necessary that rotation causes centrifugal forces in all possible worlds. In other words, there can be some possible worlds in which rotation does not produce centrifugal force. In those worlds, the distinction is not possible. As commonly known, Ernest Mach asserts that there is a centrifugal force caused by the mass of celestial bodies while he tries to object Newton's Bucket Argument. It entails that no centrifugal force does occur in a possible world where there is one, only one, homogenous object. And this supports Zimmerman's objection.

There is one more example based on the same idea. Let us suppose two possible worlds, w_1 and w_2 in each of which there is just an infinite sequence of qualitatively indistinguishable objects with no space among them. Let the sequence in w_1 be absolutely static and the one in w_2 moving. One of the strong arguments against four-dimensionalism is that it cannot account for the difference between these two possible worlds. The proponents of this objection say that since the identity of an object through time is postulated, endurance theory does not encounter such a problem.

²⁶ Dean W. Zimmerman, "Temporal Parts and Supervenient Causation," *Australasian Journal of Philosophy* 76 (1998): 265-288.

Last two objections are very important because they show the adequacy of four-dimensionalism. Four-dimensionalism can give an account for processes only indirectly. So if there is a need to give an account for processes directly, it fails.

We can make a plausible analogy between the conception of an object in Four-dimensionalism and a film-tape. Every film-tape is constituted of successive film-slides, like the way in which, according to four-dimensionalism, every object (time-worm) is constituted of successive temporal parts. Can a process in two successive film-slides be directly recognized? No. We can recognize all processes by the difference of the successive slides, i.e., indirectly. So if there is a case that a process cannot be indirectly noticeable, i.e., a process which cannot be inferred by looking at the difference of slides, we cannot notice the process. Because a process does not exist on individual slides, it is only an inference from the succession of film-slides.

There are similar examples. For instance, *Zeno's Flying Arrow Argument* indicates that motion, which is a special kind of process, is illusory. Zeno's argument can be elucidated from a four-dimensionalist view. He begins his argument by the claim that the flying arrow is at rest at any given moment. In order to deny this claim, four-dimensionalism has to admit absolute velocity. Otherwise, the flying arrow at any given moment, i.e., any temporal part of the flying arrow, gives us no clue that it moves.

Therefore, we can say there are some cases for which four-dimensionalism fails to give a satisfactory account. Even though it may solve the problem of change, it risks to go against our common intuitions about processes.

Objections to Endurance Theory

According to the theory of indexed-properties, F-at- t_1 is a different property from F-at- t_2 . However, they cannot be completely different, since it is not a coincidence that both of them contain 'F'. We know that straight-at- t_1 resembles straight-at- t_2 in some respect. How does such a resemblance come about? Both might share a universal 'F' that can be applied to properties but not objects. How is it possible?

Mark Hinchliff says "Relativized properties are not properties, because a thing cannot just have them. So what are they? There are nothing new; they are relations in disguise."²⁷ So the power of indexed-properties account depends on the success of the relational theories.

With respect to adverbialism, Mark Johnston draws a supportive analogy between modal adverbs and temporal adverbs.²⁸ Descartes can be both actually straight and possibly bent, in that he is straight, but he *could have been* bent. Modal and temporal adverbs seem to dissolve the contradiction about the problem of change. Nevertheless Hawley argues that we need some further explanation to understand what it is about time that allows temporal modifiers to dissolve contradiction.²⁹

On the other hand, Haslanger says "The intuitive idea behind the so-called 'adverbial' option is that objects have properties at times, and that time should modify the 'having', rather than the subject or the property."³⁰ But David Lewis argues significantly that to have a property is not the same as bearing some relation

²⁷ Mark Hinchliff, "The puzzle of change," *Philosophical Perspectives* 10 (1987): 122.

²⁸ Mark Johnston, "Is there a Problem about Persistence," *Aristotelian-Society* 61 (1987): 107-135

²⁹ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 22.

³⁰ Sally Haslanger, "Endurance and Temporary Intrinsic," *Analysis* 49 (1989): 120.

to it. For, if there is a relation between an object and its properties, the object is alienated from them.³¹

In the beginning of his famous article, “Tensing the Copula,” David Lewis writes:

A solution to the problem of intrinsic change for enduring things should meet three conditions. It should not replace monadic intrinsic properties by relations. It should not replace the having *simpliciter* of properties by standing in some relation to them (unless having them *simpliciter* always means standing in some relation to them, which is refuted by Bradley’s regress). It should not rely on an unexplained notion of having an intrinsic property at a time. Johnston’s solution satisfies the first condition at the expense of the second. Haslenger’s solution satisfies the first and second at the expense of third.³²

He says he would be grant the talk of *having* relation to describe that something bears to a property. However he argues that these relations cannot explain having *simpliciter*. He invokes Bradley’s Regress in order to show that trying to explain having *simpliciter* in terms of relational having entails that the explanation we seek will never be finished.

Let P be a permanent, i.e. atemporal, property of X. Then,

X has P by having *bearing-having-to-P*

... by having *bearing-having-to-(bearing-having-to-P)*

... by having *bearing-having-to-(bearing-having-to-(bearing-having-to-P))*

... by ...

And so *ad infinitum*. Our explanations never end. The statements above are not explanations but only equivalences. In order to avoid deffering *ad infinitum*, we need

³¹ David Lewis, “Tensing the Copula,” *Mind* 111(2002): 5.

³² *Ibid.* p.1.

to stop the regress (we can do it anywhere we like), and have to admit that the having we use is a having *simpliciter*. It is a confession that relational having does not possess the explanatory power of having *simpliciter*.

On the other hand, Lewis objects the theory of properties as relation to times by maintaining that temporary properties, e.g. shape, are intrinsic properties, not relations. Katherine Hawley asserts that Lewis' objection fails. She admits that an object's shape is not a relation to any other material object, but it does not entail that an object's shape is not a relation to anything at all.³³ She suggests to suppose a possible world containing merely a banana, and nothing else including any time moments. Then, she maintains, it is not obvious what properties the banana would have.

The crucial question is whether such a relation (to times) is intrinsic or extrinsic. How can an intrinsic relation (to times) be distinguished from an extrinsic one? The answer depends on whether time is outside the objects or not. Because if time is something outside the objects, then objects that have relations (to times) do not have them regardless of what may be going on outside themselves. This entails that all relations (to times) are extrinsic.

Let us suppose that Descartes is straight at t_0 and bent at t_1 . Then Descartes has *the relation-straight-at* to t_0 and *the relation-bent-at* to t_1 . Since time is something outside Descartes, *the relation-straight-at* and *the relation-bent-at* are extrinsic. It follows that there can not be any "real" change, but we know intuitively, there is.

So the theory of properties as relation to times is committed to the counter-intuitive claim that time is not something outside the objects. How can it be

³³ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 17.

asserted? I think, it cannot. Could “The Relational Doctrine of Time” be basis of such an assertion? The Relational Doctrine of Time holds that time is no more than a set of temporal relations among some sequence of particulars.³⁴ Yet, at least, temporal relations are outside the objects also. So to argue that time is not something outside the objects does not seem possible either.

The main problem comes from *the theory of the bundle of properties*. This view holds that an object is no more than the bundle of some properties. Hawley says

The idea that an object must have some non-relational properties arises naturally from the belief that an object is composed of its properties, for it is hard to make sense of the idea that an object is composed of the relations it bears to other things, or of those relations plus a very limited intrinsic nature. ... those who are tempted by this view of objects have a good reason to reject this account of change.³⁵

³⁴ Clifford A. Hooker, “The Relational Doctrine of Space and Time,” *British Journal for the Philosophy of Science* 22 (1971): 113.

³⁵ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 19.

CHAPTER IV

STAGE THEORY

There is also one more significant theory about the philosophical issue of change, which is neither an endurance theory nor a perdurance theory. This is “Stage Theory,” which is developed by Theodore Sider. According to stage theory, there is nothing that is “wholly” present through time.³⁶ In this respect, stage theory differs from endurance theory. On the other hand, perdurance and stage theory share a commitment to the four- dimensional metaphysical framework. But they differ on what counts as the “real” object. According to perdurance theory, “real” Descartes is a worm constituted by temporal parts. In contrast, Sider maintains that Descartes in every time slice is really Descartes.

But Stage Theory does not solve the identity problem. There are no objects that exist in different times. Every object in instantaneous time-slices is different. In other words, it satisfies Hawley’s second criteria, but not the first. Therefore, Stage Theory cannot be a solution to the problem of change.³⁷

³⁶ Theodore Sider, *Four Dimensionalism* (New York: Oxford University Press, 2001): 193.

³⁷ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 46.

CHAPTER V

AN ENDURANTIST SUGGESTION: TIME AS RELATION

Neither the endurantist nor the perdurantist approaches are fully satisfactory. The first as opposed to the second captures our intuitions better. Haslanger expresses this motivation quite well:

Although the endurance theorist's resistance does not demonstrate that endurance is preferable to perdurance overall, it does offer a response to the charge that the endurist position is metaphysically untenable. That the position is tenable is significant, for it is the endurance theory which allows us to preserve the intuition that there are some objects which persist through a change in their intrinsic properties.³⁸

While saving this intuition, I do not think that there is no possibility to save the endurantism. I propose an alternative account of change through approaching time as relation to properties.

Let us use common sense: there is no way to imagine a world that has no time-flow but some change. Every change occurs by means of an event. Without the difference between just before the event and just after the event absolutely means the absence of change. Thus we have to be able to talk about before the event, and/or after the event, to be able to talk about a change. So time flow is required for change.

³⁸ Sally Haslanger, "Endurance and Temporary Intrinsic," *Analysis* 49 (1989): 125.

Additionally if we are going to talk about change in material objects, how can we imagine a change in an object without any time moment? Does not the definition of a material object necessarily require at least one time moment? So time moments are required for the being of material objects.

However it seems possible to suppose a world, or even a case, that has no change but some time-flow. We can easily imagine a world in which there is no change even though time flows, or proceeds, or continues. This imagination is based on the claim that time, or time-flow, is an objective matter, that is, independent from objects or/and change.

Katherine Hawley argues that it seems that space and time are real,³⁹ but it is not obvious that both of them have to be accepted as real. There is no sufficient argument for that the debate between Relational Theories and Absolutists Theories, or between substantivalism and Anti-substantivalism. For instance, it seems that The Theory of General Relativity denies the absolutism. On the other hand Hole Argument maintains that Manifold Substantivalism, which is a sort of substantivalism, is incompatible with determinism. This entails that determinism and manifold substantivalism cannot be saved together. This is some of the discussions which show that the debate is still alive.

So we can correctly say that objective time view is merely a suggestion. Relational Theories are as plausible as Absolutist Theories.

In physics, time is defined purely in terms of change. For instance, in modern physics, a second is defined in terms of the half-life of the caesium-133 atom. Halving of caesium-133 atom is a change affected least by circumstances. In the previous century a second was defined in terms of the revolution of the Earth around

³⁹ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 52.

the Sun, which is also a change. So in physics time is seen as a function of change, or/and vice versa, aside from whether it is or not. Then why do we not hold that time is a relation between objects and properties?

I met only one debate on “time as relation.” MacBride claims that “time as relation” theory incorporates substantial commitment such that there cannot be empty time. However he admits that “time as relation” theory can be a genuine alternative to the other theories of intrinsic change.⁴⁰

The theory of time as relation holds that time has no objective existence. A time moment is a two-place relation between objects and properties. Now, let us explain the account more thoroughly.

A two-place relation is defined over two non-empty sets independently of whether they are identical or not. For instance, the relation *being a wife of* is defined over the set of men and the set of women which are different. The relation *being older than* is defined over the set of humans and set of humans. Since they are identical, we simply say that it is defined over the set of humans.

Every non-empty subset of the Cartesian product of the sets in question is a two-place relation. (Since the Cartesian product of A with B is not necessarily the same as the Cartesian product of B with A, extension of the relations that can be defined over each product is not necessarily the same. So the direction of a relation could be important.) Hence if we want to define a relation from objects to properties, we need two sets over which the relation is defined.

Let O be the set of all material objects and P be the set of all properties. The set of Cartesian product of O with P consists of ordered pairs such as $\langle o, p \rangle$. Let us construct the class of all its subsets, i.e. the class of all relations that can be defined

⁴⁰ Fraser MacBride, “Four New Ways To Change Your Shape,” *Australian Journal of Philosophy* 79 (2001): 86.

over O and P. However some of these subsets contain some elements which may give raise to inconsistency. For instance, there is at least one set containing both $\langle \text{Descartes, straight} \rangle$ and $\langle \text{Descartes, bent} \rangle$ in the class. Let T be the subclass in which there is no such set. Every element of T is a possible relation over O and P. I suggest that every relation in T is a possible time-moment.

Let us recall our example: Descartes is straight at t_0 and bent at t_1 . Let us focus on two sets in T and call them t_0 and t_1 respectively.

$$t_0 = \{ \langle \text{Descartes, straight} \rangle, \langle \text{Descartes, humankind} \rangle, \langle \text{Leibniz, bent} \rangle \}$$

$$t_1 = \{ \langle \text{Descartes, bent} \rangle, \langle \text{Descartes, humankind} \rangle, \langle \text{Leibniz, bent} \rangle \}$$

We can easily see that Descartes has *the relation t_0* to straightness, that is, Descartes is straight at t_0 in ordinary language; and similarly that Descartes has *the relation t_1* to being bent, that is, Descartes is bent at t_1 in ordinary language. Descartes is related to two incompatible relata. Yet the relations between Descartes and the latter are different, *the relation t_1* and *the relation t_0* . So there is not the problem of change in this account.

We can regard the difference between t_1 and t_2 as the change of the world from t_0 to t_1 . If we compare the subsets of them respectively which contain only Descartes, we find the alteration of Descartes from t_0 to t_1 .

Then a possible world can be defined as a sequence of elements of T . Does this sequence require any rule or relation? In fact the sequence is arbitrary, but of course some of them, maybe all of them, has some rules. These rules can be held as the physical laws of the world.

Does this picture lead us to the acceptance of one of the time structures and to the denial of the rests? Time could be discrete, dense or continuous. In other words, the cardinal number of the set consisting of a passage of time could be finite,

numerable or continuum. Then our question is reduced to the question what the cardinal number of the sequence can be. It is clear that it can be finite or infinite (not only numerable but also continuum). So this picture is compatible with all of possible time structure views.

The first objection might be that time is a contingent matter; there are possible worlds which has some objects but no time. However in such possible worlds the thing that does not exist is time-flow, but not time. Every possible world has, let us say, t_0 . But if it has not also any other time-point, e.g. t_1 or t_2 , we are saying that the possible world has no time. So it could be argued that time is not a contingent matter, but time-flow is.

This picture allows Sydney Shoemaker's claim that there can be time passages that has no change.⁴¹ Since the sequence does not have to have the constraint that the sequence can have an element of T , that is a time moment, for only one times. Any possible world might be constructed by any number of any elements of T .

Davis Lewis says that extrinsic change poses no further problem after giving an account of the problem of temporary intrinsic change. "It is derivative: something undergoes extrinsic change when either it or some part of its surroundings undergoes intrinsic change, or when its intrinsic relations to parts of its surroundings change"⁴² Yet there are not only intrinsic properties but also intrinsic relations in our ordinary language.

⁴¹ Sydney Shoemaker, "Time Without Change," *Journal of Philosophy* 66 (1969): 363-381.

⁴² David Lewis, "Tensing the Copula," *Mind* 111(2002): 1.

CONCLUSION

The problem of change could be described how we can paraphrase the propositions whose forms are ‘a is F at t’ to the primitive predication form, i.e. ‘a is F’. There are two main replies to this problem: endurance theory and perdurance theory.

The perdurance theory is a theory that attempts to solve the problem by holding that objects, in fact, are temporally extended and have temporal parts like spatial parts. Since an object is the union of all its spatial parts, it is also the union of all temporal parts, which exist in successive instantaneous time-slices or in time passages. Then it smartly argues that temporary intrinsic properties are not applied to the object but rather to its temporal parts. Hence the problem of change vanishes. However the perdurance theory can give a neat object account at the expense of giving up a process-account since it cannot give an account for processes that cannot be described relationally.

On the other hand, the endurance theory denies that objects are temporally extended like spatially. It argues that an object can have only spatial parts. Then only one option remains: to give an account by a *relational way* by holding properties are relations, or instantiations are relations, etc. However such a way does not seem have a power to overcome Lewis’ strong objection, “alienation” claim. This is still the hardest issue that is front of the endurance theory.

Yet the endurance theory has a significant advantage from the perdurance theory: “It fits with our commonsense ideas about how things persist.”⁴³ I agree with this well-worn idea. Thus I have attempted to construct an endurantist account, the theory of time as relation. It is not completely different from the other endurance theories, especially adverbialism, but rather an alternative account that might contribute the debate against the perdurance theory.

Although I do not argue, at least for the time being, that it perfectly solves all of the problems that an account should, it still have some advantages from the other endurantist accounts. Its main advantage is not to commit ontologically a separate existence of time. It also preserves the existence of temporary monadic properties.⁴⁴ So I believe in that it is worth to pay attention.

The theory of time as relation resembles the theory of properties as relation to times in some respect. The theory of properties as relation to times holds that properties are relations and time is relatum, and the theory of time as relation holds vice versa. So both accounts deny that a material object can be predicated without time moment because of absence of relatum (for the theory of properties to times) or relation (for the theory of time as relation). However there are many differences between them. For instance, one of them allows the existence of time without any object, but the other does not. This difference might be overcome by regarding empty relation as a time moment, and adding it to T or by adding possible objects (*de re*) to O . Another difference is that one of them commits us to monadic properties, and the other does not. This difference makes the theory of properties inferior to the theory of time as relation.

⁴³ Katherine Hawley, *How Things Persist* (New York: Oxford University Press, 2001), 12.

⁴⁴ Notice that the theory of properties as relation to times does not deny all monadic properties, but rather does deny temporary monadic properties.

Let us return to Hawley's example about a world that contains merely a banana and nothing else, not even a single moment. He says that it is not obvious that the banana can still have some properties, like green-ness. If it cannot have, this is compatible with both the theory of properties as relations to times and the theory of time as relation. However, the former holds time as relatum, the latter holds property as relatum.

I believe in that the claim that objects are related to properties is not less persuasive than the claim that objects are related to times. If the banana, in the example, cannot be green, why is so, because of absence of relatum or of relation?

Let us recall that Descartes is straight at t_0 . If straight-ness is the relation from objects to times, the relation must be like $\{ \langle \text{Descartes}, t_0 \rangle, \langle \text{Descartes}, t_7 \rangle, \langle \text{Leibniz}, t_6 \rangle \dots \}$. On the other hand, if time moments are relations, there must be a relation like $\{ \langle \text{Descartes}, \text{straight-ness} \rangle, \langle \text{Descartes}, \text{crookedness} \rangle, \langle \text{Leibniz}, \text{wise-ness} \rangle \dots \}$. Second type of relations seem intuitively more comprehensible.

In fact, the theory of time as relation resembles fundamentally to Adverbialism. Neither of them denies monadic properties. Moreover both of them treat objects and properties as relata. Nevertheless adverbialism takes instantiation to be a relation and takes time to be another relatum whereas the theory of time as relation takes time to be a relation. So, according to adverbialism, that Descartes is straight at t_0 is just that Descartes has the three-place relation, say instantiation, to straightness and t_0 . However the proposition is interpreted that Descartes has the t_0 -relation to straightness by the theory of time as relation.

Both theory share the same strait since both theories does not have the ability to give having *simpliciter* account. As Lewis says, to have a property is not the same

as bearing some relation to it, because relation allows the alienation between the property and the object.

However adverbialism depends on the nature of instantiation, but time as relation account depends on the nature of time. Relations, properties or time moments, seem to serve a framework upon which the reality constitutes. I think time is a better framework for empirical reality.

I believe in that the time relation is fruitful account. It might be a good way to think on, for instance, whether it is imposed from out of ontology, i.e. ideology.

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