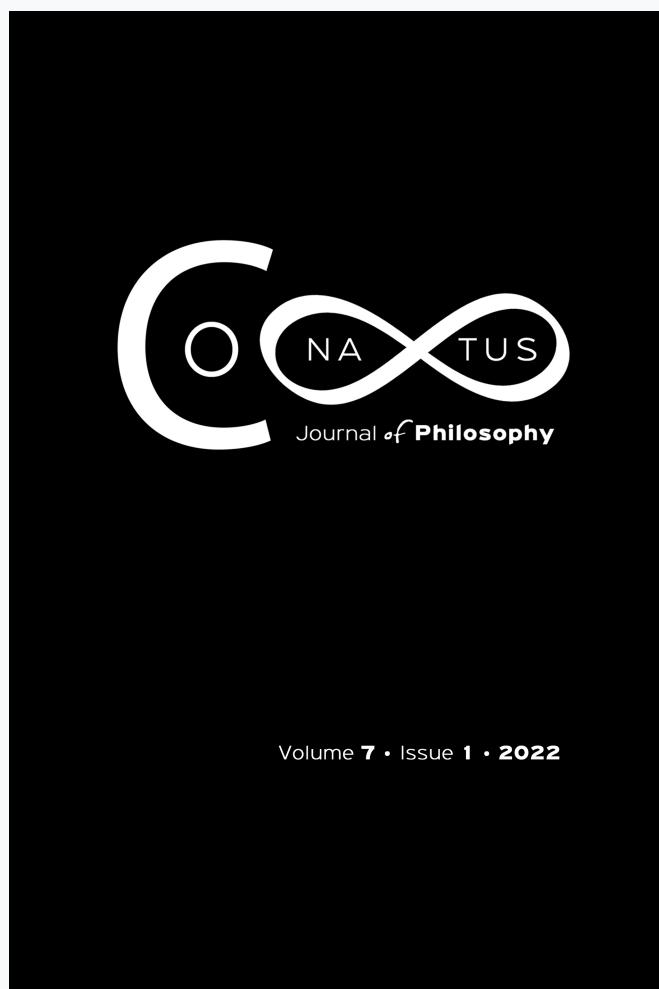


Conatus - Journal of Philosophy

Vol 7, No 1 (2022)

Conatus - Journal of Philosophy



The Persisting Problem of Persistence: A Call for an Alternative Theory

Omobola Olufunto Badejo

doi: [10.12681/cjp.24808](https://doi.org/10.12681/cjp.24808)

Copyright © 2022, Omobola Olufunto Badejo



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0](https://creativecommons.org/licenses/by-nc/4.0/).

To cite this article:

Badejo, O. O. (2022). The Persisting Problem of Persistence: A Call for an Alternative Theory. *Conatus - Journal of Philosophy*, 7(1), 9–31. <https://doi.org/10.12681/cjp.24808>

The Persisting Problem of Persistence: A Call for an Alternative Theory

Omobola Olufunto Badejo

Obafemi Awolowo University, Nigeria

E-mail address: olufunto@oauife.edu.ng

ORCID iD: <https://orcid.org/0000-0002-2537-3650>

Abstract

The question of how to characterise the diachronic identity of a concrete particular within a metaphysical framework is the problem of persistence. There are two major theories, Endurantism and Perdurantism affirming a problem of persistence for concrete particulars. While Endurantism, on the one hand, argues that concrete particulars persist wholly, Perdurantism, on the other hand, argues that they persist as temporal slices. This paper argues that neither Endurantism nor Perdurantism adequately characterise the persistence of concrete particulars. This is because there is an impasse between these two major theories of persistence. The article concludes that hence, there is a need for another hypothesis or theory of persistence to address the problem of persistence in metaphysics. This paper broadens the discourse on persistence of concrete objects beyond a debate between Endurantism and Perdurantism. The paper uses the methods of conceptual analysis and philosophical argumentation.

Keywords: persistence; endurantism; perdurantism; concrete particulars; metaphysics

I. Introduction

In metaphysics, the issue of persistence arises for concrete particulars such as persons, animals, plants, and other inanimate objects. Concrete particulars are objects, both animate and inanimate, that can come into existence and go out of existence. Hence, it excludes objects such as leptons, protons, and neutrons. They are objects that are temporally bounded and occupy space; they can come into existence at a particular time location and can go out of existence at another time location. During the period of their existence, they can go through changes and gain or loss properties without changing identity. They do not exist necessarily, because their non-

existence is possible.¹ The question then is “how can we characterise, within a metaphysical framework, the persistence of an object from one time location to another, without losing its identity?” If a concrete particularly persists in time and retains its identity, despite all changes, how do we characterise this ability to retain identity over time within a metaphysical framework? This paper argues that the major attempts towards addressing this within a metaphysical framework, so far leaves more questions than answers.

The contemporary discourse in the attempt to resolve or address the problem of persistence has been centred on two major theories: Perdurantism and Endurantism, with one competing for plausibility over the other. However, there are devastating defects of these theories, which suggest that none could offer an acceptable solution to the problem of persistence. This paper argues to establish these defects and asserts that rather than solve the problem, the existing theories of persistence are the reasons why the problem persists. To achieve this, the paper is divided into four parts. The first characterises the problem of persistence of concrete particulars within a metaphysical framework. The second outlines and critically examines the two major theories of persistence. The third defends the ontological status of the problem of persistence. While the fourth identifies the persistent problems with the two major theories of persistence, and argues that these theories, rather than solve the problem, had made the problem persistent. The concluding part of the paper calls for a search for an alternative theory of persistence that responds better to the question problem of persistence.

II. Problem of persistence in metaphysics

Thomas Reydon characterised the problem of persistence thus,

How does a given object remain in existence as numerically the same object for an extended period of time, even though its material composition and its observable properties may be different at different times? I am the same entity that I was a year ago, notwithstanding that in the meantime most of the cells in my body have been replaced by new ones and there have been some changes in the way I look, in my body mass, in what I believe to be true, in what I prefer and dislike, etc. But exactly how am I still the same?²

¹ Michael Loux, “Persistence through Time,” in *Metaphysics: A Contemporary Introduction*, eds. Michael Loux, and Dean Zimmerman (New York: Routledge, 2016), 85.

² Thomas Reydon, “Species in Three and Four Dimensions,” *Synthese* 164, no. 2 (2008): 161-162.

According to Sally Haslanger, the problem of persistence is "... whether (or how) something can gain or lose a property and persist through that gain or loss."³

Consider this example: I put a bunch of bananas on a table at time location T_1 ; at that time location T_1 , the bunch of bananas is green. At time location T_2 , I observe that the bunch of bananas that was green at T_1 is now yellow. I acknowledge the change in colour of the bunch of bananas between time location T_1 and time location T_2 , but I have no doubt that it is the same bunch of bananas. At time location T_3 , I notice that the bunch of yellow bananas is now black in colour.⁴ I acknowledge this difference between the bunch of bananas at time location T_2 and the bunch of bananas at time location T_3 , but I still agree that it is the same bunch of bananas. Simply put, the bunch of bananas persists through time locations T_1 to T_3 , experiences various degrees of changes in the course of persistence through these time locations, yet its identity is preserved.

The problem of persistence, given the example of the bunch of bananas, is how to justify the acknowledged sameness of the bunch of bananas at time location T_1 , time location T_2 , and time location T_3 , within a metaphysical framework. The bunch of bananas at different time locations has incompatible properties; at T_1 it is green, at T_2 it is yellow, and at T_3 it is black, yet it is assumed it is still the same bunch of bananas that persists from time location T_1 to time location T_3 . The problem of persistence is how it can be explained, within a metaphysical framework, that the bunch of bananas persists through time T_1 to time T_3 .

There are two major theories that respond to the problem of persistence within a metaphysical framework. These, according to Loux, are

endurantism and perdurantism. The endurantist claims that for a concrete particular to persist through time is for it to exist wholly and completely at different times. The perdurantist, by contrast, denies that it is possible for numerically one and the same concrete particular to exist at different times. On this view, a concrete particular is an aggregate or whole made up of different temporal parts, each existing at its own time; and for a particular to persist from one time to another is for it to have different temporal parts existing at those different times.⁵

³ Sally Haslanger, "Persistence, Change and Explanation," *An International Journal for Philosophy in the Analytic Tradition* 56, no. 1 (1989): 1.

⁴ Note that the notion of time in this study is the simple notion of time, except otherwise stated.

⁵ Loux, "The Nature of Time," 230.

The problem of persistence makes a distinction between two identities of an object numerical identity and diachronic identity. The identity of an object at a particular time location is the numerical identity of that object. While the identity of the object with itself at another time location is the diachronic identity.⁶ The diachronic identity of an object is the identity holding between an object at a particular time location and that same object at another time location. The problem of persistence in metaphysics is concerned with how to explain the diachronic identity of an object, and the relationship it has with its numerical identity. The problem of persistence presupposes that the numerical identity of an object is simple and unproblematic. However, the attempt to explain the diachronic identity of objects creates or raises problems.

III. Overview of Endurantism and Perdurantism

Endurantism is one of the major theories of persistence. It is also called ‘Endurantism,’ ‘Endurance theory’ or ‘three-dimensional theory.’ Endurantism has its ontological background in Eternalism. Eternalism states that time has three spatial dimensions: the past, the present, and the future. These three dimensions of time are real and objective, and none is more important than the other is.⁷ Hence, Endurantism’s response to the question of persistence is that objects endure wholly from one time location to another. In other words, objects extend in space, but not in time. For example, the bunch of bananas at different time locations that has incompatible properties persists wholly through time locations T_1 to T_3 . There is no point in time that the bunch of bananas is less than whole because of the obvious changes.

According to Endurantism, at each time location, objects are wholly present, not as slices, but the whole object. Hence, the diachronic identity of objects is the same as their numerical identities. According to Peter Simons, “At any time at which it exists, a continuant is wholly present,”⁸ and for Jiri Benovsky, Endurantism simply states that “...objects and people ... persist through time by being wholly present at all times at which they exist – they are thus multiply located at various times.”⁹

Perdurantism, also known as perdurance theory or four-dimensionalist theory, is the second theory of persistence. Perdurantism has its ontological background in Presentism. Presentism states that the past is gone, and the future is unknown, hence the only real and objective time is the present.

⁶ David Lewis, *On the Plurality of Worlds* (Oxford: Basil Blackwell, 1986), 204.

⁷ Harold Noonan, “Presentism and Eternalism,” *Erkenntnis* 78, no. 1 (2013). 219.

⁸ Peter Simons, *Parts: A Study in Ontology* (Oxford: Clarendon Press, 1987), 32.

⁹ Jiri Benovsky, “Endurance, Perdurance and Metaontology,” *SATS* 12, no. 2 (2011): 162.

The past may affect the present, and the future may shape the present, but both the past and the present dimensions of time are not objective.¹⁰ Hence, Unlike Endurantism that argues that objects persist through time as a whole, Perdurantism argues that objects persist through time by having different temporal parts at each time location. Perdurantism argues that objects persist as temporal time slices from one time location to another. Theodore Sider explains Perdurantism thus:

Persistence through time is like extension through space. A road has spatial parts in the sub regions of the region of space it occupies; likewise, an object that exists in time has temporal parts in the various sub regions of the total region of time it occupies. This view – known variously as four dimensionalism, the doctrine of temporal doctrine of temporal parts, and the theory that objects “perdure” – is opposed to “three dimensionalism”, the doctrine that things “endure”, or are “wholly present.”¹¹

To explain Perdurantism’s point, consider this example: If there is a bunch of bananas that is green at time location T_1 , the property ‘green,’ according to Perdurantism, is a temporal part. If at time location T_2 , the same bunch of bananas is yellow, according to Perdurantism, it is with a new temporal part, ‘property yellow.’ If at time location T_3 , the bunch of bananas is black, and then it has a new temporal part ‘black.’ In all of these, the bunch of bananas retains its identity despite changing its temporal parts as it persists through time. The temporal part of objects, according to Perdurantism, is the fourth dimension of objects. Hence, Perdurantism is also known as four-dimensional theory. This fourth dimension of an object, also known as the temporal part, extends in time and space.

In other words, the fourth dimension of an object has a strict trans-temporal identity. Hence, the diachronic identity of an object cannot be identical with the numerical identity of that object. Hence, the numerical identity of an object is identical with itself, but the diachronic identity is as numerous as the time slices the object has. The implication of this is that the bunch of bananas is identical to itself – numerical identity. However, the bunch of bananas at time location T_1 is different from the bunch of bananas at time location T_2 and different from the bunch of bananas at time location T_3 – diachronic identity.

Given the differences between these two major theories of persistence, the next task is to determine which of the two offers the response to the

¹⁰ Ned Markosian, “A Defence of Presentism,” in *Oxford Studies in Metaphysics: Volume 1*, ed. Dean Zimmerman (Oxford: Oxford University Press. 2004), 47.

¹¹ Ted Sider, “Four Dimensionalism,” *Philosophical Review* 106, no. 2 (1997): 197.

question of persistence. What are the strengths of Endurantism as a theory of persistence? First is that Endurantism appeals to the common sense or non-philosophical approach to the problem of persistence.¹² Simply put, Endurantism is an appealing theory of persistence because it conforms to common sense. A nonprofessional can easily understand and align with Endurantism. When I observe the bunch of bananas at time location T_1 , without any prior knowledge of philosophy, I believe I observe the whole bunch of bananas at time locations T_1 , T_2 and T_3 . Even though there may be some differences in the bunch of bananas at each time location, I still believe I observed the whole bunch of bananas.

The common-sense intuition is that the bunch of bananas exists wholly at every point or at different moments, with or without differences. This makes Endurantism simple to grasp. Moreover, the endurance thesis that objects exist wholly from one time location to another, employs restricted ontology as against loose ontology.¹³ The Endurantists thesis avoids creating entities unnecessarily by not introducing any new ontological entity into their thesis. Thus, avoiding the need of explaining the ontological status of another entity, aside the problem of persistence it already grapples with.

However, Endurantism is associated with a series of criticisms. One major objection to Endurantism is that it fails to explain how the numerical identity of an object is identical with its diachronic identity despite incompatible properties. If an object persists wholly from one time location to another, then it is right to say that its numerical identity is identical with its diachronic identity. This is the position of Endurantism. However, if the numerical identity of an object is identical with its diachronic identity, then the object at T_1 cannot have properties that are not there at T_2 or at T_3 ... Once there are different properties between an object at time location T_1 , and the object at T_2 and T_3 , then its numerical identity cannot be identical with its diachronic identity.

This is where the contradiction in the endurance thesis lies. Except the endurance thesis is amended to argue that although an object persists wholly from one time location to another, its numerical identity is not identical to its diachronic identity, the contradiction will subsist. Even if the endurance thesis is amended to argue that the numerical identity of an object is not identical with its diachronic identity, how can it be reconciled with the position of Endurantism that an object persists wholly from one time location to another

¹² Tomasz Bigaj, "Time and Temporal Objects," in *A Guided Tour for Beginners*, ed. Tomasz Bigaj (Chodakwosa: University of Warsaw Press, 2012), 60-93.

¹³ When a metaphysical theory is presented with reluctance to admit new entities into our ontology, the ontology is restricted. When a metaphysical theory is presented without inhibition in admitting new entities, the ontology is loose.

time location? If it persists wholly, then the object at each time location cannot have conflicting properties.

I will use an illustration from Jiri Benovsky to highlight and further explain this seeming contradiction.¹⁴ Cyrano has a big nose at time T_1 , but he craves a small nose. At time T_4 , Cyrano eventually summoned up courage to undergo cosmetic surgery to reduce the size of his nose. When Cyrano emerged with his desired small nose at time T_4 , he looked at himself in the mirror and saw how good his small nose looked; he really wished he had done it when he was younger. Cyrano then got a time machine that will enable him travel back in time. Cyrano travelled 10 years back to time T_1 and performed a surgery on Cyrano's nose at time T_1 . Let us assume that Cyrano at time T_1 exists in year 1990 and he had the surgery in year 2000. Cyrano before the time travel at time T_1 in year 1990 had a big nose, Cyrano at time T_1 after the cosmetic surgery under time travel had a small nose in the same year 1990.

According to Endurantism, Cyrano exists wholly, with or without changes, at each point of his existence. Hence, according to Endurantism, the diachronic identity of Cyrano at time T_1 in year 1990 before the cosmetic surgery is identical with his numerical identity at time T_1 in year 1990 after the cosmetic surgery. The consequence of this is that Cyrano at time T_1 in 1990 before the surgery is numerically identical with Cyrano at time T_1 after the surgery, both in 1990, but with contradicting properties. It follows that Endurantism aligns with the basic intuition on numerical sameness but fails to explain the metaphysical implication of diachronic identity of objects. Hence, although Cyrano is identical with himself, the numerical identity of Cyrano cannot be logically identical with his diachronic identity.

Endurantism can appeal to Derek Parfit's psychological criterion for identity to argue that what accounts for sameness in Cyrano is not the big nose or the small nose, but the direct psychological connections in Cyrano. According to Parfit, survival is not what accounts for identity but psychological continuity. In Parfit's school of thought, the justification for identity is psychological. In other words, consciousness or memory is necessary and sufficient for identity:

- (1) If there will be a single future person who will have enough of my brain to be psychologically continuous with me, that person will be me.
- (2) some future persons will neither be psychologically continuous with me, nor have enough of my brain, that person will not be me.¹⁵

¹⁴ Jiri Benovsky, "On (Not) Being in Two Places at the Same Time," *American Philosophical Quarterly* 46, no. 3 (2009): 239-248.

¹⁵ Derek Parfit, "People and Their Bodies," in *Contemporary Debates in Metaphysics*, eds. Theodore

Hence, once it can be determined that there is psychological connection and continuity between Cyrano at T_1 and Cyrano at T_2 , Cyrano at T_1 and Cyrano at T_2 are identical. The problem with Parfit's position is that persistence of objects is not restricted to animate concrete particulars but also inanimate concrete particulars; hence, psychological continuity cannot account for identity in animate objects. Even if we want to assume, for the purpose of argument, that Parfit's claim that survival cannot account for identity is correct, his position cannot account for persistence of inanimate objects.

Another major problem with Endurantism is, although it ought to be an account of change, it seems not to account for how changes occur in concrete objects during their persistence. This argument is from temporary intrinsics. The argument from temporary intrinsics states that Endurantism fails in giving a subsisting theory of change in objects in relation to the objects involved and nothing else.¹⁶ Objects have properties that are intrinsic, but change emerges or evolves from time to time. Hence, intrinsic properties are called temporal intrinsics because they evolve, change, or emerge over time. Maya Eddon characterises the problem of temporal intrinsics thus, “I am bent at one time and straight at another. However, I cannot be both bent and straight, since then I would instantiate contradictory properties. So, what underwrites this change?”¹⁷ According to Leibniz law, two objects, A and B, are identical if and only if A and B have exactly the same properties.

Back to the Benovsky's thought argument, if Cyrano before the nose surgery is identical to the Cyrano after the nose surgery, then it is the same Cyrano. Cyrano before the nose surgery has a big nose and Cyrano after the nose surgery has a small nose. According to Leibniz's law of indiscernibles, it follows that Cyrano after the nose surgery is not identical with Cyrano before the nose surgery because they do not have the same properties. How then can a theory of persistence reconcile the fact that the law of indiscernibles is true, yet objects persist through time and change properties while doing so? To avoid this problem, an account of persistence must argue and show how the change between Cyrano before the nose surgery and Cyrano after the nose surgery is both intrinsic and compatible. Hence, it will follow that Cyrano before the nose surgery and Cyrano after the nose surgery cannot be said to have different properties.

In this regard, Endurantism fails in giving a subsisting theory of change in objects in relation to the objects involved.¹⁸ Endurantism, to support the

¹⁶ Sider, John Hawthorne, and Dean Zimmerman (Malden: Blackwell Publishers, 2008), 177.

¹⁷ Lewis, *On the Plurality of Worlds*, 202-204.

¹⁸ Maya Eddon, “Three Arguments from Temporary Intrinsics,” *Philosophy & Phenomenological Research* 81, no. 1 (2010): 605.

¹⁸ Lewis, *On the Plurality of Worlds*, 202-204.

argument that objects change, yet persists wholly from one time location to another, argues that change is intrinsic, yet only relative to time and not the object.¹⁹ If a man Cyrano has a small nose at T_4 and a big nose at T_1 , it is obvious Cyrano has undergone some changes between these time locations. However, Endurantism insists that Cyrano persists wholly from time location T_1 to T_4 , albeit with contradicting properties. To defend this, Endurantism argues that change in objects is intrinsic, and is a two-place relation between time and objects. Hence, Cyrano has a small nose in relation to T_1 and a big nose in relation to T_4 . This will not in any way reduce the identity of Cyrano at any point in time but show that the change is time located. It will also not lead to any contradiction because of the time index difference. Hence, Cyrano persists wholly from T_1 to T_4 . For Endurantism change is ephemeral but should not affect the position that an object persists wholly from one time location to another.

However, according to scholars like David Lewis, an object goes through changes and a theory of persistence should be able to explain how that is possible within the object itself.²⁰ The problem with the endurance thesis is that without appealing to time, the change in objects cannot be explained. The changes occur within the objects, and ought to be explained not only in relation to something else, but also in relation to the object undergoing the change. In other words, change should be explainable with a timeless language. No matter how fleeting the change in an object is, a theory of persistence should be able to explain it largely within the object and not only outside it.

Another challenge identified with Endurantism is that it is argued, by some Perdurantists, that it fails to align with the basic scientific understanding of the world. Prior to Albert Einstein's theory of relativity, it was believed that space (in terms of spatial dimensions, for example x, y, z) is independent of time. However, the consequence of Einstein's special relativity is that space and time are interdependent and inseparable. That is, space is actually not independent of time; thus, whatever is true of space is equally true of time. Because it is assumed, the velocity of light is constant. Thus, when light travels through the vacuum of empty space, it synchronises with time.²¹ Perdurantists, then assume that because Albert Einstein demonstrates that space and time are dependent on each other and inseparable in determining the motion of

¹⁹ Benovsky, "Endurance, Perdurance and Metaontology," 163.

²⁰ Lewis, *On the Plurality of Worlds*, 4.

²¹ Tower Chen, and Zeon Chen, "Time Dilation and Length Contraction Shown in Three-Dimensional Space-Time Frames," *Concepts of Physics* 6, no. 2 (2009): 223; Albert Einstein, *Relativity and the Special and General Theory*, trans. Robert Lawson (New York: Henry Holt, 1920).

objects, it follows that space and time are analogous and whatever is true of space is also true of time. Hence, subsequently Endurantism does not align with the basic scientific understanding of the world.²²

It could be argued that the above criticism arises largely from a misconception of the special theory of relativity. That space and time depend on each other does not mean that they are analogous and what is true of one is true of the other. Moreover, as regards the problem of persistence, there is no sufficient evidence that an ontological inference can be drawn from just that aspect of the special theory of relativity, as some Perdurantists assume. Hence, there is insufficient evidence that Endurantism is inconsistent with the basic scientific understanding of the world.

However, given the challenges with Endurantism as a theory of persistence, the theory grapples with the problem of how an object persists wholly through changes, yet retains its identity without any contradiction. Moreover, Endurantism needs to account for change in its theory of persistence. Although Endurantism aligns with basic intuition, is simple to understand, and avoids inflating ontology unnecessarily, it is still faced with the challenge of how to explain persistence without any absurd consequence and how to account for change with its theory of persistence. This is the failure of Endurantism, and rather than solving the problem of persistence, it creates a further problem of persistence: If objects persist wholly, then how can the changes objects go through, as they persist in time, be accounted for? Perdurantism has been offered as an alternative theory of persistence to Endurantism. How far can Perdurantism go in addressing the problem of persistence?

IV. Perdurantism

With the denial that the diachronic identity of an object is identical to its numerical identity, Perdurantism avoids some problems connected with Endurantism. For the proponents of Perdurantism, there are various reasons why Perdurantism is preferable to Endurantism. For example, a typical Perdurantist, when confronted with Cyrano at T_1 and Cyrano at T_4 , will admit that Cyrano is identical with Cyrano. However, when confronted with the question of persistence, a Perdurantist will argue that Cyrano consists of different temporal slices at T_1 and at T_4 ; hence, Cyrano at T_1 cannot be identical with Cyrano at T_2 .²³ Any attempt to argue that Cyrano at T_1 is identical with Cyrano at T_2 , may lead into a contradiction, just as the time-travel thought experiment argues.²⁴

²² Steven Hales, and Timothy Johnson, "Endurantism, Perdurantism and Special Relativity," *The Philosophical Quarterly* 53, no. 213 (2003): 524.

²³ Bigaj, "Time and Temporal Objects," 91.

²⁴ Benovsky, "On (Not) Being in Two Places at the Same Time," 243-245.

Furthermore, some Perdurantists argue that their position fits into the current scientific understanding of the world. According to them, there is sufficient evidence that the physical world is governed by special relativity. Steven Hales and Timothy Johnson on the position that Perdurantism fits into the current scientific understanding of the world argue that:

Perdurantists hold that objects are four-dimensional, have temporal parts, and exist only partly at each moment of their existence. We argue that endurantism is poorly suited to describe the persistence of objects in a world governed by special relativity, and it can accommodate a relativistic world only at a high price not worth paying. Perdurantism, on the other hand, fits beautifully with our current scientific understanding of the world.²⁵

Perdurantism further argues that its thesis avoids the problem of intrinsic change that afflicts Endurantism. With the introduction of temporal parts and consequently a fourth dimension of an object, the contradiction that ensued from intrinsic change will not arise with the Perdurance theory. This is because the temporal part of an object is part of the object. Moreover, the temporal part accounts for change; hence, change occurs within the object and not in relation to anything outside the object.

At a first glance, it seems that Perdurantism avoids the major flaws of Endurantism, and answers questions Endurantism cannot answer. However, when examined critically, Perdurantism is plagued with just as many, if not more, flaws just as Endurantism. For example, Thomas Pashby argues that contrary to the claim of Perdurantism, it does not actually align with the scientific understanding of quantum mechanics.²⁶ This is because although Perdurantism argues that objects have temporal parts just as spatial parts, the mereological status of temporal parts is not well-defined (relationship with time). The understanding of quantum mechanics is that time and space are dependent, not analogous. Hence, what is true of temporal parts is not necessarily true of spatial parts.²⁷

The implication is that Perdurantism does not reflect that time and space are interdependent, but analogous, which is not the position of the theory of special relativity. Hence, the claim that Perdurantism aligns with the basic

²⁵ Hales, and Johnson, “Endurantism, Perdurantism and Special Relativity,” 524.

²⁶ Thomas Pashby, “Do Quantum Objects Have Temporal Parts?” *Philosophy of Science* 80, no. 5 (2013): 1139.

²⁷ Josh Parsons, “Must a Four-Dimensionalist Believe in Temporal Parts?” *Monist* 83, no. 1 (2000): 399-418.

scientific understanding of the universe is not a well-grounded inference. Hence, as noted by Michael Loux, contemporary Perdurantists, as much as possible, should avoid drawing any inference from the theory of special relativity.²⁸ Moreover, there is evidence that a three-dimensional space-time frame can be used to provide insights into our understanding of space and time, and even enhance our understanding of the theory of special relativity.²⁹ Hence, given the assumption that because Perdurantism is a four-dimensional theory of persistence, it follows that its alignment with the scientific understanding of space and time fails.

The question “Why should an ontological theory be compatible with a scientific theory, which is primarily of epistemic nature?” may arise. Simply put, why does it matter that a theory of persistence does not align with the scientific understanding of space and time? The problem of persistence is of an epistemic nature and does not necessarily need validation from or compatibility with a scientific theory. Yuri Balashov argues that, “Relativistic considerations seem highly relevant to this debate. But they have played little role in it so far.”³⁰ However, it is important to confirm if there is already a solution to the problem of persistence in science. If this is the case, the debate will become unnecessary. Furthermore, since both theories of persistence make claims that borders on scientific facts, it is relevant to fact check the claims. Thus, the debate on the epistemic nature of persistence of objects requires a minimum understanding on the basic intuition and scientific claims on space and time.

Another major objection to the Perdurance theory is that going by its position it is difficult to explain what exactly temporal parts are as used by Perdurantists, and the role they play in persistence. Hence, Perdurantists have been accused of unnecessarily inflating ontology. In other words, why introduce an entity that causes more problems for persistence rather than solve the problem of persistence? It is argued that temporal parts are vague, and the role they play in explaining and justifying the changes objects go through as they persist is not well defined within a metaphysical framework.

According to Theodore Sider, a temporal part can be defined thus:

x is an instantaneous part of y at instant t = if (i) x exists at, but only at t (ii) x is part of y at t (iii) x overlaps at t everything that is part of y at t.³¹

²⁸ Loux, “The Nature of Time,” 243.

²⁹ Chen, and Chen, “Time Dilation and Length Contraction Shown in Three-Dimensional Space-Time Frames,” 224.

³⁰ Yuri Balashov, “Relativity and Persistence,” *Philosophy of Science* 67, no. 1 (2000): 549.

³¹ Sider, “Four Dimensionalism,” 204.

In other words, a part is a temporal part of an object if it exists at a particular time location and exists as a part of the object at the particular time location. The implication of this definition is that a property is a temporal part of an object at a particular time location, if it fulfils the following conditions:

1. The temporal part is part of that object throughout that time location. (There is no part of that time location that temporal part does not exist).
2. The temporal part exists only at that particular time location. (The temporal part ceases to exist after that time location).
3. For any sub-time, location of that particular time location, the property overlaps every part of that object.

Katherine Hawley argues that:

Temporal parts are analogous to spatial parts: just as the conference has one spatial part which occupies the seminar room, and another which occupies the lecture hall, it has one temporal part which ‘occupies’ Friday and another which ‘occupies’ Saturday. These temporal parts of the conference have half-hour coffee-breaks as temporal parts of their own; these coffee-breaks are also temporal parts of the whole conference.³²

In other words, according to Hawley, temporal parts are necessary parts of objects (or necessarily parts of objects?). For example, the temporal part of being green in a bunch of bananas at time location T_1 remains green throughout time location T_1 , and not beyond time location T_1 . At time location T_2 , the temporal part of being yellow comes into play; so is the temporal part of being black at T_3 .

As simple as the definition of temporal parts appears to be, Endurantism still insist that it is difficult to understand and counterintuitive.³³ When the temporal part thesis is examined in conjunction with the role it ought to play, one cannot but realise that a proper understanding of temporal parts is lacking. If it is a part of an object, albeit temporal, can it be observed in the same way we observe the other parts of the object? How does a temporal part go out of existence? How is a new temporal part acquired at another

³² Katherine Hawley, *Temporal Parts* (University of St. Andrews, 2011), <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.422.9389&rep=rep1&type=pdf>.

³³ Nick Effingham, “Endurantism and Perdurantism,” in *Continuum Companion to Metaphysics*, eds. Robert Barnard, and Neil Manson (New York: Continuum, 2012), 171-172.

time location? When a temporal part ceases to exist in an object, does it go out of existence? If yes, how? If no, where does it then stay? Is it that when an object comes into existence, the temporal parts are already in existence somewhere, waiting to emerge appropriately at each time slice? If this is not the case, then probably the object has the power to create and destroy a temporal part as need to be. Many questions arise from the ontology of temporal parts. Perdurantists have not succeeded in properly analysing the concept of 'temporal part' to its simplest form.

Arising from the problem of temporal parts is the consequence of temporal parts on ontology. A question then arises on the consequence of this on ontology: "How many objects exist?" It seems as if there exists a bunch of bananas multiplied by the bunch of bananas at each different time slices in existence. Invariably, Perdurantism is accused of unnecessarily over-populating ontology. This is because the temporal part thesis of Perdurantism introduces a new entity into ontology that it cannot properly define. This will create more problems for persistence, rather than address the problem. Endurantism is eager to apply Occam's razor on Perdurantism here and take its seat as the more reasonable theory of persistence. However, Endurantists should note, as Nikk Effingham points out, that problems with a theory do not automatically indicate the alternative theory is more appropriate.³⁴

The response of Perdurantism to the problem of temporal intrinsics is temporal parts. For Perdurantism, objects have temporal parts; hence, are four-dimensional and their diachronic identity differs from their numerical identity. Perdurantism seems to have an edge over Endurantism; however, is this really the case? Perdurantism explained change as a one-way relation between an object and its temporal part. The edge Perdurantism seems to have over Endurantism is that Perdurantism argues that all properties are had *simpliciter*. However, do objects own properties *simpliciter*? To say that objects have properties *simpliciter* is to argue that properties are gained or lost in relation to the object and nothing else. Nevertheless, this assertion seems to be too broad, as objects do have some properties in relation to other external factors such as time, space, motion, and reference frame.

There is at least some scientific evidence that persisting objects may gain or lose intrinsic properties in relation to other factors, for example, reference frame. In physics, motion is measured with reference to a frame.³⁵ Consider Mr A and Mr B facing each other across a road, Mr C drives past them at T in a car, according to Mr A the car is driving towards the right, while according to Mr B the car is driving towards the left, according to Mr C, however, his car is driving straight down. None of the three observers is wrong; this is because their

³⁴ Ibid., 173.

³⁵ Mark Srednicki, *Quantum Field Theory* (Cambridge: Cambridge University Press, 2007), 98.

explanations depend on their individual frame of reference. Each person defines the motion of the car using his point of observation as the starting point. This is why in Physics speed is not measured in isolation, but according to a reference point.³⁶ Motion takes place regardless of a reference frame; nevertheless, its speed cannot be measured without a reference frame. This is because a starting point must be considered in measuring speed, and this cannot be independent of the location of the observer, which is the reference frame.

How is this applicable to the problem of temporal intrinsics? Consider three bunches of bananas – bunch A, bunch B and bunch C. At time location T_1 , bunch A is left on a table in a well-ventilated room; bunch B is kept in a refrigerator; and bunch C is kept in a deep freezer. At time location T_2 , bunch A has acquired the property 'yellowness,' bunch B retains its property 'greenness,' while bunch C has acquired the property 'blackness.' While these properties are intrinsic to each bunch of bananas, which of these properties are had in relation to nothing else but the property? In other words, there are other factors to be considered in the gaining and losing of properties in objects apart from the object and time. Hence, in persistence of objects, it is necessary to determine the reference frame responsible for intrinsic properties in objects. While Endurantism over-concentrated on time as the factor responsible for change, Perdurantism over-concentrated on an object itself as the factor responsible for change. Neither of both theories asked the question, "In reference to what?"

Time can also play an active role in temporary intrinsics. For example, let us assume that year 2015 is time location T_1 and 2017 is time location T_4 in the life of a baby. The properties lost and gained between time locations T_1 and T_4 are intrinsic to the baby but are not properties simpliciter. Many other factors, apart from the baby itself, are responsible for the lost and gained properties, especially time. It will be absurd for the baby to look the same in 2015 in 2017. There are milestones a baby is expected to meet over a period. Hence, with nutrition, nurturing and environment, the weight, height and speech of a baby in 2017 ought to be different from what obtained in 2015. Hence, it will be medically alarming for a baby to appear the same in 2017 as it was in 2015.

It is expected that given some factors, the baby will gain and lose some properties between time locations T_1 and T_4 . This does not imply that the properties are not intrinsic, but it challenges the assumption that intrinsic properties are had simpliciter as Perdurantism argues. Hence, that a property is intrinsic does not imply that it cannot be had in relation to something else as Perdurantism assumes. Simply put, both Endurantism and Perdurantism do not address the problem of persistence from the angle of temporal intrinsics.

³⁶ Srednicki, *Quantum Field Theory*, 98.

Another major objection to Perdurantism is that, just as much as Endurantism, fails to explain without absurdities and within a metaphysical framework how change takes place in objects. In other words, between one time location and the other, how does change occur given temporal parts? Cyrano at T_1 has a big nose and Cyrano at time location T_4 has a small nose. Between T_1 and T_4 , Perdurantism has no clear explanation for how the change from the big nose to the small one occurs. According to Peter Simons, temporal parts only tell us what happens in objects at time location and nothing more.³⁷ Temporal parts do not explain change but explains what happens in objects at each time location. Simons argue that Perdurantism only tells us stories about temporal parts at each time location, not how it transmits into change. Hence, it seems Cyrano exists wholly from time location T_1 to time location T_4 just as Endurantism will argue. How the thesis of temporal parts translates into change is not well elucidated.

Perdurantism, contrary to its assumption, has a lot of work to do in explicating the ontological status of temporal parts. Moreover, the argument of Perdurantism that it aligns with the scientific understanding of the world largely relies on its misconception and overstretching of the theory of special relativity. In addition, Perdurantism, even with temporal parts, fails to properly address the problem of temporal intrinsic. It follows then that Perdurantism as much as Endurantism is yet to answer the question of persistence.

V. Superficialism and the problem of persistence

There is however a school of thought which argue that the impasse on the problem of persistence is because the problem of persistence is a superficial ontological dispute. In other words, what some ontologists call the problem of persistence is a mere verbal dispute that can be resolved by appealing to semantics and common sense. According to Hirsch,

The composite objects we ordinarily talk about really exist; they typically persist through changes in their parts; they typically do not have sums; and they typically do not have temporal parts. According to my first claim the dispute between these various positions is purely verbal, and this implies, according to my second claim, that the position of common sense ontology must be correct.³⁸

³⁷ Simons, *Parts: A Study in Ontology*, 64.

³⁸ Eli Hirsch, "Physical-Objet Ontology, Verbal Disputes and Common Sense," *Philosophy and Phenomenological Research* 70, no. 1 (2005): 67.

Hence, for scholars like Hirsch, the whiff of a verbal disagreement is easily detected in the problem of persistence. The dispute between Endurantism and Perdurantism is reducible to whether objects have temporal parts or not; Endurantists deny this, while Perdurantism affirms it. While Endurantism argues that persistence is three-dimensional, Perdurantism argues that persistence is four-dimensional.³⁹

However, according to superficialism, the disputants use different language to make the same claim and they are ignorant of this. Hirsch characterised it thus:

In my view, an issue in ontology (or elsewhere) is “merely verbal” in the sense of reducing to a linguistic choice only if the following condition is satisfied: Each side can plausibly interpret the other side as speaking a language in which the latter’s asserted sentences are true.⁴⁰

Hence, in the language of Perdurantism the claim that temporal parts exist is true, while in the language of Endurantism the claim that temporal parts exist is false. Hence, it is not the case that temporal parts exist in objective reality, but it is a case of linguistic choice. The striking feature in this verbal dispute is that both disputants make right assertions in their respective languages. Hence, in this ontological dispute on the problem of persistence, the dispute is verbal and the arguments for each side of the dispute are reducible to linguistic choice. Hirsch thus argues that:

We can, if we wish, think of X as forming its own linguistic community. If side X is perdurantism then X’s language is the language that would belong to an imagined linguistic community typical members of which talk like perdurantists, i.e., they assert the sentences that perdurantists assert and endurantists reject.⁴¹

In other words, the preferred language of Perdurantism favours the term temporal parts in characterising persistence, while that of Endurantism rejects it.

One challenge with the claim of superficialism is that it did not consider the possibility that an argument can be substantial even in the midst of a seeming verbal dispute. Consider this illustration, in America a football is

³⁹ Eli Hirsch, “Ontology and Alternative Languages,” in *Metametaphysics: New Essays on the Foundations of Ontology*, eds. David Chalmers, and Ryan Wasserman (Oxford: Clarendon Press, 2009), 233.

⁴⁰ Ibid., 231.

⁴¹ Ibid., 239.

spherical, has two pointed edges and is brown. However, in Britain, a football is round, has no edge and is black and white. If an American and a Briton are not aware, that football in America is different from football in Britain, it is possible they disagree over the appropriate description for a ball.⁴² A dispute of this sort is verbal, and to resolve it the disputants can be educated on the differences in what is called football in both countries. Awareness that a football can be round and black and white in some climes, and spherical and brown in some climes can resolve the dispute.

However, the American may insist that it is more appropriate to call the American ball football, than the British ball. The Briton may also insist that the British football is the type of ball that should be called football. If this occurs, the disagreement will no longer be a mere verbal dispute, but a substantive dispute. In the first case nevertheless, there is no substantive disagreement. The implication of this second case is that it is possible to have a substantive disagreement and assume it is verbal. Hence, the debate between Endurantism and Perdurantism is on the appropriate way to characterise persistence in ontology.

Moreover, the fact that metaphysics seeks to answer questions on objective reality, does not imply that its arguments must always focus on fundamental facts about the world. It is possible for a theory to reflect fundamental facts about the world through the pragmatic value of that theory. For example, one of the strengths of the temporal part thesis is that it has some pragmatic value that Endurantism does not have. Hence, answering questions on objective reality can take different dimensions.

Furthermore, ontological disputes normally agree on some basic fundamental facts and there is no problem with that. It does not follow that because they agree on the obvious and less problematic fundamental facts, then they agree on all fundamental facts. Usually there are other fundamental facts and the implications of some fundamental facts that are responsible for the dispute. For example, in the case of Endurantism and Perdurantism, one of the reasons for the lingering disagreement is that there is a dispute on why and how objects persist without changing identity. Although, both theories agree that objects persist without losing identity, it disagrees on how and why.

VI. Nature of time and the problem of persistence

Another school of thought argue that time is unreal; hence, a debate on persistence through time is a pseudo problem. According to John McTaggart,

⁴² David Manley, “Introduction: A Guided Tour of Metametaphysics,” in *Metametaphysics: New Essays on the Foundations of Ontology*, eds. David Chalmers, and Ryan Wasserman (Oxford: Clarendon Press, 2009), 8.

contrary to the nonprofessional or pre-philosophical assumption that time is real, time is unreal. McTaggart characterised positions in time as a combination of events and each time these events occur. McTaggart identified two frameworks/theories of time, B-series and A-series. The B-series characterises time in terms of relational concepts, that is earlier than and later than. In other words, for two events E1 and E2, E1 can be earlier than E2, later than E2 or simultaneous with E2. While A-series characterises time in terms of tenses such as past, present, and future. The B-series uses relational concepts to characterise time, while A-series uses tenses. Time positions and events are fixed for B-series, such that if it is true that “E1 occurred earlier than E2,” no matter what it will remain true. Time positions and events are dynamic and changes constantly for A-series, such that if it is true that “It is raining now,” at another time position it will no longer be true. This is because the concepts A-series employ to characterise time are tenses and tenses change depending on the position of time.⁴³

Based on these, McTaggart argue that first, the A and B-series exhaust the characterisation of time. In other words, there is no other way time can be characterised except for these two frameworks.⁴⁴ Second, McTaggart argues that the validity of the B-series framework depends on the A-series framework. Such that if the A-series is valid/invalid. The B-series will also be. Third, McTaggart argues that properties of the tense’s past, present and future are contradictory and therefore cannot be used to characterise time in the same framework. Hence the A-series is contradictory, consequently the B-series and therefore, time is unreal.⁴⁵

McTaggart’s justification for argument that the A-series is contradictory is that A-series position implies that an event that is in the future at T1, becomes present at T2 and past at T3. To account for change an event moves from T1 to T2 to T3 to T4... The implication of this is that an event has the properties past, present and future together. For McTaggart, the property of the tense ‘past’ is different from that of ‘present’ and the properties of both different from that of ‘future.’ It is therefore contradictory for one event to have the three properties together. However, according to McTaggart, the A-series implies that one event has the properties together and this is contradictory.

McTaggart’s justification for his argument that the B-series is dependent on the A-series is that the B-series acknowledges that time presupposes change; thus, though it uses fixed concepts to characterise time, it is not a fixed framework of time, but a temporal framework of time. That is time

⁴³ John McTaggart, “The Relation of Time and Eternity,” *Mind* 18, no. 71 (1909): 343-362.

⁴⁴ Ibid., 343-362.

⁴⁵ Ibid.

at T1 will be different from time at T2 and different from time at T3 and so on... T1 cannot occur twice, neither can T2 nor T3 ... Hence, time is temporal and not permanent. If time is temporal but B-series uses fix concepts to characterise time, there must be a way that the temporal framework that B-series acknowledges will be justified. Hence, the B-series must rely on the permanent concepts of A-series to justify its temporal framework of time.

The first problem with McTaggart's position is the assumption that the A-series implies that an event has the three positions, past, present, and future simultaneously. There is no evidence that this implication is true, rather a more plausible interpretation is that an event can have the three positions successively. That is, an event can be in the future at T1, at that moment it has only the property of the verb 'future' and no other property. It is at another time location that it can then have the property of the verb 'present' and subsequently that of the verb 'past.' There is no point in time that it has the three positions simultaneously. Hence, there is no contradiction as argued by McTaggart.

Another challenge with McTaggart's position is the claim that only events necessarily account for change. For McTaggart, the only evidence that time changes is the change in events. For example, it rained at T1, but it is sunny at T2. The evidence that time changed from T1 to T2 is the change of event. The best way to explain change in time is to refer to change in events. This conception of change is curious. The assumption that a fixed framework of time cannot account for change except it employs a tensed language arises from a misconception that events account for change. Objects account for change and not events as assumed by McTaggart. Events do not change; hence, the fixed framework of time. Objects change; hence, the temporal aspect of the framework. In other words, McTaggart equivocated on events and order, and assumed that events play the role that objects actually play and this is a category mistake.

VII. Persisting problem of persistence

As observed from the foregoing, there is no sufficient evidence that the problem of persistence is not a substantive ontological dispute, yet both theories of persistence pose challenges that make the problem of persistence a lingering problem. On the one hand, Endurantism offers a simple theory of persistence, which is argued to align with basic intuition. Moreover, Endurantism is careful not to appeal to new entities that will create the problem of reconciling them with our hitherto accepted ontology. However, it did not address some issues on persistence. First, the theory fails to give a proper account of change. Second, it has the problem of how to reconcile identicals with contradicting properties.

For example, how can Endurantism claim that Cyrano exists wholly and is identical at each time location, and account for the contradicting properties between Cyrano at time location T_1 and time location T_4 ? If Cyrano at T_1 is identical to Cyrano at T_4 exists wholly at each time location, then he cannot have contradicting properties. Third, Endurantism makes it difficult to explain how change at least to an extent within objects itself, even though the change is said to be intrinsic. Endurantism appeals to time to explain change in objects. However, persistence seeks to explain change in relation to objects largely and not only in relation to other things.

Perdurantism on the other hand, avoids the problem of explaining change in relation to things outside objects by introducing the thesis of temporal parts and reconciling incompatible properties. However, it is not the case that Perdurantism has actually fared better than Endurantism. First, Perdurantism has the challenge of how to reconcile temporal parts with existing entities. Second, Perdurantism struggles with properly stating the ontological status of temporal parts.⁴⁶ Third, without properly stating the ontological status of temporal parts, Perdurantism cannot claim its thesis properly accounts for change, especially because the entity that ought to account for change-temporal parts is not well defined.

Though Endurantism and Perdurantism have different metaphysical explanations to account for change in objects, both explanations have gaps to fill on persistence. The primary purpose of a theory of persistence is to explain how objects persist through changes, without contradictions and absurdities. However, both Endurantism and Perdurantism encounter more challenges on how to explain changes in objects, without absurdities, conflicts, and contradictions than answers. Simply put, the debate between Endurantism and Perdurantism is presently inconclusive. There is an impasse on the problem of persistence between Endurantism and Perdurantism, and both theories do not adequately address the problem of persistence. Both theories create more questions for the problem of persistence than answers. Hence, there is a need for scholars to beam their searchlights beyond Endurantism and Perdurantism and seek an alternative theory of persistence in metaphysics.

References

Balashov, Yuri. "Relativity and Persistence." *Philosophy of Science* 67 (2000): 5549-562.

Benovsky, Jiri. "Endurance, Perdurance and Metaontology." *SATS* 12, no. 2 (2011): 159-177.

⁴⁶ Sally Haslanger, "Persistence through Time," in *The Oxford Handbook of Metaphysics*, eds. Michael Loux, and Dean Zimmerman (Oxford: Oxford University Press, 2005), 323.

Benovsky, Jiri. "On (Not) Being in Two Places at the Same Time." *American Philosophical Quarterly* 46, no. 3 (2009): 239-248.

Bigaj, Tomasz. "Time and Temporal Objects." In *A Guided Tour for Beginners*, edited by Tomasz Bigaj, 60-93. Chodakwosa: University of Warsaw Press, 2012.

Chen, Tower, and Zeon Chen. "Time Dilation and Length Contraction Shown in Three Dimensional Space-Time Frames." *Concepts of Physics* 6, no. 2 (2009): 221-235.

Eddon, Maya. "Three Arguments from Temporary Intrinsics." *Philosophy & Phenomenological Research* 81, no. 1 (2010): 605-619.

Effingham, Nick. "Endurantism and Perdurantism." In *Continuum Companion to Metaphysics*, edited by Robert Barnard, and Neil Manson, 170-187. New York: Continuum, 2012.

Einstein, Albert. *Relativity and the Special and General Theory*. Translated by Robert Lawson. New York: Henry Holt, 1920.

Hales, Steven, and Timothy Johnson. "Endurantism, Perdurantism and Special Relativity." *The Philosophical Quarterly* 53, no. 213 (2003): 524-539.

Haslanger, Sally. "Persistence through Time." In *The Oxford Handbook of Metaphysics*, edited by Michael Loux, and Dean Zimmerman, 315-354. Oxford: Oxford University Press, 2005.

Haslanger, Sally. "Persistence, Change and Explanation." *An International Journal for Philosophy in the Analytic Tradition* 56, no. 1 (1989): 1-28.

Hawley, Katherine. *Temporal Parts*. University of St. Andrews, 2011. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.422.9389&rep=rep1&type=pdf>.

Hirsch, Eli. "Ontology and Alternative Languages." In *Metametaphysics: New Essays on the Foundations of Ontology*, edited by David Chalmers, and Ryan Wasserman, 231-259. Oxford: Clarendon Press, 2009.

Hirsch, Eli. "Physical-Object Ontology, Verbal Disputes, and Common Sense." *Philosophy and Phenomenological Research* 70, no. 1 (2005): 67-97.

Lewis, David. *On the Plurality of Worlds*. Oxford: Basil Blackwell, 1986.

Loux, Michael. "Persistence through Time." In *Metaphysics: A Contemporary Introduction*, edited by Michael Loux, and Dean Zimmerman, 230-258. New York: Routledge, 2016.

Loux, Michael. "The Nature of Time." In *Metaphysics: A Contemporary Introduction*, edited by Michael Loux, and Dean Zimmerman, 205-229. New York: Routledge, 2016.

Manley, David. “Introduction: A Guided Tour of Metametaphysics.” In *Metametaphysics: New Essays on the Foundations of Ontology*, edited by David Chalmers, and Ryan Wasserman, 1-37. Oxford: Clarendon Press, 2009.

Markosian, Ned. “A Defence of Presentism.” In *Oxford Studies in Metaphysics: Volume 1*, edited by Dean Zimmerman, 47-82. Oxford: Oxford University Press, 2004.

McTaggart, John Ellis. “The Relation of Time and Eternity.” *Mind* 18, no. 71 (1909): 343-362.

Noonan, Harold. “Presentism and Eternalism.” *Erkenntnis* 78, no. 1 (2013). 219-227.

Parfit, Derek. “People and Their Bodies.” In *Contemporary Debates in Metaphysics*, edited by Theodore Sider, John Hawthorne, and Dean Zimmerman, 177-208. Malden: Blackwell, 2008.

Parsons, Josh. “Must a Four-Dimensionalist Believe in Temporal Parts?” *Monist* 83 no. 1 (2000): 399-418.

Pashby, Thomas. “Do Quantum Objects Have Temporal Parts?” *Philosophy of Science* 80, no. 5 (2013): 1137-1147.

Reydon, Thomas. “Species in Three and Four Dimensions.” *Synthese* 164, no. 2 (2008): 161-184.

Sider, Ted. “Four Dimensionalism.” *Philosophical Review* 106, no. 2 (1997): 197-231.

Simon, Peter. *Parts: A Study in Ontology*. Oxford: Clarendon Press, 1987.

Srednicki, Mark. *Quantum Field Theory*. Cambridge: Cambridge University Press, 2007.

