

# TIME

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## 1. What Should a Philosophical Theory of Time Do?

Should it define the word “time”? Yes, and as a working definition we can say time is a sequence of moments in a linear order. However, it is improper to demand that we give a very precise and detailed definition of the word as a prelude to saying anything more about time, in large part because definitions often need to be changed when more is learned. What we really want is to build a comprehensive, philosophical theory of time that helps us understand time by solving problems about time. We do not want to start building this theory by adopting a prior, unrevisable definition of time that might prejudice the theory-building project from the beginning.

Although there are theories of how to solve this or that specific problem about time, it is always better to knit together solutions to several problems. Ideally, the goal is to produce a theory of time that will solve in a systematic way the constellation of problems involving time. What are those problems?

One is to clarify the relationship between time and the mind. For example, does time exist for beings that have no minds? It is easy to confuse time itself with the perception of time.

Another problem is to decide which of our intuitive beliefs about time should be retained when they conflict with other beliefs. Some of these intuitions may reflect deep insights into the nature of time, and others may be faulty ideas inherited from our predecessors. It is not obvious which is which. For one example, if we have the intuition that time flows, but our science implies otherwise, then which view should get priority?

A third problem for a philosophical theory of time is to clarify what physical science presupposes and implies about time. A later section of this article examines this topic. Most all philosophers of time claim that philosophical theories should be consistent with physical science, or, if not, then they must accept the heavy burden of proof to justify the inconsistency.

A philosophical theory of time should describe the relationship between instants and events. Does the instant that we label as “11:01 A.M.” for a certain date exist independently of the events that occur then? In other words, can time exist if no event is happening? This question or problem raises the thorny metaphysical issue of absolute vs. relational theories of time.

A theory of time should address the question of time’s apparent direction. If we were to view a movie of brown coffee separating into black coffee—with cream leaving it and flying up into the pitcher—we in the audience could immediately tell that the actual events did not occur in this order. We recognize this arrow of time because we know about the one-directional processes in nature. However, this unidirectionality or arrow becomes less and less apparent to us viewers as the movie subject gets smaller and smaller and the time interval gets shorter and shorter until finally we are viewing processes that could just as easily go the other way, at which point the arrow of time has disappeared. Philosophers disagree about the explanation of the arrow. Could it be a consequence of the laws of science? The arrow appears to be very basic for understanding nature, yet it is odd that asymmetries in time do not appear in the principal, basic

dynamical laws of physics. Could the arrow of time reverse some day? Philosophers wonder what life would be like in some far off corner of the universe where the arrow of time is reversed. Would the people there walk backwards up steps while remembering the future?

Another philosophical problem about time concerns the two questions, “What is the present, and why does it move into the past?” If we know what the present is, then we ought to be able to answer this question: “How long does the present last?” And regarding the second question about the “movement” of the present into the past, many philosophers are suspicious of this notion of the flow of time, the march of time. They doubt whether it is a property of time as opposed to being some feature of human perception. Yet other philosophers are adamant that the flow is quite real objectively.

Are there ontological differences among the past, present, and future? Some philosophers doubt whether the future and past are as real as the present, the feature that is referred to by the word “now.” A famous philosophical argument says that, if the future were real, then it would be fixed now, and we would not have the freedom to affect that future. Since we do have that freedom, the future can not be real. Some philosophers consider this to be a clever, but faulty argument.

For a last example of a philosophical issue regarding time, is time a fundamental feature of nature, or does it emerge from more basic features—in analogy to the way the smoothness of water flow emerges from the complicated behavior of the underlying molecules?

A full theory of time should address this constellation of philosophical issues about time. Narrower theories of time will focus on resolving one or more members of this constellation, but the long-range goal is to knit together these theories into a full, systematic, and detailed theory of time.

## **2. How Is Time Related to Mind?**

Physical time is public time, the time that clocks are designed to measure. Psychological time or phenomenological time is private time. It is perhaps best understood as awareness of physical time. Psychological time passes swiftly for us while we are enjoying reading a book, but it slows dramatically if we are waiting anxiously for the water to boil on the stove. The slowness is

probably due to focusing our attention on short intervals of physical time. Meanwhile, the clock by the stove is measuring physical time and is not affected by anybody's awareness.

When a physicist defines speed to be the rate of change of position with respect to time, the term "time" refers to physical time. Physical time is more basic for helping us understand our shared experiences in the world, and so it is more useful than psychological time for doing science. But psychological time is vitally important for understanding many human thought processes. We have an awareness of the passage of time even during our sleep, and we awake knowing we have slept for one night, not for one month. But if we have been under a general anesthetic or have been knocked unconscious and then wake up, we may have no sense of how long we have been unconscious. Psychological time stopped. Some philosophers claim that psychological time is completely transcended in the mental state called "nirvana."

Within the field of cognitive science, one wants to know what are the neural mechanisms that account not only for our experience of time's flow, but also for our ability to place events into the proper time order. See (Damasio, 2006) for further discussion of the progress in this area of cognitive science. The most surprising experimental result about psychological time is Benjamin Libet's experiments in the 1970s that show, or so it is claimed, that the brain events involved in initiating our free choices occur about a third of a second before we are aware of our choice. Before Libet's work, it was universally agreed that a person is aware of deciding to act freely, then later the body initiates the action.

Psychologists are interested in whether we can speed up our minds relative to physical time. If so, we might become mentally more productive, get more high quality decision making done per fixed amount of physical time, learn more per minute. Several avenues have been explored: using drugs such as cocaine and amphetamines, undergoing extreme experiences such as jumping backwards off a tall tower with bungee cords attached to the legs, and trying different forms of meditation. So far, none of these avenues have led to success productivity-wise.

Any organism's *sense* of time is subjective, but is the time that is sensed also subjective, a mind-dependent phenomenon? Without minds in the world, nothing in the world would be surprising or beautiful or interesting. Can we add that nothing would be in time? If judgments of time were subjective in the way judgments of being interesting vs. not-interesting are subjective, then it would be miraculous that everyone can so easily agree on the ordering of public events in time. For example, first, Einstein was born, then he went to school, then he died. Everybody agrees that it happened in this order: birth, school, death. No other order. The agreement on time order for so many events is part of the reason that most philosophers and scientists believe physical time is an *objective* phenomenon that is not dependent on being

consciously experienced. Another part of the reason time is believed to be objective is that our universe has a large number of different processes that bear consistent time relations, or frequency of occurrence relations, to each other. For example, the frequency of a fixed-length pendulum is a constant multiple of the half life of a specific radioactive uranium isotope; the relationship does not change as time goes by (at least not much and not for a long time). The existence of these sorts of relationships makes our system of physical laws much simpler than it otherwise would be, and it makes us more confident that there is something objective we are referring to with the time-variable in those laws. The stability of these relationships over a long time also makes it easy to create clocks. Time can be measured easily because we have access to long-term simple harmonic oscillators that have a regular period or “regular ticking.” This regularity shows up in completely different stable systems when they are disturbed: a ball swinging from a string (a pendulum), a ball bouncing up and down from a coiled spring, a planet orbiting the sun, organ pipes, electric circuits, and atoms in a crystal lattice. Many of these systems make good clocks.

Aristotle raised this issue of the mind-dependence of time when he said, “Whether, if soul (mind) did not exist, time would exist or not, is a question that may fairly be asked; for if there cannot be someone to count there cannot be anything that can be counted...” [ *Physics*, chapter 14]. He does not answer his own question because, he says rather profoundly, it depends on whether time is the conscious numbering of movement or instead is just the capability of movements being numbered were consciousness to exist.

St. Augustine, adopting a subjective view of time, said time is nothing in reality but exists only in the mind’s apprehension of that reality. In the 11th century, the Persian philosopher Avicenna doubted the existence of physical time, arguing that time exists only in the mind due to memory and expectation. The 13th century philosophers Henry of Ghent and Giles of Rome said time exists in reality as a mind-independent continuum, but is distinguished into earlier and later parts only by the mind. In the 13th century, Duns Scotus clearly recognized both physical and psychological time.

At the end of the 18th century, Kant suggested a subtle relationship between time and mind—that our mind actually structures our perceptions so that we can know a priori that time is like a mathematical line. Time is, on this theory, a form of conscious experience, and our sense of time is a necessary condition of our experience. In the 19th century, Ernst Mach claimed instead that our sense of time is a simple sensation. This controversy took another turn when other philosophers argued that both Kant and Mach were incorrect because our sense of time is an intellectual construction (see Whitrow, p. 64).

In the 20th century, the philosopher of science Bas van Fraassen described physical time by saying, “There would be no time were there no beings capable of reason” just as “there would be no food were there no organisms, and no teacups if there were no tea drinkers,” and no cultural objects without a culture.

The controversy in metaphysics between idealism and realism is that, for the idealist, nothing exists independently of the mind. If this controversy is settled in favor of idealism, then time, too, would have that subjective feature—physical time as well as psychological time.

It has been suggested by some philosophers that Einstein’s theory of relativity, when confirmed, showed us that time depends on the observer, and thus that time is subjective, or dependent on the mind. This error is probably caused by Einstein’s use of the term “observer.” Einstein’s theory does imply that the duration of an event is not absolute but depends on the observer’s frame of reference or coordinate system. But what Einstein means by “observer’s frame of reference” is merely a perspective or framework from which measurements could be made. The “observer” does not have to be a conscious being or have a mind. So, Einstein is not making a point about mind-dependence.

For more on the consciousness of time and related issues, see the article “Phenomenology and Time-Consciousness.”

### **3. What Is Time?**

#### **a. The Variety of Answers**

Among philosophers of physics, the most popular short answer to the question “What is physical time?” is that it is not a substance or object but rather a special system of relations among instantaneous events. This working definition is offered by Adolf Grünbaum who applies the contemporary mathematical theory of continuity to physical processes, and he says time is a linear continuum of instants and is a distinguished one-dimensional sub-space of

four-dimensional spacetime.

How do we tell whether this is the correct answer to our question? To be convinced, we need to be told what the relevant terms mean, such as “special system of relations.” In addition, we need to be presented with a theory of time implying that time is this system of relations; and we need to be shown how that theory adequately addresses the many features that are required for a successful theory of time. Finally, we need to compare this theory to its alternatives. This article will not carry out these tasks.

A different, but popular answer to the question “What is time?” is that time is the form of becoming. To assess this answer, which is from Alfred North Whitehead, we need to be told what the term “form of becoming” means; we need to be presented with a detailed theory of time implying that time is the form of becoming; and we need to investigate how it addresses those many features required for a successful theory of time.

If physical time and psychological time are two different kinds of time, then two answers are required to the question “What is time?” and some commentary is required regarding their relationships, such as whether one is more fundamental. Many philosophers of science argue that physical time is more fundamental even though psychological time is discovered first by each of us as we grow out of our childhood, and even though psychological time was discovered first as we human beings evolved from our animal ancestors. The remainder of this article focuses more on physical time than psychological time.

Another answer to our question, “What is time?” is that time is whatever the time variable  $t$  is denoting in the best-confirmed and most fundamental theories of current science. “Time” is given an implicit definition this way. Nearly all philosophers would agree that we do learn much about physical time by looking at the behavior of the time variable in these theories; but they complain that the full nature of physical time can be revealed only with a philosophical theory of time that addresses the many philosophical issues that scientists do not concern themselves with.

Michael Dummett’s constructive model of time implies that time is a composition of intervals rather than of durationless instants. The model is constructive in the sense that it implies there do not exist any times which are not detectable in principle by a physical process.

An additional answer to our question is that time is a substance, not a relationship among events. It is a distinguished one-dimensional sub-space of spacetime, but spacetime is a substance. This substantivalist answer is explored in a later section.

Bothered by the contradictions they claimed to find in our concept of time, Zeno, Plato, Spinoza, Hegel, and McTaggart answer the question, “What is time?” by replying that it is nothing because it does not exist. In a similar vein, the early 20th century English philosopher F. H. Bradley argues, “Time, like space, has most evidently proved not to be real, but a contradictory appearance....The problem of change defies solution.” In the mid-twentieth century, Gödel argued for the unreality of time because Einstein’s equations allow for events to precede themselves. In the twenty-first century physicists hoping to reconcile general relativity with quantum mechanics are suggesting that either time does not exist or else it is not fundamental in nature; see Callender (2010). However, most philosophers agree that time does exist. They just can not agree on what it is.

Let’s briefly explore other answers that have been given throughout history to our question, “What is time?” Aristotle claimed that “time is the measure of change” [*Physics*, chapter 12], but he emphasized “that time is not change [itself]” because a change “may be faster or slower, but not time...” [*Physics*, chapter 10]. For example, a specific change such as the descent of a leaf can be faster or slower, but time itself can not be faster or slower. In developing his views about time, Aristotle advocated what is now referred to as the relational theory when he said, “there is no time apart from change....” [*Physics*, chapter 11]. In addition, Aristotle said time is not discrete or atomistic but “is continuous.... In respect of size there is no minimum; for every line is divided *ad infinitum*. Hence it is so with time” [*Physics*, chapter 11].

René Descartes had a very different answer to “What is time?” He argued that a material body

has the property of spatial extension but no inherent capacity for temporal endurance, and that God by his continual action sustains (or re-creates) the body at each successive instant. Time is a kind of sustenance or re-creation.

In the 17th century, the English physicist Isaac Barrow rejected Aristotle's linkage between time and change. Barrow said time is something which exists independently of motion or change and which existed even before God created the matter in the universe. Barrow's student, Isaac Newton, agreed that this absolute or substantival theory of time is correct. Newton argued very specifically that time and space are an infinitely large container for all events, and that the container exists with or without the events. He added that space and time are not material substances, but are *like* substances in not being dependent on anything except God.

Gottfried Leibniz objected. He argued that time is not an entity existing independently of actual events. He insisted that Newton had underemphasized the fact that time necessarily involves an ordering of any pair of non-simultaneous events. This is why time "needs" events, so to speak. Leibniz added that this overall order *is* time. He accepts a relational theory of time and rejects an absolute theory.

In the 18th century, Immanuel Kant said time and space are forms that the mind projects upon the external things-in-themselves. He spoke of our mind structuring our perceptions so that space always has a Euclidean geometry, and time has the structure of the mathematical line. Kant's idea that time is a *form* of apprehending phenomena is probably best taken as suggesting that we have no direct perception of time but only the ability to experience things and events

*in* time. Some historians distinguish perceptual space from physical space and say that Kant was right about perceptual space. It is difficult, though, to get a clear concept of perceptual space. If physical space and perceptual space are the same thing, then Kant is claiming we know a priori that physical space is Euclidean. With the discovery of non-Euclidean geometries in the 1820s, and with increased doubt about the reliability of Kant's method of transcendental proof, the view that truths about space and time are a priori truths began to lose favor.

The above discussion does not exhaust all the claims about what time is. And there is no sharp line between giving a definition of time and remarking on some important characteristic of time.

