

# WHAT IS TIME?

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## INTRODUCTION

Time is one of humankind's unanswerable mysteries. Aristotle called time "the most unknown of unknown things." What time is and even if it objectively exists are unanswerable questions. Time is intangible.

There have been and will be countless theories about time. Many, including in science, are simply useful definitions or conventions, and each is looking at time in a particular way and for a particular purpose. This short text looks at a variety of significant perspectives from physics, philosophy and psychology. A key is to demonstrate that there are many different incomplete and subjective ways of looking at what ultimately is beyond our mental grasp. Debate and additional perspectives and theories are welcome.

Humans have common, everyday ideas about time. These include that time is real and objective, time continually ticks away at an even rate and is the same for everyone everywhere, time flows linearly from the past to the present to the future, and that only the experienced present 'now' is real with the past and future being unreal. Most of these ideas are accepted as facts as obvious as the sky is blue and water is wet.

However, close examination brings many of these ideas into question. Cultural perceptions of time differ, physics has shown that time and space can act counter to our intuition, and biology and philosophy reveal many paradoxes about time.

There are a few ideas about time that are largely agreed up by most philosophers and scientists. Scientists and philosophers agree and define that time requires change. Time may simply be an innate abstract way for humans to understand and mark change. If there is no change there is no time. If it is only now, there is no time. It is when now becomes the past and there is a new now that there is the change that defines time.

There is general agreement amongst philosophers and scientists that time is continuous, meaning we do not experience it darting about or starting and stopping randomly. In our universe, time also appears to have an intrinsic direction from past to present to future, called the arrow of time.

Even with those agreed-upon standards, you will find some who disagree. Though his views are old-fashioned, Isaac Newton believed time didn't require change. Some quantum physicists ponder if time is indeed continual. The arrow of time is not theoretically absolute.

## **1 MAJOR HISTORICAL & CULTURAL CONCEPTIONS OF TIME**

The three major cultural and historical conceptions of time are **linear time**, **circular time** and **timelessness**. These conventions appear in theology, philosophy, science, psychology and art.

### **1.1 Linear time**

Linear time follows an inexorable line from the past to the future. Most people today imagine and mark time as linear, and our watches and clocks mark time by this convention. Linear time is the standard convention used in science. Abrahamic religions chose a linear conception of time because it allows for the creation of the universe and a final judgment.

### **1.2 Cyclical time**

Many early cultures had a cyclical conception of time, sometimes called the *wheel of time*. These cultures include Incan, Mayan, Hinduism, Buddhism and Jainism. They perceived time as consisting of repeating ages and time periods. This helps explain the idea of reincarnation. Circular or repeating conceptions of time are still used today by some cultures, including in India. (Das 2018) (Coward 2011)

The observance of repeating seasons is an example of circular time. Early agricultural and other societies were centered around the seasons, the regular apparent rising and falling of the sun, and the regular changing of star formations.

### **1.3 Timelessness**

A timeless view of time was common to many early peoples and mystical cultures such as some American Indians tribes, Australian aboriginals and Jewish Kabbalists. In this view of time, the past and present are intimately connected. History and spirits of the dead exist in the present. (Falk 2016) (Nichols 2014) (Blount 2017)

This is a mystical way of thinking, with the brain processing sensory information in a particular way. The modern brain has evolved to create cognitive constructs to define time, space and labels, including a linear perception of time. These constructs are essential to function but are artificial. With early peoples and mystical cultures, these cognitive constructs either are undeveloped or suppressed, and the sensory information is processed in different ways. A commonly described experience of mystical experiences is that everything is one and time stops or slows. (Choi 2016) (Barrett and Griffith 2019) (Yanakieve et al 2018)

### **1.4 Today We Look at Time in Different Ways**

While a linear conception of time is standard today, we also look at time in the other two ways. Modern calendars mark time both linearly (day 1, day 2, day 3, and year 2019, 2020, 2021) and cyclically (seasons, annual holidays). Our following of the “rising and falling of the sun” and regular changes in star constellations and moon phases is cyclical.

A Hindu in India who religiously conceives of the historical and future ages as cyclical may also mark time in his daily life linearly with a watch or clock.

As mystical experiences and related neurological events are not uncommon, a human who observes linear and/or cyclical time may at times additionally perceive time as timeless. Many people on a level have an idea of the past, such as past loved ones or events, psychologically existing in the present.

### 1.5 Two Other Ways of Looking at Time: Presentism and Eternalism

**Presentism** is the view that only the present (what is in front of you now) is real, and the past is unreal and the unknown future is unreal. This is the common way most people perceive time.

**Eternalism** is the view that the past, present and future are all equally real, and that our perception of only the experienced “now” being real is merely a matter of our brain’s consciousness and our arbitrary place in time.

To us, our present is perceived as real. However, to someone in 1755 or 1995, their present was perceived as just as real. It is just a matter of our arbitrary place in time that we consider our “current” as the real. In the big picture eternalism view, there is no reason to say that one present over another has privileged status. You can compare it to space or geography where, when standing in Chicago, you know that Los Angeles and Paris are as real as Chicago. You don’t say Los Angeles and Paris aren’t real because you aren’t there. With eternalism, all points of time along a timeline can be considered similarly.

Presentism and eternalism are not in conflict. They are different perspectives of the same timeline. Presentism is the up close and personal experience of time, while eternalism is a look at time from afar. It’s akin to driving along a road versus looking at the road on a map.

This section begs the question of what other possible conceptions and combinations of conceptions of time there can be. Theoretical non-humans may have very different conceptions of time. If time itself is merely a human construct, perhaps such non-humans would have no concept of time.

## 2 PHYSICS THEORIES OF TIME

Physics has offered competing mathematical theories about physical nature. Some are concerned specifically with time, while others use time as an ancillary element to the models. This section looks at the following standard physics theories: **Absolute time, relativity, quantum physics, and entropy.**

## 2.1 Absolute time

According to its most famous proponent Isaac Newton, absolute time, or Newtonian time, exists independently of any perceiver, space and even the universe. It progresses at the same consistent pace for everyone and everything throughout the universe. This aligns most people's everyday notion and experience of time.

## 2.2 Relativity

Albert Einstein's theories of relativity upheaved the age-old perception of time as absolute, showing that time is dynamic. The following are key aspects of his theories.

1. Space and time are intermingled and inseparable, and Einstein called it **spacetime**.
2. All movement is relative. Even though we often feel as if and even claim we are standing still, everything is moving and at varying rates.

For example, say someone in a train throws forward a ball inside the train. To him, it seems that the ball is moving at, say, 10 kilometers per hour. Yet, to the observer standing on the ground beside the train, the ball appears to be moving at the speed of the train plus the speed of the ball. However, while the observer on the ground may perceive that he is standing, he also is moving. The earth he is standing on is rotating and circling the sun, the sun is moving and the galaxy is moving.

3. The faster an object moves, the slower its time. If a person leaves the earth on a spaceship going close to the speed of light and comes back in a day, she will be a day older but the people on earth will be many years older. This change in personal time is only significant when nearing the speed of light. The differences humans experience, even on an airplane, are negligible.

4. Like a ball on a sheet, a massive object warps or curves the geometry of the surrounding spacetime. This warping is what we experience as gravity, and the more massive an object the more it warps spacetime. Time is slower the further it is in the well of the spacetime curve. Experiments using clocks on airplanes proved this gravitational time dilates to be accurate. (Jamaludin 2021) (Kennell 2015)

## **2.3 Quantum Physics**

The word quantum (plural: quanta) refers to the smallest amount of something that you can have. Quantum physics is the branch of physics relating to the very small: The atomic and subatomic levels. Things at the quantum level work differently than at the macro level we experience in our daily lives. Newton's classical laws do not apply at the atomic and subatomic level, and quantum physics defies common sense and normal human intuition.

In Newtonian physics and in Einstein's relativity, an object exists in a specific place at a specific time. However, in quantum physics, a subatomic particle exists in a cloud of probable places and states. When you take a measurement from a particular perspective the particle will be in one spot, when you take in another it will be another spot. If you take enough measurements it will be in all the possibilities of the probability cloud.

In quantum physics and counter to human intuition and logic, particles act both as particles and waves. They act like a wave before they are measured, then like particles when observed.

Another oddity is that subatomic particles change position and speed instantaneously. A subatomic particle goes from point a to point b, or speed c to speed d, instantaneously with no in between states or positions. This is the equivalent of a car going from 0 to 100 kilometers per hour, or from the house driveway to the store, instantaneously.

This may all sound bizarre. However, quantum physics has been one of the most reliable physics theories for predicting phenomena.

### **2.3.1 Time in quantum physics**

Quantum physics theories and models treat time as continuous and linear. This does not constitute a prediction that time in reality is continuous. Rather it is the convention used for the model.

Some physicists ponder that time may be able to be quantized. However, this is speculation and has not been shown to be true.

## 2.4 Entropy and the Arrow of Time

Most of physics's deep laws and equations do not require a time direction. On paper, the equations can go both directions. This is a reason why some say that backward time travel is theoretically possible. However, if we look at the world we live in, time appears to flow in one direction: from the past to the present to future. This flow is called the **arrow of time**.

So where does this arrow of time come from? The answer is **entropy** or the **second law of thermodynamics**.

The second law of thermodynamics says that entropy, a measure of disorder in the universe, increases in any closed system. The things in the universe move from order (or low entropy) to disorder (high entropy). If you pour milk into coffee, the milk spreads throughout the coffee. If you light a fire, the smoke spreads throughout the air. It never goes the other way. The smell of coffee or smoke spreads throughout the room and home, never the reverse. A vase falls to the cement and breaks into many pieces, and never the reverse. People, other animals and plants getting old, decaying and dying are examples of entropy. No one grows old to young.

The Big Bang and subsequent expansion of the universe is an example of entropy. The universe started as an infinitesimally small dot 13.8 billion years ago, and has been expanding since. The universe and things in it are expanding towards eventual perfect equilibrium where everything, including atoms, will be equally spread out. With this equilibrium, there will be no movement and, thus, there will be no time. Until then, change from order to disorder is the basis for our time and for the arrow of time.

### 2.4.1 Resolving the Seeming Contradiction of the Symmetry Of Physical Laws Versus that Time Goes in Only One Direction

As noted, the physics equations are symmetrical and have no direction of time, yet time in our universe moves in only one direction. This seems to be a conflict. The great mathematician Kurt Godel had troubles with the symmetry of physics's laws, because this



didn't match up with the common sense that you can't go back in time. He concluded that science's definition of time was "unreal."

However, there isn't a contradiction. The physics equations are in general for all situations, but we live in a particular universe in a particular state. If we were living in another universe of perfect equilibrium there would be no time. There could be a universe or our future universe that is contracting, or moving from high entropy to low entropy. This would mean that time would be moving in the opposite direction. Physicist Julian Barbour suggests that on the other side of the Big Bang there could be the universe that expands and time flows in the opposite direction. (Carroll 2013) (Barbour 2021)

## **2.5 Scientific Theories are Functional Tools Not Direct Representations of Reality**

Science's mathematical models and theories are functional tools used to make predictions about physical phenomena. They are not direct or whole representations of reality. Statistician George E.P. Box famously said, "All models are false, but some are useful." (Box in Barroso 2015) (Brennan 2018)

Instrumentalism is a scientific principle that focuses on the utility of scientific models and theories. It views theories and models as black boxes, with only their input and output being relevant. The theories and models themselves are not reality. (De Neufville 2015)

For example, quantum physics's mathematical models that describe subatomic particles as waves and particles don't mean the particles *are* waves and particles. They are mathematical models. Quantum physics theories have holes and mysteries. They are not fully understood and there are competing interpretations of what is going on. While making reliable predictions, quantum physics may simply be too abstract for human brains. (Information Processor 2018)

Further, some physics theories that are known to be incomplete are still used because they are, at least in areas and levels, good at predicting. Though the theories are known to be incomplete and sometimes incorrect, today's physicists still use some of Newton's laws in certain situations because they are good at predicting phenomena in those situations. The same with some of Einstein's theories. (Deep Breadth 2018)

The definitions of time used in physics-- Newtonian, relativity, quantum mechanics theories-- are not representations of what time really is. I believe that if you asked Einstein or quantum physicist Richard Feynman what really is time they would say they did not know.

Conventions play important roles in science. The physicist, mathematician and philosopher Henri Poincaré said time is not an objective thing to be discovered. He said it is something humans invented for their convenience. In the end, our definitions of time are just that: conventions and definitions. (Oxford Reference 2013) (Muzi 2015)

### **3 PSYCHOLOGY AND TIME**

Human psychology is inseparable from all human perceptions and definitions of time, including in science. Humans can only look at things from the human perspective, and this makes our thinking about anything inherently myopic and subjective. Even our philosophizing about time in this essay is done through the human lens.

Personal psychological time is the way time is perceived by the individual brain. This perception is unique to the individual, and the perception of time can change for various reasons. Psychologically, time seems to slow or speed up based on many things: if one is asleep or awake, bored or excited, young or old. Drugs, medical conditions, mental disorders and events alter our perception of time.

There also is psychological time particular to the human species. In order to function and survive as a species, the human brain has evolved to mentally process in a particular way the limited sensory information it receives. The visual and auditory perceptions in our mind are not direct representations of the physical world, but mental translations of sensory information. Visual and auditory illusions demonstrate the existence of margins or errors and misperceptions in our perceptions. Such illusions demonstrate that physical reality and our perception of physical reality are different.

Our intelligence and ability to function require a concept of time and space. Catching a ball and reaching for a doorknob require a concept of space and time. Identifying an

approaching animal as a dog requires knowledge from the past. Our consciousness, or self-awareness of ourselves and our environment, requires a concept of the past and future. Though humans may be unique in consciously conceptualizing time, our and other animal brains have automatic unconscious concepts of time and change. Though seemingly real, the flow of time we perceive may merely be an evolutionary neurological way the brain uses to make sense of sensory information.

While Isaac Newton believed that time was an objective thing independent of humans and even space, Newton's contemporary, Gottfried Leibniz, believed that time does not refer to any actual existing dimension. He felt that time is a convenient intellectual concept that enables us to sequence and compare events. Similarly, philosopher Immanuel Kant wrote that our conceptions of space and time are not substances in and of themselves but artificial cognitive constructs needed to make sense of or sensory information. (Arntzenius 2017) (Kant 1781)

Psychologist and philosopher Williams James said that our automatic, unconscious experience of the present always has an element of earlier and later, and that any perception that includes earlier and later is not a purely instantaneous perception of time. Our perceptions of everything involves a concept of change, which inherently involves an awareness of the past and future. Humans are innately storytellers and perceive everything as part of an ongoing narrative in time and space. (Anderson 2011)

Though not fully understood, the brain uses internal neurological and cognitive methods to process sensory information to make perceptions of time, space and identities. The brain has internal clocks and uses a process called integration to make time appear fluid. As with our visual perception, our perception of time is based on expectations and preconceptions. People under hypnosis can judge time more accurately than when they are awake, demonstrating the artifice and processing in our conscious perception of time. (Dawson and Sleek 2018) (Nilsen R 2017)

Further, it takes a short delay for our brains to process the sensory information to make a perception of "now." Our perception of the present is of the past. (Eagleman 2019)

As with visual and auditory illusions, there are cases of misperception of time, including misidentifying the order of events. For example, Stanford neuroscientist David Eagleman

has demonstrated that under certain circumstances a person can misperceive a later event happening before an earlier event. (Eagleman, 2019) (Dawson and Sleek 2018) (Davis 2019)

### **3.1 Is Time an Illusion?**

Humans perceive that time is past, present and future. However, close examination demonstrates problems in this perception. Philosophers Aristotle and J.M.E. McTaggart said that time as conceived and defined by humans is unreal and an illusion. McTaggart believed that all human conceptions of the universe are artificial and illusions. (Jain 2019) (McTaggart 1927)

Aristotle said that time is made up of the no longer (the past) and the not yet (the future). He said these are unreal in the present. Yet the present, the thing that separates the unreal past and the unreal future, is infinitesimally small to the point of being nothing. If the past is unreal, the future is unreal and the present does not exist, this would point to time, or at least our conception of time, being unreal and an illusion.

## **4 TIME TRAVEL**

We all travel through time. However, most people consider time travel as traveling significantly abnormally: at a different rate, skipping through time or in an unusual direction.

Some perceive of different biological ways of traveling. Keeping fit and healthy and modern medicine prolong life spans, giving people the ability to live further into the future. Some imagine such things as cryogenics as a way to bring people back to life in the future. Movements such as transhumanism and posthumanism involve many theories of medically and scientifically extending and changing human life. (McKie 2018)

Whether because of drug use, mental disorder, physical situation or neurological experience, people psychologically experience time radically differently. Learning about

the past and having new insight into one's future involve a sort of mental time travel or expanded conscious awareness.

#### **4.1 Physics Views on Time Travel**

Physics offers possible and real examples of time travel, though none realistically apply to human beings. The Fermi Paradox suggests that if time travel happens, we would have encountered people or things from the future. (Shalheveth and Madar 2017)

Time dilation in the theories of relativity shows how time changes when things speed up and are near massive objects. Einstein said that something that moves faster than the speed of light goes backwards in time. Black holes are areas of extreme gravity that suck time and space. Wormholes are speculative structures in space that link disparate points in spacetime and that would theoretically allow time travel, including backward time travel. (Stein 2021) (Moscowitz 2012) (Osbourne 2017)

Changes in the direction and/or rate of entropy would change time. This may happen in the future in our universe.

Quantum physics offers theoretical examples of time travel being possible, and some speculate that time itself may be quantized. (Fernandez 2019)

Some particles move at the speed of light and black holes exist, meaning time is different and changing for some things in the universe. However, none of this time traveling seems plausible or even possible anywhere in the near future for humans. A human wouldn't survive a black hole or wormhole, and the possibility of a human traveling at the speed of light, much less faster, is improbable.

#### **4.2 Philosophical Paradoxes**

There are many philosophical problems with time travel, some pointing to backward time travel being impossible. (Shalheveth and Madar 2017)

Entropy goes in only one direction in our universe. Backward causation, or a future or present event causing a past event, seems logically impossible. (Yami 2007) (Uyeno 2019)

There is a famous Grandfather time travel Grandfather where you are supposed to go back in time to assassinate your grandfather. Logically, you can't do this. If you killed your grandfather you would never be born to go back and kill your grandfather. Philosophers say this reasoning applies to all causal events. (Uyeno 2019)

## **5 FINAL NOTES**

There are countless ways to consider and think about and define time, including not covered in this essay: Biological time (NIGMS 2018); Different modern cultural perceptions (Pant 2013); Conceptions of time and time travel in literature and film; Non-human animal perceptions of time (Trinity College Dublin 2013); The history of timepieces: sundials to pendulum clocks to quartz watches to atomic clocks, the history of calendars (Andrewes 2006); Common philosophical questions such as "Is time infinite or finite?", which is an ultimately unanswerable question, in part as infinity itself is an abstract human concept that cannot be empirically tested and may not exist in the physical world. (Ceurstemont 2017) (ESA 2001).

Even if seemingly oppositional, the different ways of considering time often aren't in conflict, but different particular perspectives. When considering the different physics, psychological, cultural and theological conceptions, it may not always involve so much different perspectives of time but different definitions.

We can only think about time and think about our own thinking from the human perspective. Often, when you look close enough at time, you aren't looking at time but looking at your mind. The paradoxes and illusions of time are really paradoxes and illusions of our mental conceptions and definitions of time. And maybe that's all time ever is: a human abstract conception and a definition. This essay has given you many details and theories about time, yet likely has gotten you no closer to answering the question of 'What is Time?' Such is the nature of time.

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