Physics

# The Controversy of Time, Shreya Kabra

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When someone is asked the question 'What is the nature of time?', their answer would probably be the ticking of a clock or the continuous passing of a second. However, these are just physical manifestations of a more fundamental principle. Time is, indeed, a very interesting concept and one that is difficult to capture.

## Cyclical Time

In the religious texts of Vedas in Indian philosophy, time is described as a cyclical structure, with the universe going through iterations an infinite number of times. Later, this view was paired with the 'wheel of life'. Once an earthly creature dies, it reincarnates into another creature. This runs parallel to the idea that once the universe is destroyed; another one is created.

Whilst modern day philosophers might reject this idea and some might even call it unfounded, it is not unreasonable for them to hold such a view.

Consider the lunar cycle, the seasonal cycle, the iteration of day and night, the life cycle of plants like cogs of the earth keeping it functioning. Each separate cog has its own function and triggers the functioning of another cog. For example, the lunar cycle is responsible for the daily high and low and high tides of the ocean and the seasonal cycle is responsible for the annual life cycle of plants on Earth. If any one of these cogs stops working, then the grand unified structure will be disrupted. Thus, we can prove that there is a relationship between the smaller and perhaps more complex structures of the Earth to the whole Earth itself. The repetitive nature of these cogs can therefore be applied to the general nature of time. This suggests that time itself is cyclic.

However, one might ask the following question: "how are we to differentiate between each cycle of events in time?" If the seasonal cycle is repeated every year, then how can we tell one apart from the other. This suggests that each cycle overlays on a straight order of some sort. The underlying linear order is known as hypertime. Imagine a single train track stretching far into the distance. Each wooden plank is the same as the previous one, placed at different distances along the train track. Each wooden plank represents one cycle of events and the whole train track is hypertime. Since each cycle happens at a different point in hypertime, we can distinguish them from their previous and future ones.

But this does not exactly solve the problem of whether time is linear or cyclical, so let us try another example. Imagine there is a very big circle, one as large as the Earth itself. If a person were to walk around the circumference of this circle, to them it would seem like they are walking on a straight line. However, we know that they are curving ever so slightly.

We are like the person walking around the circumference of the big circle. Since we cannot see the whole 'circle of time', to us it seems like hypertime is linear but in reality it could be part of a much bigger cycle.

## Linear Time

As we are living within a space-time environment, we can confidently say that we have experienced our individual past and know it. But we cannot see into the future and we do not know what is going to happen 10 years down the line. This suggests that time is flowing in one direction (linear), from the past to the future. We can say that the time of the past is finite because it can be measured from and up to a certain event, like The Big Bang. For individuals, time in the future is finite but for the universe time in the future is infinite. There has been a long-standing debate on whether the world will expand forever or whether The Big Crunch will occur. In the past, scientists believed only two factors affected the expansion of the universe: (i) the gravitational attraction of all galaxies between each other and (ii) their outwards momentum. Ignoring air resistance, imagine throwing a ball in the air. Because of gravity, it will eventually lose all its initial speed and fall back to the ground. Similarly, any other object or body experiencing a gravitational force with no other force acting on it will eventually succumb to the gravitational force. Given this, it was predicted that the expansion of the universe will stop and, instead, everything will start to collapse towards each other and reach another point of singularity. However, scientists recently discovered that the universe was expanding at a non-uniform rate. Galaxies farthest away from us expand at a faster rate than galaxies closer to the Earth. To explain this, scientists thought there must be an unknown force acting on galaxies causing them to expand at faster or slower rates. They named this unknown phenomenon as dark energy. Since the Big Crunch requires no other force to be acting on galaxies and there is evidence of dark energy influencing the momentum of galaxies, the Big Crunch no longer has a solidified argument.

The Second Law of Thermodynamics states that the increase of entropy is inevitable with the passing of time for certain systems. Therefore, for these systems, we can consider there to be an arrow of time. Imagine watching a film in which a broken egg on the floor transforms back into an unbroken egg on top of a counter. It is apparent that the film is being played backwards because if a broken egg could easily be re-assembled to an unbroken egg it would violate the Second Law of Thermodynamics. Events like the unbreaking of an egg can only occur if time is flowing backwards. Time cannot flow backwards just as the egg cannot be re-assembled. Therefore, in our universe,

time can only flow forwards and is unidirectional.

Another reason why people consider time to be linear is because of the way we can measure it. For example, we can measure the time it takes for the Earth to travel around the Sun. This shows the linear progress of the Earth from a point onwards. Such natural phenomena and other man-made events can be recorded in 'long, cumulative and linear' sequences.

## Is the flow of time real or not?

Time feels like it is flowing and advancing. Everything falls into a chronological order once time is introduced. For example, one must be born first, then live and then die. Time brings order and structure to the otherwise chaotic world. But are these physical properties of time or just constructs of the human mind?

According to Huw Price, a professor of Philosophy at the University of Cambridge, these properties of time come from our mental state and not reality. Physics presents us with a 'block universe' where time is a part of the four dimensions of space time. Consider every event that happens as having its own coordinates. It will have 3 coordinates of space which defines the 'where' of the event and 1 coordinate of time which defines the 'when' of the event. In this scenario, all points are equally real, therefore, it cannot flow from the past to the future. The past is as real as the present which is as real as the future.

We perceive time having a direction because our minds add a 'subjective ingredient to reality'. We see things changing every day and, to be able to comprehend that change, our mind creates this illusion that time is flowing.

However, we must consider the following question: "in this four-dimensional reality of space-time, is it really possible to have change?"

Physicist Max Tegmark of the Massachusetts Institute of Technology says:

*"So, life is like a movie, and space-time is like the DVD, there's nothing about the DVD itself that is changing in any way, even though there's all this drama unfolding in the movie."* [1]

We have this illusion that things have changed from the past to the present and events in the future will possibly change. This is because we are all victims of our own brain state. Just like a person watching the movie and experiencing all the drama for the first time, our brains are only able to understand 'one event' at a time. In truth, like the unchanging DVD, the past, the present and the future are all existing and plotted within space time, therefore making change an illusion.

In conclusion, time is an essential and fundamental part of our lives, though its essence is difficult to encapsulate and still a mystery to be solved.

*For references, click here.*