Time is Perception

Solomon Leyba

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The human eye is a complex piece of machinery. It enables us to perceive shape and color in a way that most other organisms are incapable of. This adaptation has affected our growth and evolution, both biologically and socially. It is perhaps one of the most important parts of our evolution, alongside the opposable thumb. Among other things, the eye enables us to sense changes and movement of objects. These regular changes are how we measure time; the movement of a clock hand or the change in the position of the sun remains consistent, for the most part, day in and day out. We experience and measure time as a perception or measurement of change. These changes, however, are skewed, distorted, and changed slightly by certain fundamental defects in our eyes. Therefore, human perception of time is distorted and changed in some way.

The human eye is, perhaps, one of the most complicated organs in the body. It is composed mainly of the cornea, which refracts light; the retina, which senses light and sends electrical signals; the pupil, which allows light to enter the eye; the iris, which changes the size of the pupil; the aqueous humor, a clear gelatin that fills the eye; and several types of light sensing organs. Light enters the eye through the pupil, is focused by the cornea, and is translated by the light sensing organs on the retina and sent to the brain through the optic nerve.[4] We can compare the eye to a camera; the pupil and iris are similar to the aperture, the cornea is the focus, and the retina is the film.

The cells of the retina are what enable us to see. The retina is composed mainly of two types of light sensing cells, rods and cones. Cone cells enable us to see color, but only work well in bright light, whereas rod cells work best in dim light, and are responsible for night-vision. When light hits these cells, they are stimulated into sending electrical and chemical signals through the optic nerve and into the visual cortex of the brain, which reassembles these electrical impulses into an image we interpret as what we are seeing. Our eyes, however, are incredibly imperfect; the parts that make up a human eye contain many flaws, such as small blind spots in the vision and fatiguing of the rod and cone cells that enable us to see. The eye and the brain are easily tricked into perceiving things as being different from how they actually are due to the defects inherent in our eyes and the visual cortex.

When an image causes us to see things that aren't there, or when we don't see things that actually are, we say that our eyes are playing tricks on us, or we call them optical illusions. Optical illusions exist because of fundamental flaws in the structure of our eyes and of the way we sense light, color, and objects. Some of the largest flaws in the eye are the several blind spots it has: two in the peripheral vision and one where the optic nerve connects to the eye.[4] This "scomata" is due to the lack of light sensing rods and cones where the optic nerve connects. These blind spots can greatly affect our vision. For example, at three-hundred feet away, a disk with an eight foot diameter can disappear completely from our vision should it fall completely in the optic nerve's blind spot.[4] However, the visual cortex mitigates this blind spot by it simply filling in the missing details in one eye with what the other eye sees. The brain fills in missing details by either guessing at what should be there, or by using information from the other eye.[4]

The brain will connect lines that are broken, create large shapes out of groups of smaller shapes, and will interpret negative space as being a positive shape simply because instinct and past experience tell it that the lines should be connected, the small shapes should make up a larger shape, and the negative space should be an object itself.[7] This effect is a part of the "Gestalt effect". The Gestalt effect is the fact that the brain tends to interpret images and signals all at once; it does not take many small details and adds them up to a larger picture but in fact sees the larger picture first then fills it in with small details.[7] This explains how broken lines of geometric shapes will look like the actual geometric shapes; the brain sees the whole shape first and then fills in the details of the shape, such as the broken lines.

Another important flaw in the eye is the fact that the rods and cones are not arranged in perfectly straight lines.[4] Therefore if we look at a perfectly straight line, the light will activate rod cells or cone cells that are not in a perfectly straight line, and the brain will interpret these signals as not being those that correspond to a straight line. When we do see a "straight" line, it is because we believe it is a straight line; we only notice imperfections by looking closer. The rods and cones are also subject to fatigue. Looking at a colorful image for a long time will leave a complimentary colored afterimage in your eyesight when you look away. This happens because the rods and cones become tired after being activated for so long and cannot fire as strongly or as quickly. The brain interprets the lowered firing rates of one color sensing part as actually being the same as looking at that color's compliment.

Light is related to our perception because it enables us to see, with sight being arguably one of the most important senses. However, light is also restrictive, due to the fact that it travels at a limited speed, which can greatly affect our perception. People generally know a little bit about the general theory of relativity and how it relates to light and time, but my research led me further. One of Einstein's main ideas, crucial towards the development of his theory, was that the speed of light in a vacuum is both constant and limiting, in that the speed of light in a vacuum will always be the same and that nothing can ever travel the speed of light, except for light itself.[3] According to Einstein's theory, as the speed of an object increases towards light-speed, so does its mass. The equation $E=MC^2$ helps explain this: the faster an object goes, the more energy (E) it has, and since the speed of light (C) is constant, the mass (M) must increase proportionally to balance the equation.[2] So, when any object travels closer and closer to light-speed, its mass increases towards infinity, and therefore the energy needed to move the object increases towards infinity. The problem with this is that infinite amounts of energy do not exist in our universe. For Einstein, making the speed of light a constant meant that in order to balance his equation, something else would have to become a variable. As the energy of an object can be translated as the distance moved divided by the time taken, Einstein realized that both distance and time became variables in his equation.[1] Therefore, our perception of time, distance, and the order of events depends entirely on our physical position and speed.

The fact that the brain interprets all of our senses raises an interesting question: is what we perceive actually there? Electrochemical signals produce feelings that the brain interprets as our senses, and we tend to assume that all the signals we get are from objects that actually exist.[6] However, we cannot directly experience these objects, as they merely exist as chemical copies in our brain, so how can we be sure that anything actually exists? George Berkeley, one of the main proponents of immaterialism, which is also called subjective idealism, argued that objects are merely ideas in peoples' minds; they do not actually exist. As all of our senses, experiences, memories, and perceptions are merely electrical and chemical signals sent to and interpreted by the brain, then it is impossible to know whether or not we are a "brain in a vat" that is being fed these signals, or if we actually experience all that we think we do.[6] Our perception of the world is fundamentally flawed because we can only perceive copies of objects; we never truly can experience the object.

A famous thought experiment[2] posed by Einstein was to imagine a train with a passenger in the middle seat, and an observer outside the train. At the moment the passenger in the train passes by the outside observer, two bolts of lightning strike the front and back of the train. To the outside observer, who is not moving, the light from both the bolts travel the same distance and at the same speed, so he perceives both of the bolts as striking simultaneously. However, in the time between when the bolts struck and the light travelled to the passenger's eyes, the train has moved forward slightly. This means that the front bolt's light would have traveled less distance than the light from the back bolt, but they both still travel at the same speed. Therefore, the moving passenger perceives the front bolt as having struck before the back bolt. Two observers noted two different orders of events happening, so which one is right? The answer to this is that they both are correct. Depending on the frame of reference, events can happen at different times, but there is no one "absolute truth". The "truth" of events is relative to your reference point, hence the name, "theory of relativity".

The way we measure time is rather arbitrary. We have quantified and defined time as simply being regular change in bodies. The sun passing over the Earth, the movement of clock hands, the position of stars, and the grains of sand moving in an hourglass all tell us what time it is. At the very least, they tell us what time the human race has collectively decided it to be. However, these systems are imperfect. Clocks can malfunction, hourglasses can become stuck, and the light from the sun takes eight minutes to get here, so the position of the sun we see this second is its position eight minutes ago. The light from the stars takes even longer to reach our eyes. Nothing we see actually happens at the moment we see it.

The perceived or actual movements of the bodies we use to measure time do not just move on their own, they require energy to move. In fact, every particle or group of particles requires energy to move.[5] An important set of natural laws concerning the transfer and use of energy are called the laws of thermodynamics. The second law of thermodynamics, or entropy, states two important things. First, energy levels in a closed system will eventually equalize between objects, and be evenly distributed. This means that work, which is the transfer of energy between objects, can therefore no longer be done with the energy in that closed system. For example, we can imagine a completely sealed room with a glass of ice water in it. Eventually, the room will melt the ice and warm the water, and the room in turn will become slightly cooler. After the energy levels of the ice, the water, and of the room have reached equilibrium, no energy transfer could ever take place again, and the system is essentially dead. This state is called thermodynamic equilibrium. The only way that energy transfer could take place would be for an outside influence to enter the system. The entrance of a new influence capable of movement and change would affect the all other objects in the system. However, nothing can enter or exit a closed system such as the hypothetical room or our universe, making this situation impossible.

Second, the second law of thermodynamics states that systems will become steadily disorganized. For example, over millions of years, a boulder will wear down into rocks, which will wear down into pebbles, which will wear down into sand, which will wear down into atoms; a piece of burning wood will release heat energy and will produce smoke and ash, both of which are less organized than a solid chunk of wood.

We can imagine both of these effects taking place in our closed universe, but over a much longer period of time. Eventually, all matter will be in its most disorganized state and no energy will be available to do work, such as moving things around or changing the temperature of an object. This is referred to as the "heat death of the universe". All particles will be dispersed around the universe in such a manner that no movement between them could ever take place, and every inch of space, every particle, will be the same temperature. The human race does not need to consider the heat-death as a potential threat to them, as this state will not be reached for at least a googol (a one followed by one hundred zeroes) years from now.[5] But should the universe ever reach this state, it will become like the sealed room presented earlier: void of all movement and change. The only way for any change to happen would be for an outside force to enter our universe, which, again, would violate the laws of a closed system.

It is clear now that the way humans measure time is through perception of change, which is due to the transfer of energy. The change in the sun's position or the clock's hand tell us whether it is day or night, seven o'clock or eight o'clock, dawn or dusk. However, if our perception is flawed due the fundamental physical imperfections in the eye's structure and the way the brain processes information from the eyes, then our perception of the changes we measure time by must be distorted. Therefore, our perception of change, our sense of the passing of time, must be imprecise and incorrect as well.

Imagine that all movement on Earth suddenly stopped. Everything was frozen in place: clouds, people, hurricanes, cars, and the oceans were all frozen in place, but we could still process information and think, and sight was still possible. An alien watching our planet would be forced to conclude that due to the lack of movement and of change in *anything* on our planet, time must have stopped, at least on Earth, because he is noticing changes and movement in other areas. However, someone who is frozen but can still think would be able to experience time at a somewhat normal rate because they would be thinking, and would realize the change in their thoughts over time. Now, imagine our universe is in a state of maximum entropy; the heat death of the universe has happened. All movement of particles and energy, all change has stopped. To an observer outside of our universe looking in, time has effectively ceased to exist in our universe. While time as a dimension may still exist in some form in our universe, any observer would be unable to experience or notice the passage of time because no movement of particles and no transfer of energy is taking place. This outside observer is analogous to the alien watching our frozen Earth; both of them are experiencing time for themselves, but they must also conclude that time has functionally ceased to exist in the area that they are observing, as there is no observable change or movement. Heat death means that time will essentially cease to exist in any measurable way in our universe.

Time, while theorized by scientists and discussed in fiction as a separate dimension, functionally exists to humans as a measurement of change in bodies. Anything that changes regularly, such as the movement of the sun and stars, or the oscillations of radiation released from a cesium-133 ion (a second is defined as 9,192,631,770 oscillations), is used by humans as a way to measure time.[1] However, all of these things are perceived either by our own eyes, or by machines we have designed to function with our eyes. The fundamental flaws in our eyes, in the way the brain processes information, and the nature of the speed of light requires there to be some kind of misrepresentation of the change in objects with which we measure time. Therefore, our perception of change, and of time, must be skewed. The fact that we rely on change to sense time also means that time will eventually cease to exist in a measureable form in our universe. The heat death of the universe means that eventually all movement of mass and of energy will stop, as the universe will reach thermodynamic equilibrium.[5] Perception of change by any observer will no longer be possible without any movement of mass or energy, meaning that time no longer exists.

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