Universal Specificity Investigation 2: Inducing The Cause of Kinetic Time Dilation

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The results from the previous investigation into the nature of time revealed that time properly conceptualized is the interval over which change occurs, and is not a property of the universe part from physical changes. Additionally, it was revealed that changes to this interval over which identical changes occur implies a difference between their conditions. For example, when an hourglass or grandfather clock relocates to a different altitude, the interval over which the sands drops or the pendulum swings changes because of the difference in gravitational force at the two altitudes. I now turn the conception of time dilation, in much the same manner that time was analyzed.

1. On the Nature of Time Dilation

What is time dilation? The common understanding is that, in two different reference frames, two observers will record a different passage of time using the same clocks [1][2]. For example, each twins' measurement differs for how long it takes one twin to travel to Alpha Centauri and back in the twins paradox scenario. This conception of time dilation obviously assumes the common conception of time discussed in the previous investigation, where time is a property of the Universe and an aspect of spacetime.

How would our conception of time dilation change given the conception of time at the base of theory of universal specificity, where time is the interval over which change occurs? The conception of time dilation would change to the following: *time dilation* is a common change in the interval over which all change occurs. It would mean that, in the twins paradox example, each observer is measuring the same interval of time for the duration of the round trip travel, but using different units of measurement. If we accept that an hour is a standard unit of time set on earth, then it means what the traveling twin's clock is measuring as an hour is not really an hour, but something more than an hour. It is analogous to an hourglass or grandfather clock moving to a higher altitude; each would measure a local hour, but in reality it would be something more than an hour.

We know what causes the hourglass and grandfather clock to measure different units of time at different altitudes, but what causes all intervals for all physical changes in the traveling twins reference frame (or any reference frame) to change by the same rate? That is the focus of this paper's investigation.

The form of kinetic time dilation best suited for studying this change of units, is estimated to be a ratio of time passage of two identical clocks in two different reference frames, and is formulated as follows:

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} \tag{1}$$

In this form, dt represents the time rate of change for an object traveling in an inertial frame, as measured by some clock in that frame; dt' represents the time rate of change for a stationary object, as measured by an identical clock in its inertial frame; v is the velocity of the traveling object relative to the stationary object; and c is the speed of light. This form allows me to focus on what causes this differential to a change.

2. The Cause of Time Dilation

In my investigation for this cause I have identified two plausible causes posited by others, and one abdication for any need for a cause. The abdication amounts to relying on the Lorentz Transform to predict any time dilation related measurements one can possibly verify, and indeed, this transform does just that. It describes *what* one can expect to observe with regard to time differential effects with exactitude. I aim to go further and discover *why* we observe it.

In addition to the two posited causes, I added two of my own—work done and specific work done—and the compiled list is as follows:

- Relative Velocity
- Acceleration
- Work Done
- Specific Work Done

Just to give a brief description of each: relative velocity is based on the realization that changes in time differentials only occur between two frames when there is a relative velocity between them; acceleration is based on an attempt to resolve the twin paradox by concluding it must be during accelerating where the traveling twin's aging slows down; work done is one of my contributions, and it is based on the realization that velocity, acceleration, and the need for the Lorentz Transformation are all caused by work done to an object; specific work done is like my other contribution, but requires work to scale by the mass of an object.

Ruling out Relative Velocity

It might seem reasonable to think velocity is the cause of changes in time differentials between two frames because it is the only variable in Equation (1).

As an extreme counter example, consider what happens when the twin paradox is modified such that both twins travel with the same speed profile, but in the opposite direction. These

siblings can have any possible relative velocity with respect to each other; however, no difference is registered between what their clocks measure, as shown in Figure 1.

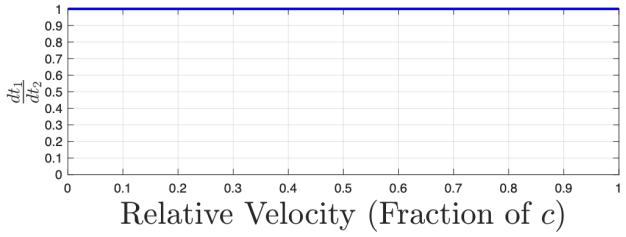

Figure 1. **Velocity changes, but time differential remains unchanged.**

Invoking the method of agreement, where the effect remained invariant when the plausible causal factor changed, proves inductively that relative velocity is necessary, but insufficient, to cause a change in the time differential.

Ruling out acceleration

In the twin paradox, one twin accelerated and the other did not, and the accelerated twin's clock slows down from the established standard set on earth—acceleration seems to be the difference that makes the difference. This approach, therefore, concludes that the time differential is less than unity during acceleration, not during differences in velocity. Einstein even attempted a twin paradox resolution assuming that the gravitational time differential was responsible for the kinetic time differential during acceleration; however, this plausible factor has been disproved in many sources [3][4][5][6].

Ruling out Work and Inducing Specific Work

The remaining plausible causal factors are the like acceleration argument, except acceleration is what causes a change in the time differential. Meaning the time differential remains constant until work (or specific work) is done, which implies time differentials have an "inertia." This conception of the time differential remaining constant for an inertial frame is termed *inertial time differential* (ITD).

That being said, let's put the remaining two factors to the test. Two simple thought experiments reveal that a change in specific work is the precise cause.

Proof:

First, I evaluate the effects of force applied over some distance.

Case 1: Consider a planet that barley accelerates to some final velocity when some work is done to it versus the same work done to a tiny marble, which causes that marble to zoom to a much higher velocity. Using the Lorentz Transformation reveals that the marble experiences a slower clock than the planet; therefore, invoking the method of difference, where each object experienced a different effect than the other, while having the same work done, proves inductively that work does not cause changes in ITD.

Now, I evaluate the effects of specific work.

Case 2: Consider the same two objects as before, but now they have the same specific work applied to them. Using the Lorentz Transformation reveals the same time differential between the two; therefore, invoking the method of agreement, where each object experienced the same effect, while having the same specific work applied, proves inductively that specific work applied causes the change in ITD ■.

It has been inductively proven that an object undergoing a non-zero net specific force applied over some distance causes its ITD to change. Of note, this ITD change is conservative, meaning when work done returns the object back to its original state, then the ITD also returns to its original state regardless of the path taken. Knowing this, I would like to derive a precise math model for changes in kinetic ITD in terms of the precise causal factor.

Deriving The Causal Math Model

If we assume that kinetic energy and work represent reciprocals of the same causal phenomenon—a non-zero net force causes a change in kinetic energy, and changing the kinetic energy (e.g., a rocket engine sending hot gas away very fast) creates a force—then Equation (1) transforms nicely into specific work as shown in Equation (2), if we assume Newtonian kinetic energy.

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} = \sqrt{1 - \frac{2\Delta e_K}{c^2}} \tag{2a}$$

$$= \sqrt{1 - \frac{2\int a(r)dr}{c^2}} = \sqrt{1 - \frac{2w}{c^2}} \blacksquare \tag{2b}$$

It is unclear at this point that its valid to use Newtonian kinetic energy over relativistic specific kinetic energy, which is $(\gamma - 1)c^2$, where $\frac{1}{\gamma} = \sqrt{1 - \frac{v^2}{c^2}}$. Equation (1) does not transform nicely into terms of specific work if we are to use relativistic kinetic energy. This brings into question the derivation of relativistic kinetic energy, and if it was based on a proper conception of time, which is the topic of the next paper.

3. CONCLUSION

The cause has been induced, but we lack confidence in our math model for it since there is some ambiguity in which kinetic energy model to use. Determining which model to correct is the focus of the next investigation.

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