The Inertia Paradox

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First, one must consider the title to be a working title because I can't be sure that there is an actual paradox or catch-22. It is something of an unknown for me and thus my child-like understanding and limited knowledge dictate for me an unclear perception of reality (although, with no disrespect to Descartes). So, my working title illustrates this unknown, this confusion and I suggest herein a sort of question as to how reality, as it is usually presented, can actually be real. I suspect a Carl Sagan or Steven Hawking or especially a Richard Feynman could explain it. Alas, all three are gone but still, I would like to ask. So, follow along in this abstract mental exploration to see if you arrive at the same place I have and what seems highly paradoxical to me.

Relativity

Everyone has heard of "Relativity" just as everyone has heard of Albert Einstein. Some have even associated the two together without really understanding much about it. Some examples from everyday life seem obvious and help clarify a basic sense of the concept. The coffee is hot. Well, not compared to the Sun. The coffee is cold. Well, not compared to an ice cube. With these examples, everyone has some operational notion of relativity in everyday life at least at a basic level.

More complex examples in real-time can be harder to grasp. But, most everyone has a sense of speed from riding in cars and public transportation, etc. Even running fast or watching race cars or race horses (figure 1) can illustrate a sense of speed. But, of course, that speed is always relative to something in the surrounding environment. For the race horse, focusing on the fast moving horse, the crowd and even the course railing blurs in comparison. For cars even the highway pavement is stationary relative to the motion of the vehicle. For planes, the clouds and the terrain below illustrate the motion.

Figure 1. Speed of race horse relative to blurred background.

But, these points of reference provide both a baseline for defining the speed and for perceiving the speed. Passing a mailbox at 70 mph establishes that the motion is indeed occurring, as the mailbox remains motionless and, with a little experience, we have the ability to perceive motion down the highway quantified and correlated with another relativistic system - time. These considerations are relatively easy to understand even if most folks don't think of them in these terms all the time.

Of course, to be more technical, the Earth is turning with the mailbox attached to the ground. The Earth is in orbit around the Sun. And, the entire solar system is even moving through the Milky Way Galaxy. Motion of all sorts is on-going relative to all kinds of reference points. But usually these extra-terrestrial perspectives are of little use to folks in their everyday lives. More on this relativity below.

Weightless in Space

Orbiting Earth and being weightless in space is a great example of something most folks do not understand. For example, riding weightless in a space capsule can allow one to leave a glove floating in the air suspended in a seemingly weightless environment. People may think that having left the confines of Earth's surface or perhaps leaving our atmosphere makes one weightless. But, technically, that is not true at all. In fact one is only weightless relative to the spaceship in which they're riding. Actually, the astronaut, the space craft, and even the glove are all falling back to Earth just as a child's drink glass falls from the table to the floor below.

Figure 2 illustrates that gravitational forces (G) on the space craft are indeed pulling downward just we experience gravity every day. But, this is offset by an equal force in the forward motion (M) of the craft. This is often described as the craft "falling around the planet." This may sound like nonsense but it's really not a bad turn-of-phrase to describe the phenomenon. As the forces, G and M, are in balance, the craft falls but also moves forward. It falls and moves forward both occurring simultaneously and in balance allowing the craft to continue moving around and around in an orbital path. If the craft slows down and disrupts that balance gravity (G) will take priority and bring down the craft.

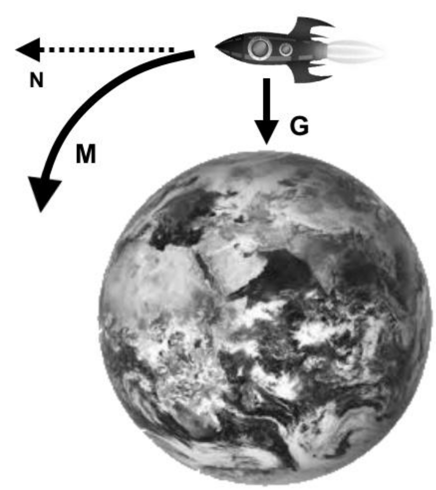

Figure 2. Illustration of space craft orbiting Earth.

If there were no gravity, Newton's First Law of motion (inertia) would suggest that the craft would continue in a straight line (N). This author has, in previous writings, suggested that there is no such thing as "gravity" - at least in the sense that there are forces acting upon objects as one might find in electromagnetism (Galloway, 2016). But, as that paper suggests, mass creates a warping of space like a sort of depression into which objects are drawn as in "falling" in toward the mass of the Earth just as the Earth is "falling" in toward the quite significant depression in space created by the incredible mass of the Sun, etc.

That's not to say, of course, that we do not experience a gravitational effect. Dropping the glass really will allow it to impact the floor. Regardless of this technical distinction in the function of gravity, the effect (G) is clear and the name of it is "Gravity." So, the space craft and any objects within are not exactly weightless and are falling to Earth. But, as stated, a balanced forward momentum offsets this effect and allows the orbit to continue (M).

This balanced effect in orbit or away from Earth's gravity in deeper space will keep that glove floating in the craft along with pencils, a tooth brush along with you and your cousin Vinnie, if he's traveling too. This "weightless" effect is practiced on earth by new astronauts riding in a 727 aircraft, commonly called the *vomit comet,* flying a parabolic arc to simulate weightlessness for 20-25 second intervals.

Simulated Gravity

In space travel far from the entrapments of Earth, as in a trip to Mars, travelers would certainly experience weightlessness. While it may seem liberating and even fun to Earthbound laymen, there are considerable consequences on the body in long-term weightlessness. Many science fiction movies over the years have invented many creative solutions to reestablish a normal gravity environment for space travelers. A common movie model, featured in Stanley Kubrick's *2001: A Space Odyssey*, provided a giant futuristic space station where people lived and worked, exercised and socialized, all within a simulated gravitational environment. Of course, it was not at all a genuine gravity field as in a three-dimensional depression generated or caused by a source of excessive mass into which the travelers are drawn.

Riding through space on the back of a huge mass creating a gravity depression to keep us firmly secure on the surface sounds like a really effective system of space travel. But, of course, we're already doing that: it's called Earth.

The movie - by far ahead of its time sparking imaginations and amazement for all patrons - used the rotating space station concept which substitutes the use of centrifugal force instead. Some amusement park rides place folks into a carriage or a cage that will spin forcing the rider outward locked against the side wall or backing as a fun thrill ride. The spinning ride's centrifugal force is, of course, the body's tendency to continue in a straight line (inertia) that forces one back and hard up against the obstruction or blocking wall to continue trapped in that circular motion. In the movie, the space station was essentially a giant rotating ring or disk large enough to contain the complete human environment, including chairs, tables, couches, while the centrifugal force, maintained at the proper level, forced everyone against the outer surface.

Unlike an amusement park ride, characters were not trapped in small cages or laying flat against a wall. Due to the sheer size of the craft (must be very, very large and continually rotating), characters could stand up and walk around. Figure 3 provides a crude illustration of such a rotating environmental disk in which space travelers might live and work.

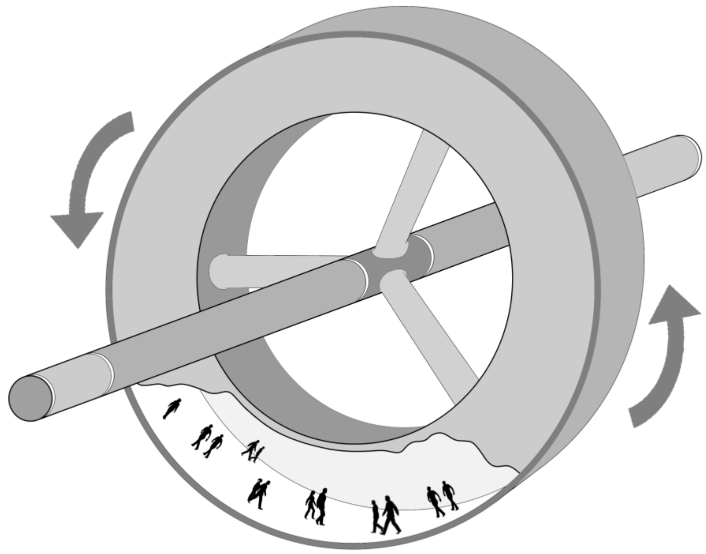

Figure 3. Illustration of centrifugal force rotating space craft to simulate gravity.

Again, the law of inertia suggests that, if not for the "floor" or outer surface of the craft against which travelers are stuck, they would instead shoot outward to continue in a straight line heading away from the craft just like David's pebble flying away from his spinning sling.

Inertia

None of that particularly presents any difficulty for understanding. The difficulty here is with the phenomenon of Inertia. The coffee cup on the dashboard will remind you when you turn left as it slides to the other side of the car spilling its contents that things do tend to continue in a straight line regardless of your turn.

The centrifugal force of the spinning space station is an experiential part of inertia as the body attempts to travel in a straight line but the curvature and spinning of the craft continually redirects the body around the center point. To explore the concept further, consider traveling in a straight line (in your car or the space craft) but then turn left. Inertia dictates that, within your transport, free objects will tend to move to the right as they attempt to hold to their straight line trajectory. This explains the annoyance of the sliding coffee cup spilling on your dashboard and your fellow space traveler pressing up against the outer bulkhead of the craft as the space ship turns left. How exactly Captain Kirk and the crew of the starship Enterprise avoided this problem has never been exactly clear.

Back to Relativity Again

It is relativity that frames my confusion; clearly not something well understood in spite of my illustrations. Let's return to the stationary mailbox as an anchor or starting point. Of course, we might intellectually recognize that it is moving as the Earth moves through space, etc., but for our local purposes, relative (that word again) to the ground and highway at that point, it is not moving. Its speed is zero (point A - figure 4) as is its rate of acceleration. So, as a force is applied to us we begin to move away from that point in a straight line and will continue to move (inertia) until another force is applied. Newton's Second Law tells us that additional force will increase our rate accordingly. So, assuming we can reliably quantify our speed at 70 mph (common freeway speed) that is clearly relative to the stationary mailbox (A) moving at zero (and to the measures of mile and hour).

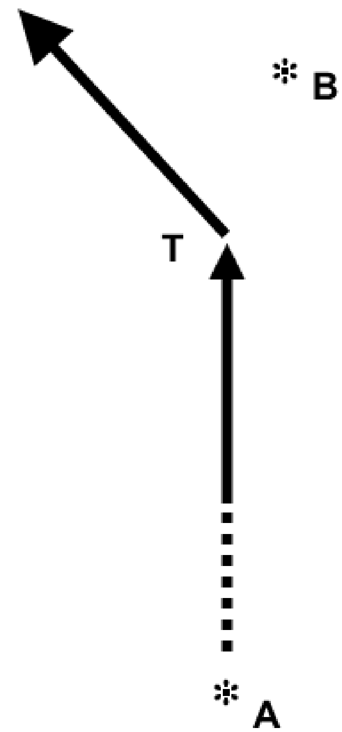

Figure 4. Illustration of relative movements.

But, regardless of whether the speed is 70 mph or 112 kph or whatever, the speed is relative to A at zero. How far have we travelled? Even our distance is relative to A. Everything requires a point of reference. In fact, everything is defined in terms of that or some other reference point. Relativity tells us that nothing is absolute and fixed (except perhaps the speed of light) and that everything is what it is based on and dependent on some frame of reference.

So, we're moving along our path and we know we're moving and could maybe even measure that movement all because of A. In real life, of course, there are many points of reference: the mailbox, the tree, other cars, and even the road itself, all continue to serve as references defining and revealing our movement. However, inside the car, if there's no change in speed or direction, the coffee cup will sit still and be just fine. We can carry on conversations with fellow travelers, look them in the eye, and pass simple objects back and forth. Turning over a simple pencil presents no difficulties even though that pencil is also moving at 70 mph. Consider for a moment a pencil in a car at 70 mph passing by as you stand on the side of the road. It would seem like blur and could not be grabbed or a handed off at all. Yet, sitting comfortably in the back seat, the pencil can be shared and manipulated with no challenge.

In other words, within the car, within that closed environment, there appears to be no movement at all. There is no speed, no motion of any kind. Speed and motion is entirely a relative condition to the external reference point (A).

Even in a plane, as we sit cramped in our tight seats listening to head phones, reading a book, one can look around the cabin and find everything resting calmly. The service cart and attendants move casually through the isle virtually unaware that the plane is moving along at 500 mph. Even a peek out the window can sometimes fail to find a reference point to verify movement. The plane is an isolated cocoon and all movement, motion, speed, essentially fails to exist. I'm not suggesting that it is simply imperceptible or hidden. I'm saying the speed and motion actually do not exist at all except in relation to a reference point (A). Even if A is not there (figure 4), then one could compare the speed and motion to another reference point, such as B. In the drawing, we are moving away from A and getting closer to

B. But, within the cabin of the plane, those reference points and that external motion are irrelevant. I can pass my head phones to a fellow traveler or select a soda from the passing service cart completely without regard to any external motion - assuming it still exists in the world external to the micro environment of the cabin.

Imagine a world where there was no mailbox, no cars, no pavement. Perhaps back in our space craft traveling in deep space. Well, there would still be stars and other solar system or even interstellar objects to serve as reference points. But, let's do away with even those stars, those planets and rocks. There must be at least some reference point otherwise one might think they are stationary. So, as figure 4 illustrates, let us keep points A and B in our universe - the only two identifiable external reference points available. As shown, we are moving away from A and clearly getting closer to B. That motion is clear. Whether we look out the window or detect it on a magic motion sensor, those reference points do not just reveal that we are moving, they actually establish and define the motion.

Even at point T, as we apply the controls of power to change direction to the left, inertia tells us that we are heading in a new direction. Within the cabin of our space craft, our coffee was secured so as not to slide off the dashboard of our ship's control room. But we know we're headed in a new direction as we are now moving away from point B. Moments before, we were getting closer to B and now we're getting further away. It's different. Something's changed. We know that the difference began at point T and, indeed, we felt the change in motion as we pressed up against the side of the cabin in making the direction change. Even the liquid in our coffee cup, the container of which was secured on our dashboard, still tilted within the cup revealing the effects of inertia.

The Dilemma

Consider the alternative. Remove both points A and B back at the start of our trip. Now there are no points anywhere. No stars, no planets, no rocks, no external points of reference. Newton's Second Law tells us that applying greater force will move us along faster. But, how can speed be defined? We're not getting closer to anything. We're not moving further away from anything. Even as we apply more power our speed, contrary to Newton's Second Law, does not change to bring us closer to anything at an increased rate. It seems as though there is no movement at all. And, I'm suggesting that there is, in fact, no movement.

So, consider point T in the case of no external reference points. This is the most challenging for me to conceive. One would again assume, as the drawing illustrates, there is a turn to the left. One would expect, with inertia, to feel the change within the cabin as the ship heads in a new direction. But, one must also recognize that after T, we are not getting anywhere closer to anything nor moving away from anything. The after T experience is exactly the same as the before T experience. There is no difference. In fact, it seems impossible to even define motion (outside of the space craft) at all. And, I suggest that that it is not merely a matter of perception but that there is no actual motion at all.

As I can best understand it, there is no motion and that, absent any reference point, all motion, speed and even acceleration cannot exist. I believe these to be entirely terms of relativity.

But, this does present a particular dilemma for point T. Without motion, how can a change in direction take place? Breaking directions down into degrees, a normal turn left might change from a heading of 360 to 315 degrees. One might note each degree of change one at a time feeling the effects of inertia in these small increments. If our sensors and perceptions were sufficiently fine, we might notice even each arc-minute or arc-second of change as we turn left. But, of course, that presumes this artificially rigid and stationary frame of reference superimposed on our universe and our position at point T. Considering that there is no such frame of reference and no reference points at all - and now no motion of any sort either - it seems there can be no left turn. Or, for that matter, no right turn either. In other words, it seems as if inertia ceases to exist.

Consider your weightless environment of the space craft with the glove floating in the cabin. Turn left. Just like applying breaks or adding power, one might expect the glove to move to the side and that you would feel the shift in direction. But that implies that the craft is now headed away from B while you and the glove were, for a moment, continuing your momentum toward B. But, there is no B and nor is there any other place. In fact, all "places" cease to exist. Without reference points, turn left, travel for 10 minutes and you're still in the exact same spot you were before. No change. Even after applying power to the point of exhausting all fuel, you're still in the exact same spot you were. There is no change. You went nowhere. You are not closer to something nor are you further away from something. In the case of turning left, the new direction isn't any different than the old direction. It seems there is no movement, no motion, no speed. But, more than mere perception, places and motion all cease to exist.

The interesting part is that even upon hitting the 'Turn Left' button one would not feel a directional change. One would not experience inertia because there is no motion. Within the cabin, I could pitch a ball to you and you could pitch it back to me, as we have numerous reference points within the environment of the craft. But, externally, by removing all reference points, there can be no inertia. Without reference points, the ship is headed nowhere and neither is your body. It seems without reference points, nothing of this sort would be felt. The coffee in the cup does not shift and sway within the container. Such behaviors would imply that the coffee was on its way somewhere that the ship is no longer going. But, the ship is going nowhere and neither is the coffee, thus no momentum and no experience of inertia.

Even a hypothetical such as, imagine moving forward only 3 feet. Well, now you've reestablished an external reference point, whether B, C or D... makes no difference. Even dropping an anchor behind you and moving away only 3 feet is using external reference points again and thus all laws of the universe apply. But, absent all reference points, I believe you would not feel momentum or inertia external to craft in which you reside.

To perhaps better illustrate the phenomenon, let's look more closely at the moment of breaking. Your imaginary space ship is moving through the void of space toward the only other object in the universe... a somewhat distant, small planet. You decide to stop and hold your place in space to prepare for your eventual arrival so you apply the "breaks." Naturally, suddenly reducing your speed by applying the break (retro-rockets or whatever the mechanism may be) creates the forward pressure and feeling of continuing forward for both you and your lose glove that wasn't secured within the craft. It will take a short time to fully stop and this experience continues as your speed is continually and drastically reduced and you feel the effects of inertia throughout the breaking process.

Suddenly that home planet disappears. It completely, fully, and immediately ceases to exist. This leaves nothing in the universe except you in your craft. It is immediate that you are no longer moving toward anything nor away from anything. There is no identifiable movement, nothing against which your speed might be compared. You are not going faster nor slower relative to anything anywhere. Even though you continue to apply the break, you are no longer slowing your approach to anything anywhere. That is, your position remains unchanged. So, this condition suggests that your sensation moving forward, the forward momentum including the drift of the floating glove would also stop immediately even though continuing to apply the break. Continued movement, the continuation of inertia, implies your body and glove is headed somewhere at a rate which the ship is no longer experiencing - but you are not.

You exist in a sort of void. This is my best description given that I cannot call it a place. A "place" has a character about it and that necessarily requires reference material. No reference - no place. No place to go. No place to leave. No place to approach. No place from which to depart. Movement of any sort cannot exist. Time for a *Twilight Zone* episode.

One usually thinks of Newton's Laws as absolutes but it seems they are quite relative. This is somewhat of an artificial argument in that I completely redefined the universe without reference material whereas Newton's Laws dictate behavior WITHIN the physical universe as we now experience it. Nevertheless, it seems paradoxical to view inertia as an absolute while still depending on relative reference points.

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Galloway, J. P. (2016). Gravity does not exist. *Amateur Astronomy Magazine, #91*, p. 24-27.