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## **A Clock on the Floor Runs Slower than One on a Table— & Other Wild Truths about Time**

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In the seventeenth century, the English politician Andrew Marvell (1621–1678) wrote of all we might accomplish if not for our human limitations: “**Had we but world enough and time.**” Or as Chaucer penned three centuries earlier: “Time flies, and for no man will it abide.” Turning the clock back even further to the first century BCE, the Roman poet Virgil (70 BCE - 19 BCE) said, “*Fugit irreparable tempus*” (“Time flies irretrievably”) (Burdick 189).

Despite the cautions of these and so many other writings about time, we humans persist in various attempts to master time. Indeed, next Sunday, in most parts of this country, daylight savings time will begin at 2:00 a.m. Get ready to “spring forward!” You lose an hour of early morning sleep, but gain an hour of daylight in the evening. I personally think messing with time twice a year is a terrible idea: the disruption to our internal sense of time is not worth it. But for now, what I’m more interested in is all the aspects of time that remain outside human control.

Time is a slippery concept. As Dean Buonomano mentioned in his book *Your Brain Is a Time Machine: The Neuroscience and Physics of Time* (W. W. Norton & Company, 2017) studies have shown ***time to be the most commonly used noun in the English language*** (3). That makes sense: time is central to the human experience. “When we are not asking for the time, we are speaking of saving time, killing time, serving time, keeping time, not having time, tracking time, bedtime, time outs, buying time, good times, time travel, overtime, free time, and lunchtime” (3).

On the other hand, the more you study time, the more most people will confess that for the most part we rarely have a precise idea of what we're talking about. As Augustine of Hippo (354-430 AD) said more than 1,500 years ago, **“What then is time? If no one asks me, I know what it is. If I wish to explain it to him who asks, I do not know”** (4).

But surely we've figured out a few things about time in the past millennia and a half since Augustine's time? If we turn to the twentieth century, physicist Richard Feynman (1918 -1988) said, “Maybe it is just as well if we face the fact that time is one of the things we probably cannot define... **What really matters anyway is not how we define time, but how we measure it**” (34). As Einstein showed us, time is relative—so Feynman highlights that what arguably matters most is how we measure the relative difference between two times. I'll say more about that momentarily.

But first, as an inspiration for this exploration, allow me to introduce you to the contemporary physicist Carlo Rovelli (1956-). If I had to limit myself to one book on the nature of time, I would recommend that you read his recent book [The Order of Time](#), which has the virtue of being short (less than 200 pages), tiny (~ 4” x 6”), and easily readable. And unlike many scientists, he has a beautiful and accessible writing style. (Have any of you read any of his books? He's been described as the new Stephen Hawking. His *Seven Brief Lessons on Physics* is also great—and brief!.)

To begin to reflect further on time, if I look around this room I can see various clocks. Your watch or phone may add further iterations of what time it is. And whenever one or more clocks disagree, our typical sense is that there remains an independent, universal standard of time to which we can reset those clocks. But the truth is more complicated than that. As Alan Burdick explores in his book [Why Time Flies: A Mostly Scientific Investigation](#) (Simon & Schuster, 2017), **time (as we typically think of it) is actually nothing more than “what everybody agrees time is”** (5).

Now, come on, you might say. We live almost two decades into the twenty-first century. Surely there is an ultra-precise clock in a room somewhere that we can consult to give us The One True Answer to what time it is. There's not. But thirty miles away from here in Gaithersburg, Maryland is one of two laboratories of the NIST (National

Institute of Standards and Technology), “a federal agency that helps produce the official, civil time for the United States.” These laboratories:

keep a dozen or more cesium clocks running at any given time. As precise as these clocks are, they disagree with one another on a scale of nanoseconds, so every twelve minutes they are compared to one another.... The data from the clock ensemble is then numerically mashed into...the basis for the official time. (7)

So the clock on your laptop or desktop computer is calibrated through servers that pass at various points through servers at the NIST or related agencies around the world. Similarly, if you have a cell phone, that clock is set through the GPS (“Global Positioning Satellite”) system, synchronized through the U.S. Naval Observatory near Washington, D.C., which utilizes a system of more than seventy cesium clocks (8).

But there is no one “World’s Best Clock.” Rather, what is known as **Coordinated Universal Time is calculated “only on paper and only in retrospect.”** If, for instance, you were to ask Dr. Elisa Arias, the director of the Time Department at the Bureau of International Weights and Measures, “What is the best clock in the world,” she would hand you the *Circular T*, a monthly newsletter documenting “the difference between Coordinated Universal Time and the local realization of UTC as measured by a particular laboratory on a particular day” (Burdick 12).

It turns out that the world’s best time does not come from a a super-smart clock, but from a committee. The committee “relies on advanced computers and algorithms and the input of atomic clocks, but the metacalculations, the slight favoring of one clocks’s input over another’s, is ultimately filtered through the conversation of thoughtful sciences. **Time is a group of people talking**” (14).

That’s not, however, how we conventionally think of time, or how scientists classically conceived of time. Isaac Newton (1642 - 1726/27)—no scientific slouch!—thought of time as absolute. He taught that “there was a true and universal time that applied unequivocally to all points in space” (7). That was a reasonable perspective in the eighteenth century, but we now know that the truth is much more complicated as Einstein wrote about in the series of papers he published in his “miracle year” of 1905.

It is no coincidence that Einstein formulated his theories of relativity in the wake of working “in the Swiss Patent Office dealing specifically with patents relating to the synchronization of the clocks in railway stations.” Einstein was intimately familiar through that work with the lack of one universal time. And after Einstein, we know that space and time are not isolated phenomena. They are relative to one another, which is why scientists started combining them in the one word spacetime. But it’s really even more complex than that—more like *spacetimes*, plural (56)!

The bizarre truth, as numerous scientific studies have shown, is that **if you are on top of a mountain, time passes faster than if you are basking in the sun at sea level**. That’s wild to me! “A clock placed on the floor runs a little more slowly than one placed on a table” (9). **Speed, in contrast, slows down time: the closer you move to the speed of light, the slower time passes** (34). That’s wild too!

So although agreeing upon a Coordinated Universal Time has many benefits to us locally here on Earth (keeping the trains and planes running on time, helping us meet up with one another on schedule), there is also an important sense in which Coordinated Universal Time is a social construct.

Let me say a little more about that. If you were to ask whether a clock on the floor or a clock on the roof was more accurate, there is a sense in which physicists tell us that:

The question is meaningless. We might just as well ask what is the *most* real—the value of sterling in dollars or the value of dollars in sterling. There is no ‘truer’ value; they are two currencies which have value *relative to each other*. **There is no truer time. There are two times that change relative to each other. Neither is truer than the other.... Times are legion.** (15)

Although that may feel like a claim that is down the rabbit hole in *Alice in Wonderland*, it is also what science tells us is the case in this sometimes uncanny reality in which we find ourselves.

Let me give you another example. Imagine that your best friend has traveled to *Proxima b*, a recently discovered planet four light years away. What is your best friend doing *now* on *Proxima b*? Scientists invite us to consider that such a question is a

category error: it makes no sense. I can say more about why with a series of comparisons:

- If your best friend is **in the room** and you ask what they are doing now, the answer is usually an easy one: you are looking...and you can tell.... The light takes a *few fractions of a second*—therefore you are not quite seeing what they are doing now but what they were doing a few nanoseconds ago.
- If they were **in New York** and you phone them from Liverpool, their voices takes a *few milliseconds* to reach you, so the most you can claim to know is what your friend was up to a few milliseconds ago....
- If your friend is on **Proxima b**, however, light takes *four years* to reach you from there....

If, ten years ago, your friend had left for Proxima b, taking with them a calendar to keep track of the passage of time, can we think that *now* for them is when they have recorded that ten years have passed? No, this does not work either: they might have returned here ten of *their* years after leaving, arriving back where, in the meantime, twenty years have passed [because time moves more slowly the closer one travels to the speed of light]. So, when the hell is ‘*now*’ on ‘*Proxima b*?’ The truth of the matter is that we need to give up on the question. (38-39)

Along these lines, one of physicist Carlo Rovelli’s catch phrases for this truth is that “‘Now’ means nothing”—because there are spacetimes (plural!) throughout the universe (37). Or more elaborately, “**Our ‘present’ does not extend throughout the universe. It is like a bubble around us**” (40). Again: bizarre, but true.

We are accustomed to thinking of the world as made up of nouns—what we called in my elementary school grammar classes “people, places, or things” (86). But **the universe is really much more of a verb than a noun**. It is more accurate to think of the universe as made up of less of “entities and substances” and more of “events, happenings, and processes” (87).

As the particle physicist Karen Barad explores in her excellent—but challenging—book titled Meeting the Universe Halfway, “**Time is not a succession of evenly**

**spaced individual moments.... Space is not a collection of preexisting points.... Rather, spaciality is intra-activity produced”** (180-181). Think about the difference between *intermurals* (“between” two rival schools) and *intramurals* (contests from teams “within” a school).

Our UU Fifth Source counsels us to “counsel us to heed the guidance of reason and the results of science.” And part of what innumerable scientific experiments have shown is:

- the slowing down of time according to altitude and speed;
- the non-existence of the present;
- the fact that the relations between times are dynamic. (172)

Science is many things, but it doesn’t have to be boring!

And to me one of the takeaways is to begin to appreciate that:

**We are more complex than our mental faculties are capable of grasping....** We barely see just a tiny window of the vast electromagnetic spectrum emitted by things. We do not see the atomic structure of matter, nor the curvature of space. We see a coherent world that we extrapolate from our interaction with the universe, organized in simplistic terms that our...brain is capable of handling. ...

Certainly one response to such truths is to be overwhelmed at the bizarreness of it all. Another equally legitimate response is awe—awe at this wondrous reality in which we find ourselves—and gratitude for all the ways in which we have been able to grasp some of the mysteries of the universe.