



Thoughts from Linda:

The Order of Time

by Carlo Rovelli
2017

There is irony in the fact that I became interested in time and found this book while reading *Time* magazine's March 27th article entitled: "Clock Wise" by Lily Rothman. The focus of her article was the impact of three years of the pandemic on perceptions of time itself.

Interest in the *meaning and use of time* has picked up since COVID, and articles for the layperson abound. Rothman told the story of Ruth Ogden, an experimental psychologist who studies time perception at Liverpool John Moores University in the United Kingdom. Ogden said that she had only been interviewed once on the topic of 'time perception' before the pandemic but has recently received over 100 interview requests. Evidently, the volume and pace of the conversation on 'time itself' has dramatically increased in academic publications as well.

The article is interesting and provides a current context for the interest in this topic. And Carlo Rovelli, with a contrarian view compared to other experts interviewed, noted that it is "unlikely that in a new normal (post COVID), we will...have new models for a happier relationship with time." As a theoretical physicist, he doesn't see that the past few years will change much in this area. And, if widespread reflection does have an impact, he doesn't see it as lasting once the crisis passes.

This book is a timely addition to the field, and he would have the intellectual high ground in this domain, with a most significant voice in the dialogue.

Carlo Rovelli is an Italian theoretical physicist and author who has worked in Italy, France, and the United States. He is the head of the Quantum Gravity group at the Centre de Physique Theorique of Aix-Marseille University and works in the field of

quantum gravity. He is a Distinguished Visiting Research Chair at the Perimeter Institute and a core member of the Rotman Institute of Philosophy of Western University. Additionally, he studies the history and philosophy of science, and his popular science book, *Seven Brief Lessons on Physics*, was translated from Italian into 41 languages and has sold over one million copies. In 2019, *Foreign Policy* magazine included him in a list of the 100 most influential global thinkers.

For me, reading this book was part intellectually challenging and, at the same time, quietly calming due to his gentle and poetic writing style. It is, in a way, a charming journey with a brilliant scientist who explains a complex subject in an easy-to-follow manner. The book has three main parts: *The Crumbling of Time*, *The World Without Time*, and *The Sources of Time*. Inside these three parts are 13 chapters and a concluding section entitled *The Sister of Sleep*. Chapters include *The End of The Present*, *The Inadequacy of Grammar*, *Time is Ignorance*, *What Emerges from a Particularity*, and *The Source of Time*.

In his introductory chapter, *Perhaps Time is the Greatest Memory*, he begins with this passage:

"I stop and do nothing. Nothing happens. I am thinking about nothing. I listen to the passing of time. This is time, familiar and intimate. We are taken by it. The rush of seconds, hours, years that hurl us toward life then drag us toward nothingness...we inhabit time as fish live in water. Our being is being in time. Its solemn music nurtures us, opens the world to us, troubles us, frightens and lulls. The universe unfolds into the future, dragged by time, and exists according to the order of time."

He begins and ends the book by reflecting on Hindu mythology and the dance of Shiva, portraying the river of the cosmos as the flowing of time. As he notes, "What could be more universal and obvious than the flowing?" Following this simple question, he takes us on a journey of discovery—his discovery as a young physics student when he realized that the structure of time is not what it seems to be. He notes, "(time) is different from this uniform, universal flowing...it works quite differently from the way it seems to."

In a stunning statement, he goes on: "The nature of time is perhaps the greatest remaining mystery...we still don't know how time actually works."

The book and his explanations invite us to consider the nature of time itself. He is part poet and philosopher as well as physicist, which makes this book both interesting and surprisingly beautiful to read at the same time.

The book's three parts all attempt to answer the basic questions he lays out at the beginning. Questions include: "What is time? Why do we remember the past and not the future? Do we exist in time, or does time exist in us? What does it really mean to say that time 'passes?' What ties time to our nature as persons, to our subjectivity? What am I listening to when I listen to the passing of time?"

The first section deals with the current understanding of modern physics about time itself. He takes apart the conventional thinking of time, noting that "one after another, the characteristic features of time have proved to be approximations, mistakes determined by our perspective, just like the flatness of the earth or the revolving of the sun. The growth of our knowledge has led to a slow disintegration of our notion of time. What we call *time* is a complex collection of structures, of layers. Under increasing scrutiny, time has lost layers one after another, piece by piece."

The second part of the book describes the reality of what his field, quantum gravity, explains as "the world without time." And finally, in the third part of the book (he calls it the most difficult), Rovelli focuses on time as we are accustomed to perceiving it and explores why this is the case. He says, referring to this section, "Here, the book becomes a fiery magma of ideas, sometimes illuminating, sometimes confusing. If you decide to follow me, I will take you to where I believe our knowledge of time has reached: up to the brink of that vast nocturnal and star-studded ocean of all that we still don't know."

You will learn how time passes faster in the mountains than it does at sea level, and thus more slowly for our feet than our heads, and what this means. Rovelli traces the history of thought on this and other conditions by looking into the ancient works of Anaximander and Copernicus and the more modern thinking of Einstein. The book's title refers to Anaximander, who lived in the 5th century BCE and was the first to develop cosmology or a systematic philosophical view of the world. He left only one written fragment of his thinking that profoundly reads: "Things are transformed one into another according to necessity, and render justice to one another, according to *the order of time*." As Rovelli explains, astronomy and physics have since developed by following the early lead of Anaximander, and they work to understand how phenomena occur according to *the order of time*. The equations of physics describe how things *change in time*.

The only equation he gives in the entire book is the second law of thermodynamics, and he asks for the forgiveness of his reader as he does this. As he refers to it, Rovelli notes, "It is the only equation of fundamental physics that knows any difference between past

and future, the only one that speaks of the flowing of time. Behind this unusual equation, and entire world lies hidden.”

One of the book’s most interesting aspects is how Rovelli tells the story of time’s exploration as it unfolds through the centuries. He has a gift for metaphors that makes this telling more understandable, and he uses a Socratic approach within his writing that is engaging if somewhat confounding at times, because of the complexity of the subject. This leads us to the fascinating story of Ludwig Boltzmann, an Austrian scholar who understood the nature of entropy, which led physicists to shift their questioning about time.

The book tells the story of the history of the understanding of time itself, including the history of key concepts and the originators of those ideas. The journey takes us through stories about heat and its impact, how Einstein synthesized the thinking of Aristotle and Newton’s theories, the Wheeler-DeWitt equation of 1967, and the concept of ‘blurring.’ He asks perplexing questions about our perspective and how that phenomenon manifests in how we conceive time.

After a wonderful journey about the great minds who grappled with the big questions of physics and continue to do so, he ends in a familiar spot with a conclusion displayed by so many brilliant and deep thinkers throughout history. The more we know, the more we realize how little we know.

This is his message as he brings his story to an end in a series of reflective paragraphs about us as human beings. “So what really drives us? It is difficult to say. Perhaps we do not know entirely. We recognize motivations in ourselves. We give names to those motivations, and we have many of them...hunger and thirst, curiosity, the need for companionship, the desire to love, being in love, the pursuit of happiness, the need to fight for a position in the world, the thirst for justice and liberty, the desire for knowledge...and where does all this come from? From the way that we are made, from what we happen to be. We are the products of a long selection process of chemical, biological and cultural structures that at different levels have interacted for a long time in order to shape the funny process that we are...we are more complex than our mental faculties are capable of grasping.”

He goes on to reflect on our brief lives, noting that they are “the incessant cry of...emotions that drive us, that we sometimes attempt to channel in the name of a god, a political faith, in a ritual that reassures us that, fundamentally, everything is in order.”

In his closing words, you can find his poetic prose. He says our feelings are like a song, and song, as Augustine observed, is the awareness of time. "It is the hymn of the Vedas that is itself the flowering of time. In the Benedictus of Beethoven's *Missa Solemnis*, the song of the violin is pure beauty, pure desperation, pure joy. We are suspended, holding our breath, feeling mysteriously that this must be the source of meaning. That this is the source of time."

Aristotle said, "Wonder is the source of our desire for knowledge." This book will leave you with a sense of wonder and an appreciation for the mysteries of time itself.