Temporality: a trait, a dimension or an aspect of reality?

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Opsomming

Hierdie artikel beoog om elemente van die nuanserykheid van tyd te ondersoek. Dit bevraagteken die gelykstelling van tyd met verandering, terwyl dit vashou aan die besef van tydelikheid as 'n integrale element van die mens se bestaan.

Dit ondersoek kortliks enkele vertrekpunte wat voortvloei uit die Griekse filosofie, insluitend Aristoteles se nadenke oor die oneindige deelbaarheid van kontinuïteit (tydperke) en sy onderskeid tussen die potensiële en aktueel-oneindige. Enkele gesigspunte rakende die Middeleeuse era, die vroeë Moderne era en die Verligtingstydperk word toegelig deur 'n aantal implikasies vir die wiskunde en fisika te oorweeg. Dit eindig in 'n beoordeling van konstantheid en verandering sowel as die onomkeerbaarheid wat in die tweede hoofwet van die termodinamika vervat is, met name die wet van nie-afnemende entropie. 'n Kort argument word gelewer oor die formulering van die eerste wet wat verkieslik as die wet van energie-konstansie waardeer moet word. Teen hierdie agtergrond word 'n beoordeling van die ontiese status van tydelikheid gegee, wat die vraag in die titel van hierdie artikel beantwoord.

Abstract

This article sets out to explore elements of the nuancefulness of time. It questions the equation of time with change while holding on to the awareness of temporality as an integral element of being human.

It investigates briefly some points of departure derived from Greek philosophy, including Aristotle's reflections on the infinite divisibility of continuity (periods of time) and his distinction between the potential and actual infinite. Brief contours regarding the medieval era, the early modern era and the Enlightenment period are followed up by considering some implications for mathematics and physics, terminating in an assessment of constancy and change as well as the irreversibility entailed in the second main law of thermodynamics, the law of non-decreasing entropy. A brief argument is presented regarding the formulation of the first law which should preferably be designated as the law of energy-constancy. Against this background an assessment of the ontic status of temporality will be given, answering the question captured in the title of this article.

Scholars, in particular philosophers, are in general familiar with what Augustine said about time, namely that he knows what time is as long as he is not asked. It appears that time in our everyday life is generally experienced in relation to *change*. Are all of us not *changing* over time. Is it far-fetched to claim that everything changes?

We do not have to go beyond our own life experience to realize that change is integrally embedded in the temporality of our existence. Just consider the familiar reality of our normal growth process: birth, growth, maturation, ageing and dying. The effect of this biotic time-order is that no one is looking exactly the same as two decades ago. If it is not the case, the companion of change is an element of *persistence* or *endurance*. We can only notice the changes to which we are subject because these changes are discerned in the on-going existence *one and the same person*. The question is if we can detect changes without an awareness of “an unchanged element”, as McTaggart (1908:23) calls it. The crucial question therefore is:

What changes and what endures?

In Greek philosophy the search for a constant underlying principle (such as water, air or fire) was introduced in order to account for what *endures*. Parmenides opposed the thesis of Heraclitus, who asserted that everything changes (*panta rei*). One cannot step into the same river twice. Parmenides in turn, opted for *static being* in order to deny *multiplicity* and *motion*.

In the Fragments of pre-Socratic philosophy brought together by Diels and Kranz in two Volumes (1959-1960) we find the argument of Zeno against the possibility of movement.

In the fourth Fragment collected by Diels-Kranz Zeno opens his argument by first conceding that something moves and then infers the impossibility of motion. His concise argument reads as follows: "Something moving neither moves in the space it occupies, nor in the space it does not occupy" (Diels-Kranz, B Fr.4). The school of Parmenides developed a static metaphysics of BEING, by employing terms respectively in a *spatial* and *metaphysical* sense. The key terms featuring in this context are found in Diels-Kranz (B Fragment 8:3-6). Here he holds that being "... was not and will never be because it is connected in the present as an indivisible whole, unified, coherent" (B Fragment 8:3-6).

The point of gravity regarding temporality at this stage moved away from change and towards static being. Yet it failed in avoiding *numerical* and *kinematic* terms, such as endlessness (infinity) and enduring (continuing). In addition, Parmenides characterizes being in spatial terms, such as "present as an indivisible whole, unified, coherent".

Two remarks are here in place. First of all, it is clear that at least three fundamental traits of temporality are at stake, anticipating a significant remark in Kant's *Critique of Pure Reason* (CPR) regarding *three modes* of time. Secondly it should be noted that the Greeks had an understanding of succession and endlessness (infinity). Aristotle, in the footsteps of Anaxagoras and Zeno, turned endlessness inwards in his emphasis on the infinite divisibility of continuity.

Static being, infinity and continuity

Aristotle holds that the present "now" of time is *indivisible* (*Phys*. 222b), like a point on a line. Moreover, "a line cannot be composed of points, the line being continuous and the point indivisible. For the extremities of two points can neither be one (since of an indivisible there can be no extremity as distinct from some other part) nor together (since that which has no parts can have no extremity, the extremity, and the thing of which it is the extremity being distinct)" (*Phys*. 231a). Between points there is a line, and between moments [a] period of time: that which is intermediate between points is always a line and that which is intermediate between moments is always a period of time (*Phys*. 231b). On the same page he continues: "Moreover, it is plain that everything continuous is divisible into divisibles that are infinitely divisible."

In his attempt to overcome the paradoxes of Zeno a new distinction was introduced by Aristotle, namely that between the potential infinite and the actual infinite. He rejects the actual infinite. Oscar Becker remarks: "Aristotle's decisive insight was that infinity and continuity only exist in potency, i.e., have no actual actuality and therefore always remain incomplete. Except for Georg Cantor, who opposed this thesis with his set theory in the second half of the 19th century, in which actually infinite manifolds were considered, the Aristotelian basic conception of infinity and continuity remained the unchallenged common legacy of all mathematicians (if not of all philosophers)" (Becker, 1964:69).

The infinity of God

Greek philosophers initially shied away from speaking about God's infinity, until Gregory of Nyssa (335-395) characterized God as the actual infinite.

Eternity as the timeless present

Under Aristotle's influence Origines taught in the 3rd century A.D. that if God is infinite, he would not be able to delimit or conceive himself – implying that God could not know himself! Plotinus (1956), however, returned to a positive appreciation of the infinite. In fact he characterizes both the *One* (out of which everything arises) and the contrasting *matter* as infinite (cf. *Enneads* II,4,4; II,4,10; II,4,15; VI,7,32), although the term infinite is used in a dialectically opposed manner with regard to the One and matter: (formless) matter receives form (as a permanent substratum) – the (formless) One gives form (cf. En. VI,7,17). This re-appreciation flows from Plotinus' view of *infinity* as the *timeless present* (cf. the whole En. III,7), which simultaneously exerted a considerable influence on the views of Boethius, Augustine (*Confessiones* XI,11,13; *De Trinitate* XII,14), Thomas Aquinas (*Summa Theologica* I,10) and Schilder (1953:61).

Augustine went further than Plotinus and stated explicitly that our inability to understand the infinite should not be used as a measure for God, since God in his omniscience understood every infinity – also the completed infinite set of all numbers – without any passage of thought, at once, without before and after. Therefore, God can also know his own completed infinite being. Creation, however, is finite.

Dooyeweerd refers to the way in which Thomas Aquinas understands *time* as follows:

> Thomas could only find some indications for his doctrine of motion and time in Aristotle. When he elaborated on it, he did not recoil from its clash with his substance-concept, which undoubtedly speaks for his honesty as a thinker and for the plasticity of his philosophical mind. I deem it more than probable that here he was particularly under the influence of Augustine's psychologically oriented view of time. Aristotle himself devoted a brief treatise to the problem of time. He tried to answer two questions there: "What is time?" and "How does time exist?" He followed the dialectic line of thinking, determined by the form-matter motive that started with Zeno's exposition of the antinomies of the concept of motion and time. The same appeared to be the case in Plato's Parmenides (Dooyeweerd, 2013 RS-II:345).

Nicolas of Cusa

At the end of the middle ages and the beginning of the modern era Cusanus changed this view with his doctrine that God is actually infinite while reality is only endless. Linked to his conviction that the infinite line is simultaneously a triangle, circle and sphere (*De Docta Ignorantia*, I,13-17) Cusanus taught that of God, as the actually infinite, one could in a certain sense say everything and nothing at all (he is e.g. the biggest and the smallest – *De Docta Ignorantia*, I,5) since all contradictions are resolved in him (*coincidentia oppositorum*) (*De Docta Ignorantia*, I,22; *De Coniecturis* II,1 and II,2).

Modern Philosophy

Descartes turns the classical view on its head with his view that the infinite is complete and the finite incomplete, so that the finite should actually be referred to as the non-infinite. Since Spinoza identified God with nature (*Deus sive natura*), he also saw the universe as completed infinite.

Within modern philosophy, time increasingly was associated with space. According to Kant space and time are two *a priori* forms of intuition. But interestingly Kant distinguishes between three distinct modes of time – succession (Folge), simultaneity (Zugleichsein) and constancy (*Beharrlichkeit*) (Kant, 1787-B:219). These modes of time reflect the meaning of number (succession), of space (simultaneity) and movement (persistence). [“Die drei modi der Zeit sind Beharrlichkeit, Folge und Zugleichsein.”]

It is striking that the familiar equation of time with change is not included in Kant’s modes of time. The second main law of thermodynamics, the law of non-decreasing entropy, entails the “arrow of time” which secures the irreversibility of physical events. Yet Kant did realize what the difference between succession and causality is. Although there is a succession of day and night none of them is the cause of the other. Geological time scales are instances of the way in which the dimension of time manifests itself within the physical aspect of reality. Note that actual (geological) time measurement concerns a process which, in turn, is conditioned by a specific time order, in this case the irreversible physical time order of cause and effect. The origination of this time order is the presupposition of all time measurement and can therefore not be dated itself.

The view of Dooyeweerd

An innovative and original concept of time is found in the philosophy of Dooyeweerd. According to him the dimension of time embraces all aspects and entities. What is unique and novel in his theory of time is that he does not reduce temporality to one aspect only, such as physical time. He distinguishes between time on the law side of reality (time order) and time at the factual side (time duration). For example, the biotic time order for “the more highly developed organisms” is revealed in the succession of birth, growth, maturation, ageing and dying – correlated with the widely differing life-spans of individual living entities. In his work on the foundations of physics (1980) Stafleu relates time measurement to the first four modal aspects:

> This is most clearly shown by an analysis of the historical development of time measurement. Initially, time measurement was simply done by counting (days, months, years, etc.) Later on, time was measured by the relative position of the sun or the stars in the sky, with or without the help of instruments like the sundial. In still more advanced cultures, time was measured by utilizing the regular motion of more or less complicated clockworks. Finally, in recent developments time is measured via irreversible processes, for example, in atomic clocks.

The phases through which time measurement developed, reflecting different *modes of explanation*, can be correlated with the *units of measurement* identified by Lorenzen in his *protophysics* (1976 and 1989). He distinguishes four units which reflect the four modes of explanation operative in the just-mentioned history of time measurement, namely *mass*, *length*, *duration* and *charge*. This shows that the generally accepted understanding of time (linking it merely with duration) is actually embedded in a context embracing diverse modes of explanation.

Heisenberg (1958), for example, accepts two universal constants: Einstein's postulate of the velocity of light and Planck's quantum of action. Yet, he was looking for a third universal constant, namely a universal *length*. He claims that one has to have at least three units – be they *length*, *time* and *mass* or replaced by *length*, *velocity* and *mass* or even *length*, *velocity* and *energy* (see Strauss, 2021:71-74).

However, Dooyeweerd's analysis of the first four (irreducible) modal aspects of reality would have helped physicists to realize that *four units* are indeed needed (see Strauss, 2021:73). Clearly these four units of measurement reflect the meaning of the four foundational aspects of reality captured in the diagram below, namely *number* ('mass'), *space* ('length'), the *kinematic aspect* ('duration') and the *physical aspect* ('charge'). Weinert (1998) mentions even that usually physicists "distinguish fundamental constants from conventional units" – and he then lists the *kilogramme* (number), the *meter* (space), the *second* (the kinematic) and *temperature* (the physical).

	Lorenzen	Heisenberg (a)	Heisenberg (b)	Heisenberg (c)	Heisenberg (d)	Weinert
Physical	charge	quantum of action			energy	temperature
Kinematical	duration	c (velocity of light)	time	velocity	velocity	second
Space	length		length	length	length	meter
Number	mass		mass	mass		kilogram

Prior to Kant no one less than Leibniz juxtaposes time – as "an order of successions", with space – as "an order of coexistences" (Leibniz, 1965:199).

Modern Physics

In the 20th century, after modern physics was successful in transcending its modern mechanistic restriction, it was realized that *physical time* is intrinsically connected with causation, for the effect can never precede the cause.

The numerical order of succession is reversible – manifested in the plus and minus directions of the system of integers, closed under the operations of addition, multiplication and subtraction. Saying that these operations are closed means that applying them to the set of integers always yield integers from the same set. When any two integers are added, multiplied or subtracted, the result is always another integer. The symmetry of any spatial configuration – allowing being turned upside down or front-backwards – shows the reversibility of the spatial time order, and the same applies to the *kinematic time order*, for the mathematical description of a constant movement (like the swinging of a pendulum) is equally valid in both directions.

Time and Mathematics

Mathematicians who are only acquainted with the dominant trend in modern mathematics, namely the axiomatic formalist standpoint, will straight away claim that time does not have a place in mathematics. However, those who took notice of neo-intuitionist mathematics exemplified in the work of L.E.J. Brouwer and his successors (amongst whom are scholars like H. Weyl, A. Heyting, D. van Dalen, A. Troelstra, M.A.E. Dummett and to a certain extent also P. Lorenzen), will realize that this school explicitly proceeds from the assumption of an original *intuition of time*. In this intuition, according to Brouwer, continuity and discreteness coincide giving birth to the primal awareness of one, another one and so on – a process that, through the endless addition of new units could never be exhausted. In other words, this process is literally infinite, without an end. This intuitionistic conception of time is historically dependent upon the philosophy of Immanuel Kant who saw time as one of the psychical forms of intuition of being human.

What intuitionism identifies as the intuition of one, another one and so on, relates to the arithmetical time order of succession on the law-side of the numerical aspect. It belongs indeed to the time intuition of every person since without this numerical time order one of the cornerstones of our modern civilization will collapse, including our measurement and calculation of (physical) time. Put differently: our experiential intuition of numerical relations provides us with an insight into the original (ontically given) numerical time order of succession.

In mathematics this time order lies at the foundation of the principle of (mathematical) induction – first introduced by Pascal. It simply says that if a statement is valid for the number 1 and, subsequently, if it could be shown that whenever it holds for a number n it also holds for the number $n+1$, then it obtains universally. According to Weyl already this principle is sufficient to safeguard mathematics against becoming a mere tautology, in other words to prevent that a set of formal axioms forming the basis of mathematics instead of a basic insight that cannot be formalized.

The most primitive correlate of the numerical time order of succession is given in the sequence of natural numbers: (0), 1, 2, 3, 4, 5, 6, 7, ... (without an end, endless, *infinite*). Axiomatic set theory sometimes attempted to define order. This is done, for example, by introducing the concept of an ordered pair. Even in the standard work on *Set Theory* (second, revised edition, 1973) Fraenkel, Bar-Hillel, Levy & Van Dalen there suddenly appears an unexpected *petitio principii* in this regard. Without explaining the technical detail, it is sufficient to take note of the remark added to their example about an ordered pair (derived from Kuratowski): "Taken in that order!" (Fraenkel *et al.,* 1973:33).

Space and Time (infinitum successivum and infinitum simultaneum)

Within the aspect of space time expresses itself in the spatial time order of simultaneity, correlated with factual spatial extension. Already this insight cancels the misconception that time is spaceless and that space is timeless. The awareness of simultaneity (that which exists at once) belongs to our basic intuition of space.

When the arithmetical order of succession on the law-side of the aspect of number is disclosed under the guidance of the theoretical insight into the nature of the spatial order of simultaneity, we discover the regulative disclosed idea of infinity, namely the idea of the actual or completed infinity – preferably designated as the idea of the *at once infinite*.

Late medieval speculation about the infinity of God generated alternative expressions for the potential and actual infinite. Compare the designations *infinitum successivum* and *infinitum simultaneum* (see Maier, 1964:77-79).

Immanuel Kant once used the expression "successive infinite" in his *Kritik der reinen Vernunft* (CPR) According to him what is *sukzessivunendlich* can never be a *whole* (cf. Kant, CPR:-B:552). The uniqueness and coherence of the aspects of number and space provides us with a sound basis for our understanding of the successive infinite and the at once infinite. The order of succession on the law-side of the numerical aspect reveals the most basic meaning of infinity, in the literal sense of one, another one and so on indefinitely, while the forward-pointing analogy of number to space enables us to view any successive infinite sequence of numbers *as if* it is an infinite whole, given *at once*.

Since every attempt to reduce spatial continuity to numerical discreteness implicitly or explicitly has to employ the at once infinite we have to acknowledge that not even the real numbers are continuous. While the integers imitate the totality character of spatial continuity and fractions the part element of the spatial whole-parts relation, one can at most say that the real numbers imitate (analogically reflect) the nature of spatial continuity.

This perspective explains why arithmeticism is problematic. Bernays states emphatically:

> The arithmetizing monism within mathematics is an arbitrary thesis. That the field of investigation of mathematics solely derives from representations of number is not at all shown (Bernays, 1976:188).

Thus far it must be clear that our temporal world exceeds the exclusive grasp of a single mode of explanation, amply illustrated by the four constants capture in the Diagram earlier.

Irreversibility

Since the arrow of time captures the irreversibility of the physical time order, we conclude with a few remarks about physical irreversibility.

Already in 1824 Carnot discovered fundamentally irreversible physical processes. The implications of this discovery were further developed simultaneously by Clausius and Thompson in their formulation of the second main law of thermodynamics. In 1865 Clausius introduced the term entropy. This law accounts for the irreversibility of physical processes – it determines the direction of a physical (or chemical) process in a closed system.

Thus, the law of non-decreasing entropy was established as the second main law of thermodynamics. At the same time, the classical mechanistic reduction of everything to pure motion was uprooted. Justifiably therefore Max Planck (in his mentioned article from 1910) remarks that the "irreversibility of natural processes" confronted the "mechanistic conception of nature" with "insurmountable problems" (Planck, 1973:55). Consequently, whereas the time order in the first three aspects is reversible, it is irreversible in the physical aspect. This is easily seen in the a-symmetrical relation of causality: it stands to reason that the cause precedes the effect!

Since the discovery of radioactivity it turned out that within micro-structure themselves there are irreversible processes present proceeding spontaneously in one direction only. In addition, this state of affairs straightaway confirms the irreducibility of the physical aspect to the kinematical aspect (with its reversible time order).

Since the physical aspect is founded in the kinematic aspect, it is understandable why change presupposes constancy. This at once also explains why the first main law of thermodynamics, the law of the conservation of energy (energy cannot be created or annihilated), should rather be designated as the law of energy-*constancy*. It represents a kinematical analogy on the law-side of the physical aspect. In terms of the theory of modal aspects one can say that energy-constancy is, on the law-side, a retrocipation from the physical aspect to the law-side of the kinematic aspect. Since the term "conservation" is ambiguous – conserving may suggest an energy-input – the expression *energy-constancy* appears to be a more exact account of the first law.

Concluding assessment

It is remarkable that our temporal existence cannot be understood by one mode of explanation alone. Clearly, Kant's three modes of time opened up the way to a more nuanced understanding of temporality. At the same time, an analysis of the way in which time is expressed in the four most basic aspects of reality helped us to shed new light on perennial philosophical issues, such as the two forms of *infinity* and the problem of *constancy* and *change*. Every aspect of temporal reality is both unique and coheres with all the other aspects. In addition, our analysis highlighted the nuanced nature of time which cannot be identified with any particular aspect.

The fact that temporality comes to expression in the four most basic aspects of reality shows that it cannot be restricted to one aspect only. This entails that although temporality is an undeniable *trait* of reality, its fundamental and encompassing nature ought to be appreciated in a way that transcends any cosmic mode of time. Temporality, the temporal way in which we exist, undergirds everything we can experience and therefore it should be acknowledged as the most basic dimension of reality. Temporality in this sense could be designated as *ontic time* or "temporosity" even though the English language does not know such a term (but compare it with the proper English term "numerosity").

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