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# Time[1]

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Everything that is individually experienced by people, along with every external event and process – especially in nature – can be ordered according to succession, and thus temporally. In this sense, time is always an ordering parameter of events. What is disputed within philosophy, however, is what else constitutes time; for example, whether it is relative or absolute, subjective or objective, a form of intuition or a substance, whether there are sub-types of time that are irreducible or can be derived from each other in a specific way, and the like. Characteristic of time as an ordering parameter is the combination of aspects of continuous change (linearity) with those of regular recurrence (cyclicity). Furthermore, in the scientific-technical description of external events, so-called B-time or tenseless ascriptions (i.e. earlier-later relations) are often of particular importance. In contrast, so-called A-time or tensed ascriptions (being present versus being past or future) are usually central to experience. Thus, in the context of natural philosophy – which deals with scientific-technical concepts of nature as well as with nature as experienced – both a separate understanding of A- and B-times and an understanding of their interrelations is of central importance.

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Everything that is individually experienced by people, along with every external event and process – especially in nature – can be ordered according to succession, and thus temporally. In this sense, time is always an ordering parameter of events. Depending on the type of events in question, time occurs in very different forms or subtypes; and in very different orders of magnitude (scales) too. If, for example, a physicist describes a natural event such as the rolling of a stone down a mountain slope, then physical time is relevant. This can be determined with a stopwatch, for example, and the order of magnitude is in the range of seconds. In comparison, the time scales that interest the particle physicist at CERN are much smaller, whereas the time scales that are usually relevant for the evolutionary biologist or the geologist are much larger; and neither the collision of two elementary particles nor the evolution of species or geological deep time can be measured with a commercially available stopwatch. What the above examples have in common is that they are concerned with time in the sense of so-called B-time or tenseless relations.[2] No specific common point of reference is distinguished, but only earlier-later relationships between the events under consideration. For example, B may occur earlier than C, but later than A.

A different form of temporal order is typically encountered in experience. Because here a specific point of reference is indeed distinguished: the present. It designates what is happening right now and is different from what is no longer happening (past) and what is not yet happening (future). In this context one speaks of an A-time or a tensed temporal ordering. Events are ordered

[1] Translation of the German-language lemma „Zeit“: Sieroka, Norman (2021): Zeit. In: Kirchhoff, Thomas (Hg.): Online Encyclopedia Philosophy of Nature / Online Lexikon Naturphilosophie. Heidelberg, Universität Heidelberg, doi: 10.11588/oepn.2021.0.79593.

[2] Today’s widespread jargon of ‘A-’ and ‘B-times’ (‘A-’ and ‘B-series’, etc.) goes back to John McTaggart (1908).

according to whether they are present or (to a greater or lesser extent) past or future.

There is not only the temporal order of individual experience but also other (tensed as well as tenseless) orders that are determined by society or the communities in which one lives, and which in this respect have an intersubjective character. In the political context there are legislative periods; in the religious context recurring rituals, such as the church year; in the historical context there are ideas of a collective past; and many more.

Thinkers have always emphasised different aspects and different types of time and provided very different interpretations of what time is. For example, scientific realists usually consider the tenseless (B-time) ordering of physical events to be the only metaphysically true time (e.g. Mellor 1998); and here some even consider time to be a substance. In contrast, philosophers of life typically assign a foundational role to experienced time. For Henri Bergson (1889), for example, 'duration' as experienced in processes of consciousness has a metaphysical primacy over spatialised and quantified (tenseless) notions. Other thinkers emphasise the moment of an order that is not individual but intersubjective; or, like Immanuel Kant (1781/1787), they even regard time as a transcendental form of intuition that makes empirical experience possible in the first place. (Analogous controversies exist around the concept of space, see e.g. Gosztonyi 1976.)

The following outline of the concept of time and its history leaves ontological questions largely untouched (on these see e.g. Beuthan/Sandbothe 2004; Hühn/Waschkies 2004; Westermann 2004). Instead, various forms and scales of time will first be discussed in a descriptive way and then brought together in a framework that combines natural philosophy and transcendental philosophy or naturalistic and idealistic views – similar in a way to what Friedrich Wilhelm Joseph Schelling (1799; 1800) aimed at with his 'System of Knowledge'.

## 1. Two elements of succession: a conceptual outline of cyclical and linear notions of time in antiquity and modern times

The oldest fragment of Western philosophy already mentions time as an ordering parameter of events: 'For they [i.e. things that exist] pay penalty and retribution to each other for their injustice *in accordance with the ordering of time (kata ten tou chronou taxin)*', it says in Anaximander (Diels/Kranz 12B1). The temporal order is understood here as a legal one. It is not a 'blind' or 'chaotic' succession but one that has to do with regular balancing – and this applies to social as well as natural events. Not only thieves are punished after their deeds but also the 'intrusiveness' or 'assault' of the sun during the hot, dry and long summer days is balanced out afterwards by the humid and short days in which dried-up riverbeds flood and seemingly dead land is brought back to life; until, in the following summer – according to 'the order of time' – this excess is balanced out once again.

The emphasis on return and balance points to a strongly cyclical understanding of time. In fact, in antiquity, linear concepts were initially limited primarily to space and spatial objects (Demandt 2015: 11–21). Even infinite or inexhaustible progress – which since Homer has been prominently associated with the adjective *apeiros* and its cognates – is not initially applied to time but to land and water masses and to the counting of external objects (Sieroka 2017: 248–251). This is remarkable because time also owes its name to spatial associations: the Greek verb *temno* – from whose Indo-European language root, among others, the words 'tempus' and 'time' derive – means 'to divide' or 'to cut off' and is found, for example, in the word 'templum', which denotes a separated (and sacred) area. Time is like space in some respects but seems to be conceptually more difficult to grasp, and more abstract. Spatial comparisons repeatedly serve as illustrations of temporal processes, as in Heraclitus' famous saying that one cannot step into the same river twice (Diels/Kranz 22B91). Regardless of this (temporally linear) comparison, however, Heraclitus's process thinking remains primarily cyclical. This is evident from the way he speaks, for instance, of the internal tensions in objects, of recurring world fires and of the 'ever-living fire' (*aeizoon pyr* – Diels/Kranz 22B30).

Cyclicity or sustained recurrence is also the paradigm for measuring time. In antiquity the reference or source of uniformity needed for measuring time is found less in earthly natural processes than in the movement of the heavenly bodies. Plato even describes the heavenly bodies as 'tools of time (measurement)' (*organa chronou* – Timaeus 42d5). However, there is no independent empirical criterion proving that the orbiting of the

heavenly bodies is actually uniform. For Aristotle, the cyclicity of time is ontologically founded and time is 'the (measured) number of change (movement) according to its before and after' (*arithmos kineseos kata to proteron kai hystero* – Physics IV, 11, 219b1 f.). For him the heavenly bodies with their eternally recurring revolutions remain the decisive bearers of change. However, Aristotle seems to be aware of the problem of the missing criterion of uniformity when he claims in a quasi-circular manner that time is measured by means of change and change by means of time (Physics IV, 12, 220b23 f.).

Starting with Aristotle and other thinkers – and especially with the beginnings of Western historiography in Herodotus and Thucydides – it is the order of earlier-later (before-after) that increasingly receives attention. In the early modern period at the latest, linear concepts of time become dominant and the permanent recurrence of similar patterns recedes into the background. This raises the question of the origin of temporal order and its progression in a new way. It is no longer primarily a question of a uniform and comprehensive cosmic balance but rather of how it can be understood in detail that one event follows another – and whether there is even a specific time pattern. Moreover, the question arises whether there is a certain (final) state towards which everything is heading. The obvious candidate here is causality, which from the early modern period up to the present day has widely been discussed as a kind of 'motor of temporal sequences' (cf. for example Reichenbach 1925; van Fraassen 1970; Dowker 2006). An event A temporally follows an event B (and by no means vice versa) if A is the cause of B. Causal chains, so the claim goes, determine the direction of time.

However, this opens up a new problem: causality only seems to apply to events of the same kind. In the early modern period, a key distinction was made between efficient causes, which link the states of physical objects, and final causes, which link mental states (Spinoza [1677] 2007; Leibniz [1686/1714] 2014). This is unproblematic if final or efficient causes are in some way reducible to one another. If not, however, the question arises whether two types of causality do not also constitute two types of time: namely, one in which the efficient causes 'do the timing', and one in which final causes do.

## 2. Time in nature versus time in experience

Against the background of the problems just mentioned, it makes sense to first separate schematically the discussion of a time in nature and a time in experience (or an experienced time) – before bringing both together again in the sense of an overall natural philosophical perspective. As already mentioned, my text thus follows the framework of a Schellingian 'system of knowledge' in which insights about natural processes (see section 2.1) are related to transcendental philosophical insights about subjectivity (see section 2.2) and examined for transitions between the two (see section 3).

In the following, when dealing with processes in nature, I mostly use the adjective 'physical' ('physical time', 'physical states' and so on). This seems justifiable for etymological reasons, since the Greek word *physis* refers to the whole of nature and to every natural process (cf. Dunshirn 2019). Above all, however, this is done for the sake of simplicity, because the following descriptions of scientific concepts of time also refer primarily to physics. Biology, for example, is only mentioned in passing (for a systematic and detailed discussion of concepts of time in biology, see e.g. Kirchhoff 2015; Cheung 2020).

### 2.1 Time in nature – efficient causes, time series analysis, operationalism

Physical states are connected to each other by efficient causes, which, according to conventional wisdom, establishes an order of time (cf. Horwich 1987). If, for example, billiard ball A hits billiard ball B, the movement of ball A (or the transfer of its momentum and energy) is the cause of the *subsequent* movement of ball B. Thus, the states line up in terms of a B-series; that is, in terms of being earlier or later than others, or being simultaneous with one another. It is remarkable that *the mathematical formalisations* of most physical theories leave the direction of this order open (keyword: time reversal invariance). The states can be arranged in an unambiguous series, but it remains open whether this series runs from earlier to later or from later to earlier. An exception in this context is provided by thermodynamics: the increase in entropy, a basic thermodynamic quantity, marks a direction from earlier to later – and

thus makes it comprehensible why, for example, hot and cold water mix to form lukewarm water but lukewarm water does not 'unmix' into cold and hot water. Applied to physical reality as a whole, however, this inevitably raises the question of why entropy was originally so low and why exactly this time-direction was established (cf. Price 1996).

On this topic, compare the first antinomy of pure reason discussed by Kant (Kant [1781/1787] 1974, KrV A426 ff./B454 ff.; see also Mittelstaedt/Strohmeyer 1990). It deals – albeit against a broader philosophical background – with the dispute as to whether the world as a whole has a beginning in time (thesis) or whether it is infinite with regard to past time (antithesis). The proponents of the thesis argue as follows: If one assumes that the world is not finite with regard to past time, then an infinite amount of time would have passed up to the present time and an infinite series of successive states would have occurred. But an infinity 'completed' in this way cannot exist, so the assumption made must be wrong and the world must have a beginning. In contrast, the representatives of the antithesis argue as follows: Assume that the world has a beginning in time. Then there must have been a time in which the world did not yet exist. Such a time, however, would be an empty time in which nothing could come into being. For no part of this 'empty' time would have any condition that differed from those of its other parts, which is why nothing could change in such an empty time and above all nothing could come into being. Individual things in the world can have a beginning but the world as a whole cannot. Consequently, contrary to its own assumption, this view must hold that the world is infinite in terms of past time.

Both arguments seem logically compelling yet taken together they end in a contradiction. According to Kant, this reveals a problem with the concept of the world as a whole. For him, the world is a so-called idea of reason; it is not a concept that can be derived directly from empirical experience. Empirical experiences, by contrast, consist of series of phenomena; and it is those series that are temporally (as well as spatially) and causally connected.

The development of modern physical-cosmological theories can be understood in terms of a progression towards ever smaller temporal and causal units. It is worth noting that these theories have a kind of 'inner capacity for resolution'. They carry within themselves, so to speak, the finding that their descriptions cannot reach back to a supposed beginning of time. The Big Bang theory, for example, makes many statements about what happened in the cosmos shortly *after* the Big Bang, but not exactly *at* the Big Bang.

Following on from this, one might ask the ontological questions of whether physical time itself possesses a kind of 'resolution limit', i.e. whether there is something like a fundamental lower limit for the duration of natural events and how this might be reflected in a discrete structure of time (cf. Forrest 1995; Dummett 2000; Sieroka 2018: 37–41). Furthermore, one may ask about the relationship between different scientific conceptions of time. For example, in evolutionary biology, at least at first glance, temporal non-reversibility and certain forms of (not closed teleologically but) open linear progression play a more central role than in physics (cf. Kirchhoff 2015; Cheung 2020).

Notably, the distinction between linear and cyclical aspects in the sequence of events remains fundamental even in the various scientific concepts of time. Or better and more generally: it is the distinction between aspects of progression and aspects of recurrence that remains fundamental. This is because, on the one hand, this distinction allows the separation of different processes within physical (or biological etc.) time. For example, when it comes to questions of climate change, one can use time series analyses to distinguish between those fluctuations in the $CO_2$ content of the atmosphere that are seasonal (and thus recurrent) and those that show an increase over years or decades. On the other hand, the distinction between linear and cyclical leads back to the above-mentioned problem of measuring time (cf. Schlaudt 2020). Does some kind of change suffice here or does one need something recurring or intersubjectively reproducible in order to be able to meaningfully define units of time? And if this is the case, to what extent can we assume that such a recurrence or reproduction takes place uniformly – i.e. after the same time intervals? Since there is no absolute, experience-independent criterion of uniformity or regularity, there is only the operational possibility of comparing different recurring natural processes and then designating as a criterion of uniformity the set of natural processes that unites as many compatible processes as possible (Carnap 1969: 84–91). For example, the numbers of oscillations of

different pendulums are highly stable in relation to each other and in this sense form a large set of such compatible processes. Indeed, the history of the development of clocks – from, among others, the water clock and hourglass to the pendulum clock and pocket watch to the quartz clock and atomic clock – can be described as a search for an ever-increasing set of compatible processes (Janich 1980: 221–245; Sieroka 2018: 50–58).

Next, the philosophical question arises whether such an operationalist approach could also get by with a weaker concept of repetition (without naming specific types of event such as pendulum oscillations) and whether the fundamental directionality of time could somehow be derived from such a concept of repetition. This would also broaden the scope of the two aspects of linearity and cyclicality mentioned above: changes do not always have to be continuous – leaps are also permissible – and recurrence may refer to certain parts (instead of entireties) of processes. One might hope for new insights in this regard from quantum information theory and quantum gravity, with the help of which changes (and their measure) can be described theoretically in a particularly streamlined manner or which consider space and time in a dynamically unified way (Ranković et al. 2015; Rovelli 2016).[3]

### 2.2 Experienced time – final causes, phenomenology, meaningfulness

Temporal orders, of course, also occur in the context of human experience. Mental states are lined up according to a relation of succession too. However, in contrast to physical states, mental states are usually ordered in a tensed fashion. That is, they are ordered in terms of being past, present or future and not in terms of being earlier or later than one another.[4] This categorically distinguishes mental states and processes from physical states and processes. For instance, it is a basic characteristic of sensory perceptions that they refer to the present – when I see or hear something, I see or hear it now. In contrast, the object of memories is something past – for example, the sea where I was a few weeks ago; and the object of a hope or worry is something future – such as the test result that will finally be available the day after tomorrow. As experienced, however, all mental states are present. Even though memories refer to something past, at the moment of remembrance, that mental act itself is, of course, present: I remember *now*. Similarly, whenever I worry about the upcoming test result, I worry about it *now*.

At the level of action, the three basic tenses (past, present, future) are linked by final causation: based on past experiences, one acts in the present in such a way that the desired goals will hopefully be realised in the future. So here, aspects of the past and the future always play into the present. In fact, this is not only the case in action. The above-mentioned acts of experience, such as sensory perception, also show input or aspects of the past and the future when analysed more closely – albeit on a much smaller scale. If you touch a surface, hear a melody or see a cyclist, you do not experience an incoherent staccato of impressions but perceive processes and transitions as a continuously connected 'temporal gestalt'. Successive events of touch, sound and sight – some of which have already passed, some of which are present and some of which are rudimentarily anticipated – come together to form meaningful wholes. A famous and more detailed philosophical investigation of the inner dynamics of these tensed connections is offered by Edmund Husserl's *On the Phenomenology of*

[3] Moreover, there continue to be debates about the ontological status of time as absolute (or substantial) versus as relational (Benovsky 2011), debates which go back at least to Isaac Newton (or his follower Samuel Clarke) and Gottfried Wilhelm Leibniz (see Leibniz/Clarke 1715/1716). Furthermore, the recently discussed concept of super-substantialism – according to which space-time is the only fundamental substance in nature and matter is derived from the properties of this space-time – shows strong similarities to Spinoza's field metaphysical ideas (see Sieroka 2010).

[4] The fact that physical events, unlike mental states, are primarily ordered in a tenseless way becomes particularly clear in the context of (special) relativity theory. According to this theory, simultaneity is a property that depends on the reference system under consideration. This means that, for different observers, different events can be simultaneous. However, this poses a particular difficulty for a tensed view of time (especially so-called presentism) because what is present (or already past or still future) is no longer universally defined (Dainton 2010).

*Internal Time Consciousness* (Husserl [1893–1917] 1969, see esp. §§1–33). His analysis can be understood as an elaboration of Kant's transcendental philosophy. Kant had already regarded time as a 'pure form of intuition' that was constitutive of everything that could be experienced (cf. Kant 1781/1787, KrV A31–49/B46–73). However, Kant failed to provide the corresponding phenomenological details of how exactly mental acts are constituted. Husserl now makes up for this and thus provides, as he himself liked to describe it, the necessary 'philosophical small change'.[5]

To learn more about the experience of time, from both a scientific and a philosophical perspective, the sense of hearing is particularly revealing (Sieroka 2009). This is because auditory perceptual qualities such as pitches, timbres and rhythms are intricately linked to temporal regularities and integration processes. Due to the close relation to bodily states (keywords: corporeality, 'embodiment') hearing is of particular interest to natural philosophy as well. In fact, over the last two decades there has been a fruitful exchange between cognitive science and philosophical analyses of time consciousness within the framework of so-called neurophenomenology (Varela 1999; Thompson 2007; Sieroka 2015).

Tensed orders give human life a certain sense of directedness and with it they ultimately provide meaning to life too – where 'meaning' might be understood in a weak sense (simply as providing temporal directedness) or in a more existentially charged sense as implying a concrete reference to one's own death (cf. Heidegger [1927] 2010). Questions about the unavailability of one's own death, which signifies the end of individual time, thus become a kind of tensed analogue of the issues involved in the Kantian antinomy (cf. section 2.1). Whereas the antinomy was about a possible temporal beginning as part of the world, here the issue is about an end as part of a temporally experienced wholeness.

Complex mixtures of both tensed and tenseless aspects of time can occur, for example, in medical-ethical contexts; especially when the perspective of a patient is supplemented by that of the patient's relatives and of the attending physicians, as well as by questions of technical feasibility (cf. Dietrich et al. 2018).

Take, as a concrete example, the question to what extent or for whom it makes sense in a specific context to take life-prolonging measures: here, the (tensed) concerns and empathy are mixed with earlier-later orders in the (non-)availability of technical means and, in some cases, also with attributions of patient intentions from a third-person perspective, which are partly tensed and partly tenseless.

What is central, also to establishing meaning in life, is again the relationship and interplay between (i) a conception of time that has to do with change or progression (which, however, does not have to be strictly linear), and (ii) a conception of time that is about the recurrence of events (Sieroka 2018: 82–85). Both aspects are important not only in the context of physical measurements (cf. section 2.1) but at the level of everyday life and human experience: in order to establish any kind of order in life at all, one is dependent on recurring events (natural events, communal or individual rituals); at the same time, however, one usually strives for something new, for new contrasts in experience. Events in life should not form a hopeless chaos, but neither should everything settle into an all-too-predictable rut. Here new or additional meaning can be created, for example, by integrating new events into a closed narrative about one's own life (cf. Ricoeur 1991).

Similar to the differences in conceptions of time that may exist between different levels of description of nature (e.g. physics versus biology versus geography; cf. section 2.1), there are also differences between levels of description on the side of human experience: in addition to the time experienced by an individual as present, there is the narrated time just mentioned, which refers to the past. Furthermore, there are inter-individual times that order and shape our communal life, and in which certain temporal events can even have an identity-forming character. Think, for example, of time zones and timetables or religious as well as public holidays.

[5] Note that St. Augustine's position (Augustinus [397–401] 2009: Book XI, 14–31) can be understood as an ontologised preliminary form of what is later transcendentally philosophically substantiated by Kant and then elaborated in detail by Husserl. For a comprehensive account of Augustine's theory of time and its history of impact, see Flasch 2016.

## 3. Relations between times – transitions in natural philosophy and the treatment of nature

Since the philosophy of nature is not simply a (formal) philosophy of science, but a meaningful consideration of nature, the results of the previous sections must now be related to one another. That is, the different insights about time and the different time-based relationships between humans and nature must now be reflected upon – along with the normative implications that result from humans' dealings with nature (cf. Janich 1994).

### 3.1 Human-nature relationship

The contexts in which we encounter time or temporal sequences are numerous and complex. There are contexts of the political, the religious, the individually felt, the communally experienced and established, the physical, the evolutionary-biological, and so on. However, based on the preceding sections and in order to avoid further complications, let us start from a dichotomy that takes humans to be mental as well as physical beings.[6] Thus, examining the relationship between human being and nature in terms of the philosophy of time means investigating the relationship between sequences (sequencing) in what is humanly experienced and what is in nature (Whitehead 1927) – and thus investigating the relationship between tensed and tenseless orders.

Peter Rohs (1996) provides an interesting approach here. He assumes that there are two coherent and feasible philosophical projects which allow for a deeper understanding of nature and human experience, respectively: on the side of nature, so-called field metaphysics, which goes back to the work of Spinoza (cf. Sieroka 2010); and on the side of experience (subjectivity), transcendental philosophy, as elaborated by Fichte following Kant. Notably, Rohs is keen to avoid any reductionism: he wants neither to naturalise subjectivity within the framework of field metaphysics (let alone a modern physicalism) nor to 'dissolve' nature entirely into transcendental philosophy. Instead, he searches for a possible transition between those two philosophical projects and for a kind of synopsis. This is indeed similar to Schelling's (1799; 1800) proposal of a 'system of knowledge', in which he also noted transitions between transcendental philosophy and (his own) philosophy of nature.[7]

The interesting thing about Rohs is that – unlike Schelling – such a transition between the theory of nature and the theory of subjectivity is made possible by time. For Rohs, time becomes the 'ontological node' of the overall system; that is, tensed and tenseless relations are viewed as two sides of the same coin and this coin, as it were, forms the origin of all philosophical theory formation – with tenseless relations on the side of nature and tensed relations on the side of subjectivity.

With regard to natural philosophy, what is more important than Rohs's ontological hypothesis about a 'node' is his general finding that the concept of time allows for important transitions in the descriptions of nature and subjectivity (Sieroka 2015). Because even if the primary temporal relations of physical events (B-time) and of mental events (A-time) are not identical, they do have structural commonalities and can be translated into each other, at least partially. For example – to give a particularly simple illustration – if event A is past and event B is present, then A is earlier than B.

These transitions should not be understood as providing the basis for a reductionism (Sieroka 2009). It is not a matter of reducing A- and B-times to one another. Instead, the transitions are intended to demonstrate the possibility of a common systematic view. To express it with a visual metaphor: it is about looking at the same object simultaneously from two different perspectives, thus creating a stereoscopic effect of depth of field. That is, a three-dimensional impression is created from two initially independent two-dimensional views (based on the possibility of transition).

[6] It is not the aim of this article to discuss the extent to which such a dichotomy is justified and whether, for example, social and individual or physical and biological aspects of our temporal existence can be reduced to one another.

[7] A similar approach can be found, for example, in Carl Friedrich von Weizsäcker (1988: 621, 640). However, von Weizsäcker speaks of a 'circular way' (rather than transitions) to link approaches to nature and to subjectivity (experience).

Two methodological approaches have already been mentioned in which such transitions or translations come to the fore very prominently: On the one hand, operationalist approaches to physical time measurement have their basis in instructions for action in the natural (material) world. They begin with the human being as a physical agent and thus build a bridge from nature to subjectivity. On the other hand, neurophenomenology (if transcendentally reflected) enables a transition from subjectivity to nature (Sieroka 2009). This is because it analyses mental events (especially time consciousness), then seeks a connection to the cognitive sciences, before reconstructing temporal conditions and incorporating ideas of corporeality.

### 3.2 Normative implications

Having dealt with the theoretical relationship between A- and B-time, the final practical question is whether this relationship can and should be changed. Normative questions arise about the role of humans, who not only experience nature but are also part of nature and deal with it (in time) (cf. Blumenberg [1986] 2001; Hartung 2015). This also raises questions of progress – analogously as in the context of evolutionary biology mentioned above. Is there a sequence of stages or even a teleology in the historical development of human societies, as prominently advocated, for example, by German Idealism and especially by Marx and Engels (see, among others, Hegel 1822–1831/1837; Marx/Engels [1845–1846] 1990)? Or, conversely, is there perhaps no progress, not even an 'order of time' but merely a disjointed appearance of mutually independent social events (the so-called occasional understanding of time; cf. for example Morgenroth 2008: 69 f.)? And what would be the consequences of these questions for the meaning and possibility of human action?

Notably, questions about human action are, for a large part, questions about specific interrelationships or between tensed and tenseless orders of events. They are questions of the relative 'tuning' of experience and natural processes; that is, of their respective or reciprocal succession: whether it is better to do A first or B first, or whether one should wait for C to occur before doing D and E, and so on. Questions of this kind form the general time-theoretic framework of political decision-making processes and are decisive whenever it comes to concrete issues such as climate change.

The fact that time is an ordering parameter of events and that questions about time are often questions about tuning also indicates that time must not be understood as an independent substance or as a resource.[8] This would even be misleading, since resources can become scarce, which is not the case with time. The perception of the present never becomes scarce, nor does physical time – every day lasts twenty-four hours. Nevertheless, a physical time interval can be short in relation to the need for, say, decisions regarding climate policy (cf. Luhmann 1971; Dietrich et al. 2018). The issue is therefore not time per se but the relationship between different events belonging to different temporal orders.

This is also what underlies complaints about an 'acceleration' of life and society that are so frequently voiced at present. It is not time that is becoming faster and faster. Instead, what increases is the frequency of personal and social decisions per physical time interval. A more accurate description of this phenomenon is therefore that of a 'shortened present' or a 'shrinkage of the present' (Lübbe 1992: 399–404). What is experienced as permanent on a social or individual level extends over shorter physical time intervals. Fashions seem to follow one another ever more quickly. However, the complaint that 'time flies' (*tempus fugit*) is by no means a new one. Besides, there is a daunting contrary tendency, at least if one considers the physical consequences of human action. A unique feature of modern technical development is its 'temporal penetration depth'. Problems such as the disposal of radioactive waste are no short-term matter. They have consequences for centuries and millennia to come. Here the social consequences of present human life are by no means accelerated or shortened but instead are long-lasting.

[8] Indeed the idea that time is a substance leads, in normative contexts, to similar implausibilities, as it does in the context of physics – compare, for instance, Newton's assumption of an absolute time into which events enter as into an existing container.

Becoming aware of such problems is the core business of a natural philosophical examination of the concept of time. Natural philosophy can help to counteract naïve findings about 'time', because it always deals with the relationship between (individually and socially) experienced time and time in nature; and the tensed experiences of the individual natural philosopher always encounter the tenseless character of the object of investigation, viz. nature, and thus reveals the relational character of many supposed problems of time.

## Basic literature

Aristotle Physics = Aristotle 1987: Aristoteles' Physik. Vorlesungen über Natur. Erster Halbband: Bücher I (A)–IV (D). Griechisch–Deutsch. Übersetzt, mit einer Einleitung und mit Anmerkungen herausgegeben von Hans Günther Zekl. Hamburg, Meiner.

Demandt, Alexander 2015: Zeit. Eine Kulturgeschichte. 2. Auflage. Berlin, Propyläen.

Price, Huw 1996: Time's Arrow and Archimedes' Point. New Directions for the Physics of Time. New York, Oxford University Press.

Rohs, Peter 1996: Feld – Zeit – Ich. Entwurf einer feldtheoretischen Transzendentalphilosophie. Frankfurt/M., Klostermann.

Sieroka, Norman 2018: Philosophie der Zeit. Grundlagen und Perspektiven. München, Beck.

## Literature

Aristotle Physics = Aristotle 1987: Aristoteles' Physik. Vorlesungen über Natur. Erster Halbband: Bücher I (A)–IV (D). Griechisch–Deutsch. Übersetzt, mit einer Einleitung und mit Anmerkungen herausgegeben von Hans Günther Zekl. Hamburg, Meiner.

Augustine [397–401] 2009: Confessiones/Bekenntnisse. Lateinisch/Deutsch. Übersetzt, herausgegeben und kommentiert von Kurt Flasch und Burkhard Mojsisch. Stuttgart, Reclam.

Benovsky, Jiri 2011: The relationist and substantivalist theories of time: foes or friends? In: European Journal of Philosophy 19 (4): 491–506.

Bergson, Henri [1889] 1910/2013: Time and Free Will. An Essay on the Immediate Data of Consciousness. London/New York, Routledge.

Beuthan, Ralf/Sandbothe, Mike 2004: Zeit, VI. 19. und 20. Jh.: von Kant bis zur Gegenwart. In: Ritter, Joachim/Gründer, Karlfried/Gabriel, Gottfried (eds): Historisches Wörterbuch der Philosophie. Band 12: W–Z. Darmstadt, Wissenschaftliche Buchgesellschaft: col. 1234–1244.

Blumenberg, Hans [1986] 2001: Lebenszeit und Weltzeit. 5. Auflage. Frankfurt/M., Suhrkamp.

Carnap, Rudolf 1966: Philosophical Foundations of Physics: An Introduction to the Philosophy of Science. New York, Basic Books.

Carnap, Rudolf [1966] 1969: Einführung in die Philosophie der Naturwissenschaft. Herausgegeben von Martin Gardner. Aus dem Amerikanischen von Walter Hoering. München, Nymphenburger.

Cheung, Tobias 2020: Natur und Geschichte. In: Kirchhoff, Thomas/Karafyllis, Nicole C./Evers, Dirk/Falkenburg, Brigitte/Gerhard, Myriam/Hartung, Gerald/Hübner, Jürgen/Köchy, Kristian/Krohs, Ulrich/Potthast, Thomas/Schäfer, Otto/Schiemann, Gregor/Schlette, Magnus/Schulz, Reinhard/Vogelsang, Frank (eds): Naturphilosophie. Ein Lehr- und Studienbuch. 2., aktualisierte und durchgesehene Auflage. Tübingen, UTB/Mohr Siebeck: 51–56.

Dainton, Barry 2010: Time and Space. Second Edition. Durham, Acumen.

Demandt, Alexander 2015: Zeit. Eine Kulturgeschichte. 2. Auflage. Berlin, Propyläen.

Dietrich, Frank/Müller-Salo, Johannes/Schmücker, Reinold (eds) 2018: Zeit – eine normative Ressource? Frankfurt/M., Klostermann.

Diels, Hermann/Kranz, Walther 2004/2005: Die Fragmente der Vorsokratiker. 3 Bände. Griechisch und Deutsch von Hermann Diels. Herausgegeben von Walther Kranz. Hildesheim, Weidmann.

Dowker, Fay 2006: Causal sets as discrete spacetime. In: Contemporary Physics 47 (1): 1–9.

Dummett, Michael 2000: Is time a continuum of instants? In: Philosophy 75: 497–515.

Dunshirn, Alfred 2019: Physis [English version]. In: Kirchhoff, Thomas (ed.): Online Encyclopedia Philosophy of Nature/ Online Lexikon Naturphilosophie. Heidelberg, Universitätsbibliothek Heidelberg, https://doi.org/10.11588/oepn.2019.0.66404.

Dyke, Heather (ed.) 2003: Time and Ethics. Essays at the Intersection. Dordrecht, Kluwer.

Flasch, Kurt 2016: Was ist Zeit? Augustinus von Hippo. Das XI. Buch der Confessiones. Text – Übersetzung – Kommentar. 3. Auflage. Frankfurt/M., Klostermann.

Forrest, Peter 1995: Is space-time discrete or continuous? An empirical question. In: Synthesis 103 (3): 327–354.

Gemelli, Laura (ed.) 2007: Vorsokratiker. Band 1: Thales, Anaximander, Anaximenes, Pythagoras und die Pythagoreer, Xenophanes, Heraklit. Griechisch-lateinisch-deutsch. Auswahl der Fragmente und Zeugnisse, Übersetzung und Erläuterungen von M. Laura Gemelli Marciano. Düsseldorf, Artemis & Winkler.

Gosztonyi, Alexander 1976: Der Raum. Geschichte seiner Probleme in Philosophie und Wissenschaften. Freiburg/München, Alber.

Hartung, Gerald (ed.) 2015: Mensch und Zeit. Wiesbaden, VS Verlag für Sozialwissenschaften.

Hegel, Georg Wilhelm Friedrich [1822–1823] 2011: Lectures on the Philosophy of World History. Volume 1: Manuscripts of the Introduction and the Lectures of 1822–3, Edited and Translated by Robert F. Brown and Peter C. Hodgson with the Assistance of William G. Geuss. Oxford, Oxford University Press.

Hegel, Georg Wilhelm Friedrich [1822–1831/1837] 1979: Vorlesungen über die Geschichte der Philosophie I. (Werke in 20 Bänden mit Registerband, Band 18). Frankfurt/M., Suhrkamp.

Heidegger, Martin [1927] 2001: Sein und Zeit. 18. Auflage. Tübingen, Niemeyer.

Heidegger, Martin [1927] 2010: Being and Time. Translated by Joan Stambaugh, Revised by Dennis J. Schmidt. Albany/NY, State University of New York Press.

Horwich, Paul 1987: Asymmetries in Time. Problems in the Philosophy of Science. Cambridge/MA, MIT Press.

Hühn, Helmut/Waschkies, Hans-Joachim 2004: Zeit, V. 17. und 18. Jh.: von Gassendi bis Lambert. In: Ritter, Joachim/Gründer, Karlfried/Gottfried, Gabriel (eds): Historisches Wörterbuch der Philosophie. Band 12: W–Z. Darmstadt, Wissenschaftliche Buchgesellschaft: col. 1228–1234.

Husserl, Edmund [1893–1917] 1969: Zur Phänomenologie des inneren Zeitbewusstseins (1893–1917). Herausgegeben von Rudolf Böhm. (= Husserliana X). The Hague, Nijhoff.

Husserl, Edmund [1893–1917] 1991: On the Phenomenology of the Consciousness of Internal Time. Translated by John Barnett Brough. Dordrecht, Springer Netherlands.

Janich, Peter 1980: Die Protophysik der Zeit. Konstruktive Begründung und Geschichte der Zeitmessung. Frankfurt/M., Suhrkamp.

Janich, Peter 1985: Protophysics of Time. Constructive Foundation and History of Time Measurement. Dordrecht, Springer Netherlands.

Janich, Peter 1994: Vom Menschen in der Zeit zur Zeit im Menschen. Methodische Abhängigkeiten temporaler Bestimmungen in Anthropologie und Naturphilosophie. In: Löw, Reinhard/Schenk, Richard (eds): Natur in der Krise. Philosophische Essays zur Naturtheorie und Bioethik. Hildesheim, Bernward-Morus: 199–215.

Kant, Immanuel [1781/1787] 1974: Kritik der reinen Vernunft. Werkausgabe in 12 Bänden, Bände III/IV. Herausgegeben von Wilhelm Weischedel. Frankfurt/M., Suhrkamp.

Kant, Immanuel [1781/1787] 1998: Critique of Pure Reason. Translated and Edited by Paul Guyer and Allen W. Wood. Cambridge, Cambridge University Press.

Kirchhoff, Thomas 2015: Die Zeitform der Entwicklung von Ökosystemen und ökologischen Gesellschaften. Richtschnur für menschliche Vergesellschaftung? In: Hartung, Gerald (ed.) 2015: Mensch und Zeit. Wiesbaden, VS Verlag für Sozialwissenschaften: 226–248.

Leibniz, Gottfried Wilhelm [1686/1714] 2014: Monadologie und andere metaphysische Schriften. Französisch–Deutsch. Herausgegeben, übersetzt, mit Einleitung, Anmerkungen und Registern versehen von Ulrich Johannes Schneider. Hamburg, Meiner.

Leibniz, Gottfried Wilhelm/Clarke, Samuel [1715/1716] 2000: G.W. Leibniz and Samuel Clarke: Correspondence. Edited, with introduction, by Roger Ariew. Indianapolis/Cambridge, Hackett.

Lübbe, Hermann 1992: Im Zug der Zeit. Verkürzter Aufenthalt in der Gegenwart. Berlin, Springer.

Luhmann, Niklas 1971: Die Knappheit der Zeit und die Vordringlichkeit des Befristeten. In: Luhmann, Niklas (ed.): Politische Planung. Aufsätze zur Soziologie von Politik und Verwaltung. Opladen, Westdeutscher Verlag: 143–164.

Marx, Karl/Engels, Friedrich [1845–1846] 1990: Die deutsche Ideologie. Kritik der neuesten deutschen Philosophie in ihren Repräsentanten Feuerbach, B. Bauer und Stirner, und des deutschen Sozialismus in seinen verschiedenen Propheten. In: Marx, Karl/ Engels, Friedrich: Werke, Band 3 (= MEW 3). Berlin/ DDR, Dietz: 9–472.

McTaggart, John M.E. 1908: The unreality of time. In: Mind 17: 457–474.

Mellor, D.H. 1998: Real Time II. Cambridge, Cambridge University Press.

Mittelstaedt, Peter/Strohmeyer, Ingeborg 1990: Die kosmologischen Antinomien in der Kritik der reinen Vernunft und die moderne physikalische Kosmologie. In: Kant-Studien 81: 145–169.

Morgenroth, Olaf 2008: Zeit und Handeln. Psychologie der Zeitbewältigung. Stuttgart, Kohlhammer.

Plato Timaeus = Plato 2000: Timaeus. Translated, with Introduction, by Donald J. Zeyl. Indianapolis & Cambridge/MA, Hackett.

Price, Huw 1996: Time's Arrow and Archimedes' Point. New Directions for the Physics of Time. New York, Oxford University Press.

Ranković, Sandra/Liang, Yeong-Cherng/Renner, Renato 2015: Quantum clocks and their synchronisation – The Alternate Ticks Game. arXiv:1506.01373.

Reichenbach, Hans 1925: Die Kausalstruktur der Welt und der Unterschied von Vergangenheit und Zukunft. In: Sitzungsberichte der Bayerischen Akademie der Wissenschaft 1925 (November): 133–175.

Ricoeur, Paul 1991: Narrative Identity. In: Philosophy Today 35 (1): 73–81.

Rohs, Peter 1996: Feld – Zeit – Ich. Entwurf einer feldtheoretischen Transzendentalphilosophie. Frankfurt/M., Klostermann.

Rovelli, Carlo 2016: Reality Is Not What It Seems. The Journey to Quantum Gravity. London, Allen Lane.

Safranski, Rüdiger 2015: Zeit. Was sie mit uns macht und was wir aus ihr machen. München, Hanser.

Schelling, Friedrich Wilhelm Joseph [1799] 1985: Einleitung zu dem Entwurf eines Systems der Naturphilosophie. In: Schelling, Friedrich Wilhelm Joseph: Ausgewählte Schriften. Band 1: 1794–1800. Frankfurt/M., Suhrkamp: 337–394.

Schelling, Friedrich Wilhelm Joseph [1800] 2000: System des transzendentalen Idealismus. Herausgegeben von Horst D. Brandt, Peter Müller und Walter Schulz. Hamburg, Meiner.

Schlaudt, Oliver 2020: Measurement. In: Kirchhoff, Thomas (ed.): Online Encyclopedia Philosophy of Nature / Online Lexikon Naturphilosophie. Heidelberg, Universitätsbibliothek Heidelberg, https://doi.org/10.11588/oepn.2020.0.76654.

Sieroka, Norman 2009: Ist ein Zeithof schon genug? – Neurophänomenologische Überlegungen zum Zeitbewusstsein und zur Rolle des Auditiven. In: philosophia naturalis 46 (2): 213–249.

Sieroka, Norman 2010: Spinozistische Feldmetaphysik und physikalisches Materieverständnis. In: Allgemeine Zeitschrift für Philosophie 35 (2): 105–122.

Sieroka, Norman 2015: Leibniz, Husserl, and the Brain. Basingstoke, Palgrave Macmillan.

Sieroka, Norman 2016: Phänomenale Zeit, Leid und Leidvermeidung. Eine Bestandsaufnahme. In: Journal of Philosophical Research 70 (1): 47–73.

Sieroka, Norman 2017: The bounds of experience. Encountering Anaximander's in(de)finite. In: Ancient Philosophy 37 (2): 243–263.

Sieroka, Norman 2018: Philosophie der Zeit. Grundlagen und Perspektiven. München, Beck.

Spinoza, Baruch de [1677] 2007: Ethik in geometrischer Ordnung dargestellt. Lateinisch–Deutsch. Neu übersetzt, herausgegeben, mit einer Einleitung versehen von Wolfgang Bartuschat. Hamburg, Meiner.

Spinoza, Benedictus de [1677] 1985: Ethics. In: The Collected Works of Spinoza, Volume I. Edited and Translated by Edwin Curley. Princeton, Princeton University Press: 408–617.

Theunissen, Michael 1991: Negative Theologie der Zeit. Frankfurt/M., Suhrkamp.

Thompson, Evan 2007: Mind in Life. Biology, Phenomenology, and the Sciences of Mind. Cambridge/MA, Harvard University Press.

van Fraassen, Bas C. 1970: An Introduction to the Philosophy of Time and Space. New York, Random House.

Varela, Francisco J. 1999: The specious present. A neurophenomenology of time consciousness. In: Petitot, Jean/Varela, Francisco J./Pachoud, Bernard/

Roy, Jean-Michel (eds): Naturalizing Phenomenology. Issues in Contemporary Phenomenology and Cognitive Science. Stanford, Stanford University Press: 266–314.

Weizsäcker, Carl Friedrich von 1988: Aufbau der Physik. München, Deutscher Taschenbuch Verlag.

Weizsäcker, Carl Friedrich von 2006: The Structure of Physics. Edited, Revised and Enlarged by Thomas Görnitz and Holger Lyre. Dordrecht, Springer Netherlands.

Westermann, Hartmut 2004: Zeit, II. Antike. – B. Platon bis Boethius. In: Ritter, Joachim/Gründer, Karlfried/Gabriel, Gottfried (eds): Historisches Wörterbuch der Philosophie, Band 12: W–Z. Darmstadt, Wissenschaftliche Buchgesellschaft: col. 1196–1207.

Whitehead, Alfred North 1927: Time. In: Brightman, Edgar S. (ed.): Proceedings of the Sixth International Congress of Philosophy. New York/London, Longmans Green: 59–64.