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Composite Time Concept for Quantum Mechanics and Bio-Psychology

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Time has multiple aspects and is difficult to define as one unique entity, which therefore led to multiple interpretations in physics and philosophy. However, if the perception of time is considered as a composite time concept, it can be decomposed into basic invariable components for the perception of progressive and support-fixed time and into secondary components with possible association to unit-defined time or tense. Progressive time corresponds to Bergson's definition of duration without boundaries, which cannot be divided for measurements. Time periods are already lying in the past and fixed on different kinds of support. The human memory is the first automatic support, but any other support suitable for time registration can also be considered. The true reproduction of original time from any support requires conditions identical to the initial conditions, if not time reproduction becomes artificially modified as can be seen with a film. Time reproduction can be artificially accelerated, slowed down, extended or diminished, and also inverted from the present to the past, which only depends on the manipulation of the support, to which time is firmly linked. Tense associated to progressive and support fixed time is a psychological property directly dependent on an observer, who judges his present as immediate, his past as finished and his future as uncertain. Events can be secondarily associated to the tenses of an observer. Unit-defined time is essential for physics and normal live and is obtained by comparison of support-fixed time to systems with regular motions, like clocks. The association of time perception to time units can also be broken. Einstein's time units became relative, in quantum mechanics, some physicist eliminated time units, others maintained them. Nevertheless, even the complete elimination of time units is not identical to timelessness, since the psychological perception of progressive and support-fixed time still remains and cannot be ignored. It is not seizable by physical methods, but experienced by everybody in everyday life. Contemporary physics can only abandon the association of time units or tenses to the basic components in perceived time.

Keywords: composite time, time perception, progressive time, time association, physical time, quantum mechanics, bio-psychology

1. Introduction

In everyday life, time is generally conceived as clock time, which punctuates the progression of a day. A dual concept of time dates back to ancient Greek philosophers. In physics, Newton (1687) defined time as an absolute mathematical unit. The French philosopher Bergson (1922) perceived it as continuity and duration. In Einstein's theory of relativity, absolute time units were changed to relative time units (Einstein 1982). Some

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quantum physicists completely eliminated time (Zeh 2007; Rovelli 2008; Babour 2009; Kiefer 2009; Tegmark 2014), but others maintained it as a fundamental factor (Smolin 2013). Clearly, there is no consensus on time and opposite views still permeate its contemporary understanding.

Instead of deducing the nature of time from its physical formalism, in bio-psychology, the opposite approach is tried by starting with the initial time perception and to understand its interpretation put forth by physicists (Jansen 2011). The psychological perception of time has primacy, since it is necessarily the starting point of time observation, whereas physical interpretations follow thereafter, trying to justify the bio-psychological time analysis. Time can be considered as a composite concept with several components. It comprises of unchangeable basic components represented by the perception of progressive duration by Bergeson and retrieved memorized time, as well as changeable associated components, like change-based unit-based or tense-based time. Qualitative aspects are not adapted to physical formalism, which is based on precise quantitative units obtained by comparison with periodic movements, such as those of mechanical as well as quantum clocks. Progressive and memorized time remain unchangeable basic time components, but their associations can be abandoned, thereby suggesting apparent timelessness. Such decomposition of the time concept into basic components and secondary associations may help elucidate the complexity of the nature of time.

2. Short Historical Overview

The concept of time has always led to contradictory opinions, as can be seen in the works of the ancient Greek philosophers, as well as renowned scientists like Newton and Einstein. Multiple interpretations by physicists and philosophers continue to emerge.

2.1. Opposing Time Concepts in Ancient Greek Philosophy

In about 500 BC, Heraclitus wrote: “Everything flows and nothing abides; everything gives way and nothing stays fixed. You cannot step twice into the same river, for other waters and yet others, go flowing on” (Savitt 2017, introduction). Parmenides gave an opposite view on time, stating that “there are many signs that What Is has no beginning and never will be destroyed… It neither was nor will be, it simply is” (Savitt 2017, introduction).

2.2. Newton’s Absolute and Relative Time

Newton distinguished between absolute and relative time. As cited in Barbour (2009),

> Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year. (1)

Newton’s absolute time is identical to duration, which continues to flow and has no boundaries, similar to the concept proposed by Heraclitus. In contrast, he defines relative time as an interruption of the flow of time by boundaries imposed by external periodic movements.

2.3. Bergson’s and Einstein’s Time Conceptions

Two opposite concepts on the nature of time were publicly debated by Einstein and Bergson at the French Society of Philosophy in Paris in 1922 (Canales 2015). The highly dramatic discussion between Bergson as a

philosopher (Nobel prize in literature, 1928) and Einstein as a physicist (Nobel prize in physics, 1921) revealed two irreconcilable concepts of time. Einstein considered Bergson's interpretation of time continuity as a psychological notion based on intuition. On the other hand, Bergson criticized Einstein's concept of the relativity of time as limited to quantitative aspects of physical time.

In his article "Duration and Simultaneity," Bergson (1922) wrote: "The time that lasts is not measurable. The measure, which is not clearly conventional, includes indeed division and superposition. But successive durations cannot be superposed in order to verify if they are equal or unequal" (38, translated by the author). The essential differences between Bergson's and Einstein's concepts stem from time boundaries. Bergson insisted on time duration without boundaries and Einstein on the relativity of the boundaries of time units, since they are dependent on the speed of an observer with respect to the speed of light.

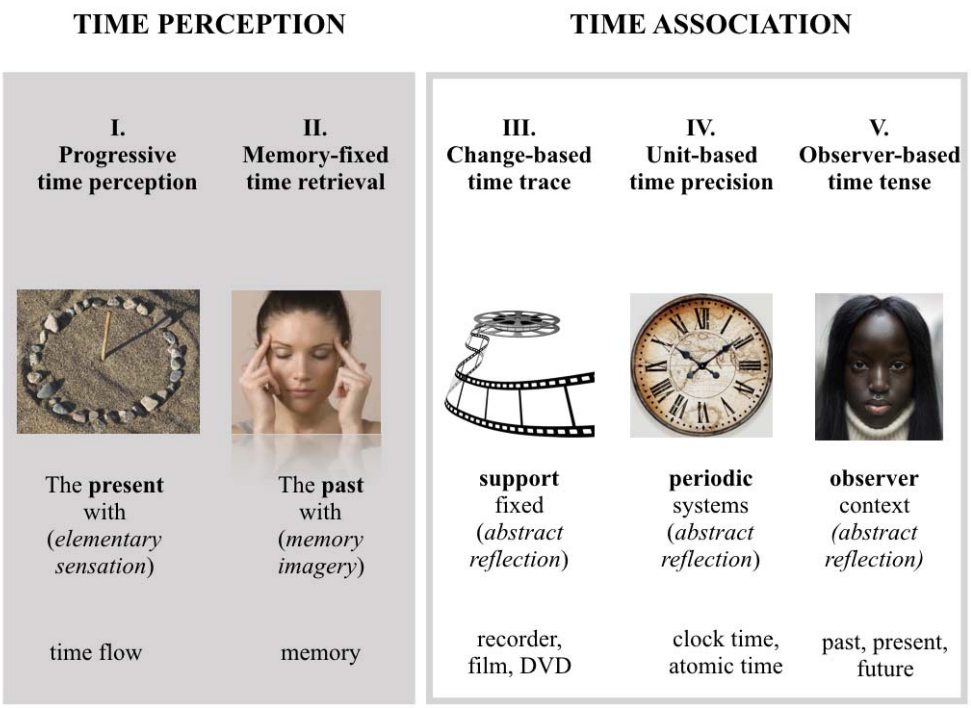


Fig. 1. Five time components.

For continuous progressive time, the mental function of elementary sensation indicates the present only, support-fixed time with memory imagery shows the past and can be fixed on different supports, whereas abstract reflection allows a comparison and association with unit-based time as well as with the past, present, and future of an observer.

2.4. Some Time Theories in Contemporary Physics

The notion of time was an uncontroversial factor on which classical physics was built. Rovelli (2008), for example, noted, "in pre-relativistic mechanics, time is a special physical quantity, whose value is measured by physical clocks" (2). Yet, in Einstein's theory of relativity, there is no observable, preferential time and no past, present, and future in a timeless block universe. In quantum theory, the notion of time loses its meaning, since superposition in a Hilbert space no longer allows any precise estimation of a particle trajectory or time (Zeh 2007). Barbour (2009) wrote that "the flow of time and motion are illusions" (2). Rovelli (2008) proposed "a

picture of the physical world where the notion of time plays no role at all" (1). Concerning quantum field theory, Kiefer (2009) wrote: "We can thus draw the conclusion that quantum gravity is timeless" (5). Nevertheless, other physicists maintain the existence of time, since Smolin (2013) stated "We need a new theory—one in which the reality of time is a central element" (95).

3. Composite Time Concept

Just as the views put forth by Heraclitus challenged those of Parmenides, and as Bergson and Einstein criticized each other's stance, opposite time concepts persist today. Yet, from a bio-psychological perspective, different aspects of time are valid and can be interrelated if time is viewed as a composite concept.

3.1. Progressive and Support-Fixed Time

The essential property of Bergson's time is continuous progression, similar to Heraclitus's flow of time, which is only perceived in the present with specialized but still unknown inward-directed sense organs, similar to the mental function of elementary sensation (Figure 1). There is no beginning and no end, only continuation. Therefore, time cannot be divided into fractions, which could be compared to other fractions in physics. The continuous change without boundaries, a characteristic of progressive time, cannot be aligned with physical formalism, which requires precise time units. Consequently, progressive time eludes recognition by physical methods.

From a bio-psychological perspective, progressive time without boundaries is limited to the present, whereas time periods with finished boundaries are already in the past. To be grasped in its entirety, a time period has to be fixed on a support. Memory serves this purpose as the natural support for memorized time with imprecise boundaries limited to the three degrees of comparison long, longer and longest. Other supports such as a recorder, a film or digital equipment would perform the same function by recording change-based time in the sort of multiple snapshots (Table 1). Support-fixed time lying in the past no longer exhibits the flow of time, but flowing time can be reproduced from the support in a new present. A true reproduction of original time is only possible if the movement of the support remains identical to the registration conditions; otherwise, the reproduced time is changed and becomes falsified. An accelerated or slowed down film projection is no longer representative of the initially registered time. Hence, manipulation of the support of fixed time is responsible for an identical reproduction of the original time. Under different conditions, such as acceleration or deceleration, the reproduced time becomes an artifact.

Table 1

Basic Time Components of Observer Perception and Associations

TIME COMPONENTS	EXAMPLE	BOUNDARIES	PROPERTY	REPRESENTATION
OBSERVER perceived time:				
1. progressive time	**perception** of time duration (Bergson)	**no** time boundaries	**unchangeable** passive perception	**original** time flow
2. memorized time	**retrieval** from memory support	**imprecise** time boundaries	**changeable,** (degree of comparison)	**reproducing** time flow
ASSOCIATIONS to perceived time:				
3. change-based time trace	**support-fixed** on film, recorder geological layer,	**arbitrary** time boundaries	**prior - later** sequences, (snapshots)	**reproduced** time flow
4. unit-based time precision (*t*)	normal or atomic **clocks**,	**precise** time unit boundaries	**dissociable** from progressive time	**sequenced** time flow
5. observer-based time tense	past, **present**, future,	**observer** dependent boundaries	**dissociable** from progressive time	**categorized** time flow

Composite time comprises of different time components, namely basic progressive time (Bergson) and retrieved memorized time constituting perceived time. The basic components can secondarily be associated to varying components, which are change-based, unit-based and tense-based time with different definitions and properties.

A physical time concept requires a division into identical unit-based time points obtained by comparison of fixed time to systems characterized by periodicity (Figure 1). Support-fixed time can be compared to fractions of the revolution of the Earth (hours, minutes, seconds) or for more precision to other regularly revolving systems, such as the natural vibration frequencies of the atomic cesium clock. Thereby, the boundaries become simple relations to other systems. Finally, observer-based time tense concerns events, which can be associated to the tense, in which an observer is living and for whom future events have not yet occurred, present events are happening now, and past events have already taken place.

3.2. A Camera Model Illustrating Progressive and Memorized Time

The distinction between progressive time and support-fixed time can be illustrated using a camera model (Figure 2). When recording a bike race, the camera stores images of events taking place in a continuous manner on a special film support. As a result, time becomes fixed by multiple successive snapshots in a reel. Although the action of the camera can be modified by zooming, accelerating or decelerating during recording, the camera is unable to change the race itself by modifying it in any way. With respect to the bicycle race, the camera remains completely passive, as it is merely recording what happens outside.

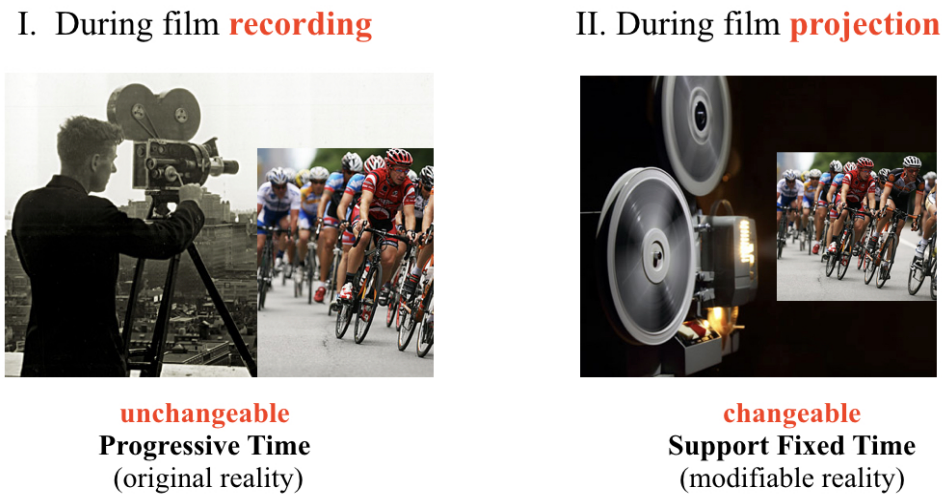


Fig. 2. Film of a bike race.

Recording and projecting a bike race with a film camera and a projector showing changeable (+) and unchangeable (−) properties of the race by acceleration, cut of sequences, backward direction and repetition.

A completely different situation emerges when the bike race is already fixed on the support of a film and then reproduced. In contrast to the process of recording in the present, the film projection only reproduces past time fixed on a support. The manipulation of the support now allows the bike race to be changed during reproduction by acceleration, deceleration, shortening by eliminated sequences, or prolonging by adding sequences. When joining the end of a film to its beginning, the race appears endless. With a backward projection, the time arrow appears reversed. Fixed time allows the support to be manipulated, entailing modifications during the reproduction of time. However, the apparent change of time during projection is an illusion, as it is due solely to the modification of the support and not to changes to the originally recorded time.

3.3. The Block-Universe

Einstein's theory of relativity led to the concept of a block-universe, which is enclosed in a four-dimensional framework with time as one parameter, along with three spatial parameters. Ellis (2006) stated: "The standard spacetime diagrams used in representing the nature of space and time present a view of the entire spacetime, with no special status accorded to the present time" (1).

According to Tegmark (2014), time is "the fourth dimension of an unchanging spacetime that just is, never created and never destroyed, containing our cosmic history as a DVD contains a movie" (241).

The block-universe concept is based on unit-based fixed time supported by mathematical formalism. Due to the absence of movement, the formalism appears static and could be compared to a DVD or the reel of a movie. Such supports carry multiple snapshots of time, which can be individually visualized one after the other, or randomly, and then appear static. However, if the reel is set in motion by a projector, time reappears. Thus, the reel as the support of fixed time can be manipulated to either show static snapshots or passing of time.

There is some similarity between the movie reel and the four-dimensional formalism of the block-universe, where mathematical formalism provides the support for time, which is linked to all events happening in the universe. However, the static four-dimensional formalism requires a mathematical observer to become functional. If the observer inserts only one point-like time parameter in the equation, he/she obtains a kind of time slice or Barbour's (2009) snapshot showing all the events linked to this specific time parameter. With the introduction of another random time parameter, another snapshot linked to other events will appear. Jumping from one time parameter to others without any order reinforces the impression of a static formalism. The introduction of individual, independent (t) values in the four-dimensional formalism cuts all movements into slices corresponding to individual time points. Nevertheless, all information pertaining to support-fixed time is still contained in the formalism. If the mathematical observer introduces a continuous series of time parameters in the right order, like in a graphic representation, he/she retrieves all snapshots (and the corresponding events) one after the other, and thereby creates a virtual movement, which indicates time again. Following a world line in the block-universe also imitates a movement and thereby time. In other words, whether physical formalism appears static in equations or dynamic in graphic representations only depends on the manipulation by a mathematical observer. Most importantly, it proves that time is not lost, but rather merely hidden in the four-dimensional formalism (Jansen 2011). The physical treatment of time signifies a reduction of the complexity of time perception to the simplicity of static time points by eliminating with the use of graphics the real movement of observation, with the use of equations the virtual movement of graphics, and with random time points the precise order of appearance (Table 2, see discussion).

Fixed time in formalism acquires the properties of the support. Since physical formalism is infinite, time is considered as never created and never destroyed, according to Tegmark (2014). It also becomes symmetric, like the formalism, with a forward and backward direction. Consequently, time fixed in physical formalism acquires properties contradicting the arrow of time. As a result, the physical formalism is not in agreement with the normal perception of time and needs a correction by breaking the symmetry (Atmanspacher and Filk 2012).

In everyday life, the memory as support of time shows some resemblance with static or dynamic time processes. The impression of static time is given when briefly recalling longer time periods in the past in a random manner, such as one's house construction, marriage or college time. Nevertheless, one can also retrieve an ordered succession of images dynamically, for instance the details of a recent car accident. The memory as a support for stored past time allows, like the reel of a film, static or dynamic reminiscence of time periods.

3.4. Bio-psychological Functions for Progressive Time and Memorized Time

Time perception has characteristics similar to the perception by other sense organs with the mental function of *elementary sensation*, which is unchangeable and experienced passively (Jansen 2016). Although the organ is still unknown, it is biologically sustained by a circadian rhythm about 24 hours in length. Without any clock, in darkness and solitude, Siffre (1964) spent 63 days in an underground cave, but conserved a circadian time rhythm of about 24 hours, which was subjectively perceptible by tiredness. This proved experimentally the passive perception of a biological circadian rhythm. In psychological experiments, time perception of less than a second showed that subjective time corresponds approximately to objective clock time, although with some distortions (Eagleman and Pariyadath 2009).

In bio-psychology, two separate mental functions distinguish between progressive and memorized time, *elementary sensation* and *memory imagery*. Elementary sensation consists of an uninterrupted physical chain of

reactions from the extra-mental environment to the brain, like in the eye. Light emitted by or reflected from extra-mental objects enters the eye and depolarizes neurons in the retina, which transfer their activation to specialized brain regions for a mental representation. Elementary sensation requires sense organs and simultaneously encodes their activity in the memory. After closing the eyes, the same extra-mental objects can still be retrieved from the memory; however, the uninterrupted physical chain is now broken (Jansen 2016). Whereas elementary sensation with sense organs warrants a precise representation of extra-mental reality in the present, memory imagery without active sense organs remains a representation of the past limited to encoded and then retrieved information, which could be different from the present. In the camera model, elementary sensation corresponds to recording in the present and memory imagery to the projection of already support-fixed information of the past.

Applied to time perception, elementary sensation passively perceives time without any possibility of interfering with its progression in extra-mental reality, which correlates well to the recording process in the camera model. In contrast, memory imagery retrieves fixed time, which can be concentrated when recalling long events that took place in the past. It also allows going forward or backward in time, as if time could be symmetric and no longer analogous to an arrow pointing in the forward direction. In summary, the mental function of elementary sensation uniquely represents unchangeable progressive time, whereas time fixed on the support of the memory allows modifications of past time perceptions.

4. Association to and Dissociation from Boundaries and Units

Progressive time has no boundaries, whereas memorized time is limited to qualitative boundaries with the imprecise degrees of comparison, such as long, longer, or longest (Table 1). Their imprecision renders them unusable in physics, since in mathematics numbers or letters represent identical units. Qualitative estimations are therefore excluded from physical formalism. However, support-fixed time can be secondarily associated to precise time units through comparison to systems with regular movements, such as clocks.

4.1. Association to Boundaries or Units

Support-fixed time is a time period entirely lying in the past, which is automatically fixed on the support of the memory. Besides the memory, change-based support-fixed time can also be fixed on other supports like recorders or films as time trace and allow the attribution of arbitrary boundaries. Before the creation of regular time units, change-based time trace therefore remains immeasurable, only characterized by the change from prior to later events according to McTaggert's B series.

For the creation of time units, boundaries of support-fixed time with arbitrary boundaries can be compared to boundaries of systems with regular movements, such as Earth's revolution and its fractions (designated as a 24-hour period) or an atomic clock based on Cs-133 cesium isotope. Only the comparison between change-based time and periodic movements allows the association of precisely defined time periods based on identical units necessary for life and physics. Thereby, unit-based time becomes a relation to different periodic systems. The association of change-based time to precise time units, for instance seconds or hours, allows the quantification required for physical formalism, an important condition for physical exploration. Nevertheless, without the association of time units, immeasurable change-based time still contains the basic component of progressive time perception (Table 3, see discussion).

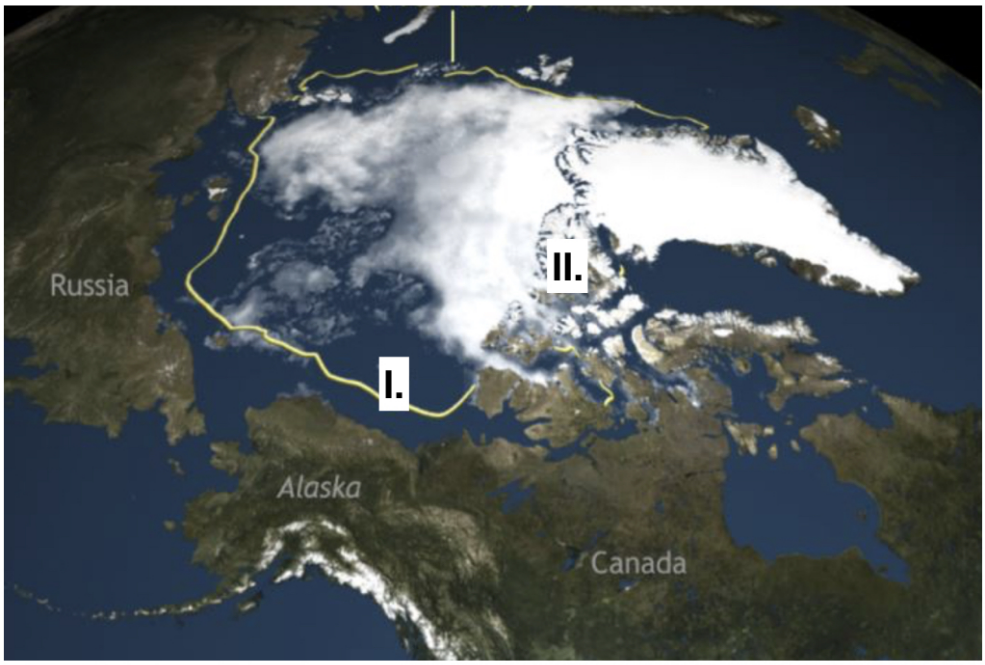


Fig. 3. Sea ice around the North Pole.

There is a change-based time trace between the extension of sea ice in I (prior) and II (later), which can be causally linked to general warming of the planet between I and II, although unit-based time is not required for this conclusion. Time units would only indicate that the speed of the change is rapid or slow, but any change requires already progressive time.

4.2. Dissociation from Boundaries or Units

The association of fixed time to units in other systems can also be broken. This is possible if precise time is not particularly relevant, as is the case in, for instance, the establishment of causal relations. Global warming can be estimated by the extension of the sea ice around the North Pole. Figure 3 shows a comparison of images taken in the same periods of different years, where the change in the ice extension can be noted without requiring any reference to time units. Indeed, McTaggert's B-series with the concepts of "earlier" and "later" would be sufficient. In this case, time units would only be important if the speed of the change needed to be measured. The different extensions of sea ice could be considered as change-based time trace corresponding to change without measured time units (Table 1). Nevertheless, time had to pass between the beginning and the end of the change, even if it is not measured. Thus, fixed time with arbitrary boundaries did not disappear; it was only dissociated from precise boundaries of unit-based time.

4.3. Change Not Considering Progressive Time

Barbour (2009) claimed that timeless laws can govern change: "Duration and the behavior of clocks emerge from a timeless law that governs change" (1). However, change is a succession of different events. Even if time is not measurable in units, one event following another requires passage of time. Barbour illustrated his view with a succession of snapshots stacked one over the other. Even looking at the snapshots one after the other would consume time, but not necessarily unit-based time. Barbour's view on timeless laws

would thus correspond to unit-less time, but not to complete timelessness. Nevertheless, Barbour might have considered a quantum mechanical approach of time with superposition in a Hilbert space, where time can no longer be determined.

The philosopher McTaggert claimed that change is essential to time and Aristotle wrote that "time is the measure of change" (Dowden 2009, 3.b). Therefore, Barbour might only claim that physical laws are governed by unit-less time, since any change from a prior to a later state would inevitably require time.

5. Abstraction of Time Perception by Successive Conceptualization

The association or dissociation of unit-based time does not constitute a prerogative of physics, since it can also be found in everyday life. Physics simply renders it more apparent. The conceptualization by the mental function of *abstract reflection* dissects time perception into increasingly abstract concepts, from tensed time to delta time and time inversion.

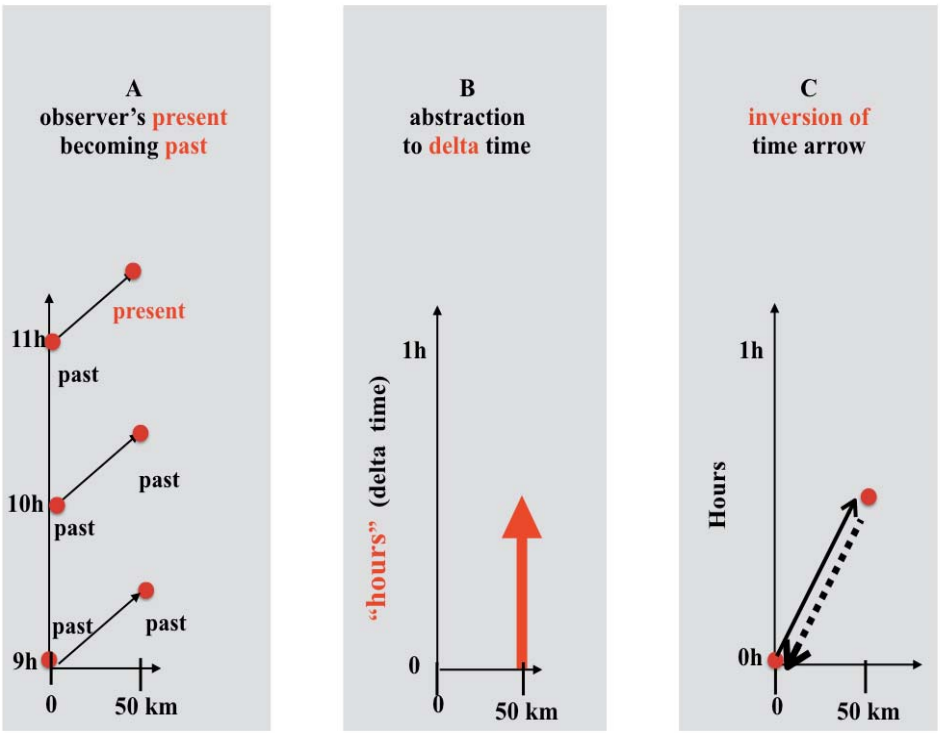


Fig. 4. Abstraction of individual time properties by grouping.

Experiments are executed in the observer's present, but former experiments are already in the past (A), calendar time has to be changed into delta time units (B) and time inversion appears after inversion of starting and endpoint references (C).

Laws of physics cannot be based on the findings of a single experiment, but require multiple concordant experimental results to become convincing. This necessitates grouping of individual results to one common outcome (Figure 4), due to which individual properties disappear. Multiple identical experiments can be performed by an observer, each of which is conducted in his/her present. However, all finished experiments are already lying in the observer's past. Consequently, combining all experimental findings necessitates abstraction

of the tenses corresponding to the individual measurements. Therefore, tense is completely removed from physical formalism. Grouping different results with classical statistics requires another level of abstraction. Different calendar times have to be reduced to delta time periods before they can be grouped together to produce means. Their individual variations are calculated and represented as +/− standard deviations from the means. Time inversion is also possible by exchanging starting and ending reference points.

In a similar vein, human abstract reflection in everyday life reduces individual details of events into common impressions. If someone is always too late for his appointments, the precise time points are rapidly replaced by a general impression of unreliability of that person. Abstract reflection also allows for time inversion. For example, knowing how long it takes for a car to drive in a forward direction from A to B allows to estimate the time it takes to travel in a backward direction (from B to A) by simply inverting the start and end reference points. Memory-fixed time thereby allows for inversion of the time arrow by exchanging the reference points. However, such an inversion is not always in agreement with nature, and would produce invalid predictions if, for instance, the road from A to B has a very steep slope. Thereby, mental functions show very similar reduction of individual properties as physics.

6. Association and Dissociation of Tense

Einstein (1955) wrote on tense: “the separation between past, present and future has only the importance of an admittedly tenacious illusion” (1). Prosser (2000) also considered time, noting that “our understanding of the role of time in physical science suggests that the putative flow of time has no role in determining the physical state of the world” (1). Einstein and Prosser gave physics primacy when explaining time perception. In contrast, from a bio-psychological perspective, the perception of progressive time has absolute primacy since, like a sense organ, it defines the starting point for information acquisition, which cannot be changed. Due to the absence of boundaries, it cannot be used in physical formalism and therefore escapes physical consideration. Nevertheless, it can be secondarily associated to unit-based time and tense.

6.1. Association to Tense

Tense corresponds to McTaggert’s (1908) A-series, which he exemplified by an unchanging event, Queen Anne’s death: “It began by being a future event. It became every moment an event in the nearer future. At last it was present. Then it became past, and will always remain so, though every moment it becomes further and further past” (3). Whereas the event itself seems to remain unchanged, it has three changing existences—in the future, the present and the past. Since this understanding is incompatible with reality, McTaggert judged the A-series of time as unreal. His analysis was shared by contemporary physicists (Davies 2002; Ellis 2006). However, some major objections must be noted:

(1) The future is not an absolute position in time, through which an event can pass to the present, and then to the past.

(2) Future and past are relative positions in time with respect to the present of an individual observer or of the actual humanity as a common observer.

(3) The future is not physical reality, since it has not yet happened, but it can be a mental representation of a potential future imagined by an observer. The past is not physical reality either, because it already happened and now only exists as a mental copy in the memory of an observer.

(4) Past, present, and future would be inexistent without a mental representation by an observer, who perceives the flow of time in his/her present, and is aware that the future is still inaccessible, whereas past is already fixed.

(5) An essential property of the future is its uncertainty, which characterizes the apprehension or expectations of an observer when imagining in his present a potential future, whereas the memorized past is judged as certain, since it already happened.

The unchanging event of the death of Queen Anne is a conceptual abstraction of global perception and lacks important details. Perception is characterized by additional properties, such as the date of death, its cause and circumstances. In an uncertain future, the date and cause of death are clearly unknown, the circumstances might be known in the present, whereas the cause might only be revealed when the event is in the past. The complexity of an event requires a mental representation by an observer who characterizes the position of events in terms of whether it is expected to happen in his/her future, is taking place in his/her present or has already occurred in his/her past (Figure 5).

From a bio-psychological perspective, three mental functions can explain the different tenses in which an observer can exist. The present is only transmitted by *elementary sensation* with sense organs relaying extra-mental reality by a chain of physical interactions to the brain of an observer (Jansen 2016). The mental function of *memory imagery* represents the past as a simple copy of prior sense organ activity in the memory. The future requires a mental representation of probable possibilities with the mental function of *abstract reflection*. Since the three mental functions characterize the past, present, and future, they depend on an existence of an observer, although McTaggert ignored this requirement (Figure 5). An event is not itself future, past, or present, but it can be secondarily associated to the tense as perceived by an observer, which confirms that the observer context is essential for understanding the psychological aspect of the tense of time.

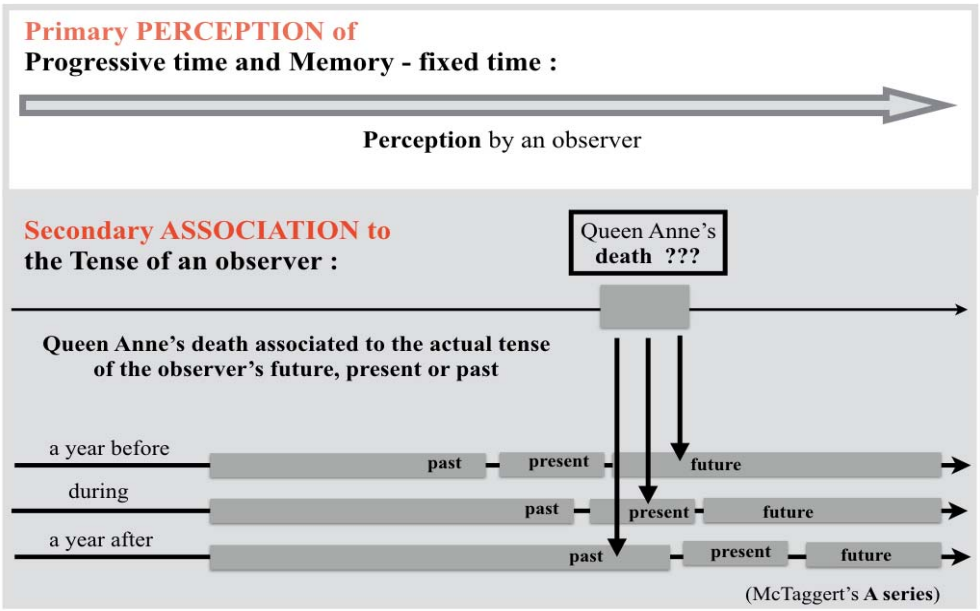


Fig. 5. Time as a composite concept.

McTaggert's A-series (1908): Queen Anne's death can be in the future, the present or the past depending on the date at which an observer thinks about her. Thus, support-fixed time is secondarily associated to the tense of an observer.

6.2. Dissociation from Tenses

A physical experiment is necessarily performed in the present and belongs to the past when it is finished and fixed on any kind of support. Physics needs multiple repetitions of observations, the findings of which are summarized by means and standard deviations. Identical results at different time points suggest that physical laws remain the same over time and can be used for predicting outcomes of new experiments. However, when calculating the means of the results of different experiments performed by the same or different individuals, the tense in which those measurements are taken is not the same and thus cannot be taken into consideration and means become tense-less. The need for repetition in order to reproduce and group experimental findings explains why individual tenses are absent in physics. The same phenomenon can also be found in everyday life. There are car accidents that took place in the past, as well as those occurring in the present, and it can be expected that some would happen in the future. By considering all these events together, an observer would conclude that car-accidents are frequent—an assessment that is no longer associated to the initial tenses.

6.3. Tense-less and Dynamic Theories on Time

Two contrasting interpretations of time, the tense-less theory and the dynamic theory, are worth considering at this point. Favoring the tense-less theory, the idealist McTaggert (1908) wrote: "It may be the case that the distinction introduced among positions in time by the A series—the distinction of past, present, and future—is simply a constant illusion of our minds" (2). The philosopher Smart (1963) observed: "Our notion of time as flowing, the transitory aspect of time as Broad has called it, is an illusion which prevents us seeing the world as it really is" (132). Craig (2013) said in an interview that "the difference between past, present, and future is just an illusion of consciousness… in fact, all moments of time are equally real and existent" (3). These philosophers considered the tense of time without recourse to an observer, who makes a distinction between the certainty of the present and past and the uncertainty of the future. Without the observer context, tense has indeed no meaning and could be considered as illusion. In a tense-less time theory, past, present, and future are equally real and existent, as exemplified by the four-dimensional spacetime block of Einstein's theory of relativity.

Bio-psychology is in a better agreement with a dynamic theory of time, in which perceived time can be considered by an observer as past, present or future. The past has gone; it no longer exists and is unreal, whereas the present is really perceived with the observer's sense organs. The future has not yet come into existence and is a mere uncertain potentiality, but only in the mind of an observer. The dynamic theory includes the observer context, as the observer provides the starting point of incoming information in the present, retains past events in his/her memory and imagines the not yet existing future with uncertainty. From a bio-psychological perspective, the dichotomy in past, present, and future is based on different mental functions. The present is due to *elementary sensation* requiring sense organs, which create an open system with an uninterrupted chain of physical interactions from the extra-mental reality to the brain and can be called sense reality. The past is a copy of prior elementary sensation in *memory imagery*, which no longer needs active sense organs, but is limited to a closed system without any contact with extra-mental reality. Finally, the future is imagined with *abstract reflection* as potentiality by associating parts of past events with potential future events, but is also included in the closed system. The lacking access to extra-mental reality by sense organs in the closed system is compensated by exhaustive possibilities of mental potentiality largely exceeding all possibilities of reality.

7. Conclusion

Time has different and similar aspects in physics and bio-psychology. The perception of continuous progression of time or duration, as well as tenses, is dominant in the perception of everyday life, but cannot be found in physical formalism. In contrast, quantitative unit-based time corresponding to clocks is needed in both physics and everyday life. A common time concept encompassing physical and psychological time aspects is possible if time perception is considered as a composite concept with different components—perceived time with two constant components of progressive time (Bergson 1922) and memorized time, along with varying components, change-based time, unit-based time or tense-based time, sometimes associated with or dissociated from perceived time. Tense is only meaningful with respect to an observer, who perceives in his/her present the past as certain and the unknown future as uncertain. This is a pure psychological aspect of time. Events can secondarily be associated to the observer's tense, if they took place in his/her past or are expected in his/her future. Experiments are realized at different time points and are therefore associated with different observer tenses. When summarizing the findings, tenses are necessarily eliminated in physics.

In classical physics, the association between perceived time and unit-based time is mandatory, but Einstein's theory of relativity treats time units as relative. In quantum mechanics, some physicists eliminated time completely, whereas others tried to maintain it. Even if time units have to be eliminated from physical formalism, the basic progressive and memorized time still remain, as experienced by everybody in everyday life. Consequently, a composite time concept maintains invariable progressive and memorized time, but allows their association with or dissociation from tense or time units.

In bio-psychology, the distinction between the different time aspects and their varying associations is induced by different mental functions, *elementary sensation* with active sense organs and *memory imagery* without active sense organs, which have different properties. Whereas elementary sensation with sense organs warrants a true representation of extra-mental reality, but only in the present, memory imagery that does not require sense organs remains a representation of the past in a closed system, already encoded in the memory, but sometimes different from the actual present.

As a result, elementary sensation corresponds to a recording camera in the present, which cannot change the event during recording but remains a passive bystander. In contrast, memory imagery would correspond to the projection of a recording already fixed on the film tape. During projection, the support-fixed event can be changed by acceleration, deceleration, shortening, or extending the corresponding time period. It can also go back from the actual to a former period, as if time is symmetric, no longer following the arrow of time. This example shows that time fixed on any kind of support can be artificially changed through the manipulation of the support to which it is linked. Only if the conditions of the support during registration and reproduction are identical, the initial fixed time can be reproduced; otherwise, it is artificially modified and therefore an illusion. Nevertheless, artificial changes during reproduction cannot eliminate the initially perceived progressive and memorized time that follows the direction of the time arrow.

Table 2

Comparison of Time Reduction in Physics, Films, and Perception

	TIME ASPECTS	PHYSICS unit-based	FILM snapshots	PERCEPTION of time	LOSS of	REDUCTION to
	Time perception representing movements					
A	**progressive** time (present)	**observation:** movement	**registration:** movement	**time flow:** movement	-	-
B	**support-fixed** time (past)	**graphics:** for virtual movements	**reproduction:** of movement	**reminiscence:** of movement	**real** movement	**reproduction** from support-fixed time
	Reduction to static time equivalents by space time formalism					
C	time **overview**	**equation:** ordered past to future	**film reel:** ordered past snapshots	**overview:** past to future extrapolation	**virtual** movement	**juxtaposition** of ordered time points
D	time **points**	individual (t) random **parameters**	individual random **snapshots**	individual random **images**	**ordered** time points	**individual** random time points

There is a great resemblance of the corresponding time components in physics, films, and perception, which lead by reduction from time perceived as movement (A) to static time evaluation (D), albeit lost properties are not definitely eliminated and can be reacquired.

Modifications of fixed time are not limited to physics, but are also found in bio-psychology. The mental function of memory imagery without active sense organs corresponds to memory-fixed past time and allows artificial modifications, akin to those made by manipulating the film recorded by a camera. Time acceleration would correspond to retrieving an event of long duration only briefly. Time deceleration would be akin to reliving in our mind a short but striking event in great detail, thus requiring a much longer time, whereas time shortening would result in omitting major details and extending time would require "padding" the existing content with new, imagined, content. Consequently, the same rules govern support-fixed time in physics and bio-psychology and induce artificial modifications of time.

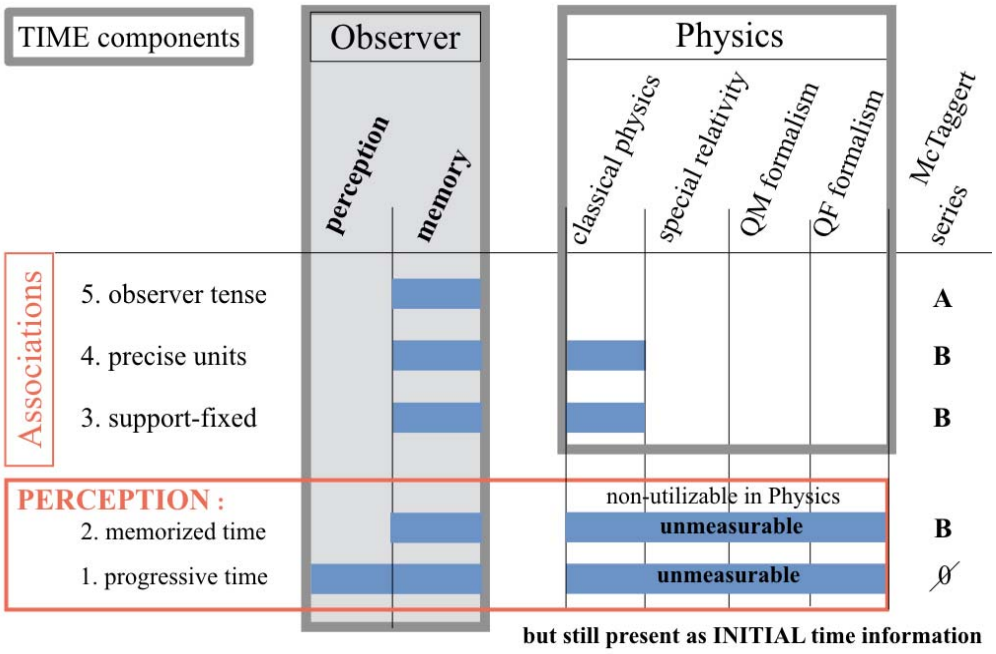
The reduction of the movement of time to static time points is not a precondition applicable to physics only, as it also characterizes other supports, such as a film or the human memory (Table 2). The time component of continuous progression (A) can be experienced as movement during physical observation, during the registration of a film and simple time perception. The support-fixed time component (B) corresponds in physics to graphic illustrations of movements, in the film to time reproduction during projection and in perception to remembering anterior events in detail. The movement of time can be reduced in physical equations to a range of time points (C), in the reel of a film to multiple snapshots and in the memory to different historical events associated with, for instance, the Roman Empire. Finally, support-fixed individual time points (D) are realized in physics by random (t) parameters, in the film by random individual snapshots and in perception by random memorized images.

Time as movement is transformed to static time by reduction of the complexity of perceptible time first to a reproduction from support-fixed time, then to an overview of all ordered time points and finally to random time points. Nevertheless, all information is still contained in the formalism. Time can be reconstructed if individual time points become ordered and are followed in rapid succession in support-fixed time before being reproduced as movement with the support.

The distribution of the five different time components is not equal for the first person perception and physics (Table 3). Associated components disappear from physics besides classical physics. Nevertheless, the basic time components of progressive timeand memorized time are always present, since they represent the entry door of time perception allowing the secondary association of other time components, such as support-fixed time, unit-based time and observer-based tense.

Table 3

Time Components for Physics and for Bio-psychological Observer



Physics as well as bio-psychology has a different approach for analyzing time. For physicists, the formalism for time has primacy, nevertheless, it has to explain the bio-psychological time perception. The corresponding formalism is based on the invariance of the affine time group, which mandates complete symmetry for time-scale, time-translation and time-reversal (Atmanspacher and Filk 2012). The interpretation of the formalism signifies that there is no intrinsic time unit, no preferred present or now, and no time arrow. This leads to a great discrepancy between physical time and time perception in everyday life, since the present and the time arrow cannot be explained by physical time symmetry. Bio-psychology proceeds in the opposite direction by attributing primacy to the perception of progressive time by an observer, since time perception

stands at the entry door of information coming from inward-directed sense organs. Physical formalism is then considered as a secondary interpretation of the initial information obtained by time perception. The two opposite interpretations of time lead to two theoretical possibilities with respect to primacy in explaining human time perception.

If primacy is given to physical formalism, the affine time group considers time as symmetric. Consequently, the perception of progressive time or time flow experienced in everyday life is deemed a mere illusion (Einstein 1955; Barbour 2009; Craig 2013; Tegmark 2014).

If primacy is given to bio-psychological perception of progressive and memorized time, the symmetry of physical formalism can no longer explain progressive time as well as past, present, future, and is inconsistent with the direction of the time arrow. As a result, the corresponding formalism can only be partially valid. Therefore, the affine time group symmetry has to be broken by introduction of initial conditions (Atmanspacher and Filk 2012). Physicists will probably favor the first and psychologists the second theoretical possibility.

In summary, a composite time concept of perceived time permits the distinction between two constant components of progressive time and memorized time, along with associated or dissociated components, tense and time units. This concept can be found in physics as well as in everyday life. Nevertheless, the perception of progressive time (time arrow) and memory-fixed time, not seizable by physical formalism, remains reality.

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