# Time Opined: a Being in the Moment

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## In the beginning there was a brief tale of time

Undoubtedly, our continued existence, which is the basis for all speculation on time, is, and has always been, marked by regular events. The earth has been spinning on its axis since before sentient life evolved. There is no period in the story of life, or for that matter there is no period in the history of any species, able to reflect on 'time' during which the cyclical processes of night and day, and of the seasons did not operate. The origin of prototypic timekeeping, whether that be in the mystery traditions that emerged and evolved from regular events in the heavens, or the everyday experiences of most human generations, are based upon the motions of the earth and moon, of the stars and planets.

It is clear from at least prehistory that celestial time has been considered important enough to warrant the building of monuments all over the prehistoric world. Time reckoning is known to have been undertaken by the use of astronomical monuments and/or calendars since antiquity, and in not directly connected civilizations. Examples of these include Stonehenge and Newgrange in Britain and Ireland, dated conservative to around 5,000 BCE; in Sumer (3,500 BCE) and Egypt, where calendars have been used since the 8$^{th}$ -10$^{th}$ Century BCE; China since the 18$^{th}$ Century BCE; whilst calendars were in use in the pre-Colombian Maya civilization, one of the last major stone age civilizations, and a civilization, which to the point of European colonization, existed in geographical isolation of cultural developments Europe, Asia and Africa.

The understanding that things change regularly and may be measured is a general human observation on the nature of existence. From this we may conclude that time, as 'object' is also a human observation, and in this sense, time is the condition within which change occurs. However, in this contribution, I do not intend to appeal (much) to philosophical speculation on the nature of time as 'object.' This is partly due to the problem, outlined in the next section, in being able to actually generalize beyond the experience of time as 'subject' to the ontological status of time. It is also because, for the most part and in my opinion, time as 'object' is simply a functional or useful measure of other psychological phenomena, including most particularly, the way psychological content relates to the brain. Again, more on this topic in later sections. It is also because, for the most part, I will discuss the idea of subjective experience of, or in time and this refers to time 'in the present', or the experience of 'nowness.' This refers to a metaphysical position called 'Presentism' which argues that neither the future nor past exist and that everything exists in the present. A synopsis of the Presentism thesis is beyond the scope of this contribution but it may be found in

Crisp (2003), however, when relating to 'time' it is perhaps pertinent to refer Presentism to the deliberations of Augustine of Hippo who proposed (like Zeno before him) the present to be analogous to a sharp edge of a blade placed exactly between the perceived past and the imaginary future. The present, of itself, does not include the concept of time.

I intend to confine my opinion to consideration of the everyday human, subjective experience of time, and the generalizability of this experience to time beyond the subjective. However, this raises the first issue: How generalizable is the human experience of time?

## Of fighting fish, sea urchins - and men

Bergson (1910) considered the experience of time to be related to experience 'in time,' while Husserl considered the immediate present, the 'moment now' to be an amalgamation of future time with the immediate past (Husserl, 1917). Real time, as in the experience of an enduring and continuous flow of events from the future towards the past, Bergson argued, was not directly knowable, but may be judged through intuition arising from a series of acts of direct participation in immediate experience. This intuition Bergson referred to as 'lived time' and it is 'lived time' that is the continuous experience of the moment now, influenced by past events, whilst influencing and perhaps influenced by events occurring in the future. 'Now' is where we experience events and it is, at the same time, the nexus of past and future.

The original scientific investigations measured the duration of 'now,' known in some scientific circles as the 'psychological moment.' These investigations were undertaken in early schools of theoretical biology, such as that of von Uexküll [1928, 1934, translated as von Uexküll, (1957)]. From Uexküll's school, experimental work was published in the 1930's, using near identical experimental techniques to delimit the minimum duration of the psychological moment in various creatures, including human beings, fighting fish and snails (Brecher, 1932). Whilst this moment 'quantum' was found to differ between species, in all of the species studied, Brecher found that events separated by time might, given short intervals between their occurrence, combine to form a co-existent experiential content, that has meaning by virtue of its' presence in the 'now.'

While Brecher showed that both animals and humans could provide an estimate of the experience of present co-existence using similar experimental techniques, he also showed that this experience relates to the 'content' of the temporally separate, but experientially coincident events. At least this is true for the fighting fish who experienced repeated exposures to the image of a conspecific, viewed through slits cut at right angles to one another in a rapidly rotated disk Above a certain exposure frequency (equivalent to around 30 Hz), the successive images fused to form a continuous image, at which point the fish attempted his attack. Two points can be taken from this example: firstly, in so far as psychological presence includes content provided the fusion of temporally separated events, this content may be meaningful. At least, and for creatures other than humans, the past and present are meaningfully unified into an experience of nowness. The

second point refers to Uexküll's concept of 'Umwelt,' or 'meaningfully relevant aspects of the environment.' Ultimately, Umwelten determine the sensory, perceptual and subsequent physiological responses of the animal, and in so far as the moment is an index of basic cognitive capacity (i.e. the amount of information we can process in the smallest interval of psychological time), the complexity of Umwelt' responses, and so Umwelt itself determines a given species' moment quantum.

This entails psychological presence to be equated, not with the experience of time flow, but with the 'content structure' of what occurs in time - in this case the meaningful content of a given moment. Uexküll was clear that while moments may be related to relevant aspects of the environment to which the animal responds, this in turn refers to the number of coordinated reflex arcs in the animal's behavioral repertoire. Uexküll rejected the reflex arc as sufficient to explain either the response itself or the cognitive organization underlying the response. In fact, this may be better conceived as a form of cognitive capacity limit, which may be indexed by the duration, hence, in the content of the moment. Consequently, the moment, in so far as this links past and future, is determined by the content structure that defines the meaningful interaction of the animal with their environment.

The issue raised by the representation of temporality in different species becomes more complex when we take into consideration a further example discussed by Uexküll. He noted that the sea urchin possesses multiple independent reflex arc systems, entailing these animals might experience multiple, but nonetheless concurrent, experiences of Umwelten in time. This clearly differs from the human experience of a single channel flow of time from future-past, and as such, offers one limit to the desired generalizability of the human model. Additionally, and as argued earlier, across species, the qualitative content of Umwelten, as well as the timing of the moments within which they present, and the nervous systems within which they are instantiated (their quantitative aspect) are different, and this provides a second limit, because we do not experience the world as animals do. However, this is not all the animal case tells us. It also tells us that any theory of psychological time, at least a theory that intends to be a complete theory, requires an absolute - that is to say, a non-relative measure of the experience of time passing in each animal species, not only those who are still living, but also of species that are now extinct. It may be that this line of argumentation can be extended to include animals and humans living and dead, but of course, this is an impossible task even if left at the level of the species.

However, by linking time with the content of Umwelt, Uexküll also showed that one possible solution to this problem lies not in the consideration of psychological time as 'object,' but as 'subject' and subject to the Umwelt structure experienced by the animal. More on this later.

## The human experience of time: what's not measurable

At best then, we may have to limit our model of psychological time to humans and as many animals as we can examine, without reference of the resulting animal model of experienced time to our own model. Importantly, generalization to support one or other thesis referring to 'time as object' seems impossible. But this is not the topic of this section. Let's instead consider the human experience of time.

For the most part, human beings have not paid much attention to time as object. Consider the common experience of time in the life of a typical individual. First, very few probably considered ontology to any great depth, almost none possessed a timepiece and almost all measured time implicitly - that is to say as a part of the event structure in their everyday lives. To do this, they would use both external time markers (the heavenly events mentioned in the introductory paragraphs, as well as more down to earth correlates), and internal events (for instance regular times for hunger, arousal or sleep, defecation and so on). In addition, there would be task related events, and events related to time, to which their response is a second-order effect. Consider the life of our ancestors, Hans, Hildegard, John, Elizabeth, Oleg, Katja, Ahmet, Emine, Chang, Chin Chin, Akinyi, Mbuta. Just before cockcrow he or she would rise ahead of the dawn. Preparing for the day, he or she would check any animals before dawn to feed them or let them out to pasture, prepare lunch and take this to the far field where he or she would work with the land until midday (when the sun is at midheaven), until they intuitively felt it was time to eat, or when he or she, and with the others nearby, created consensus that this was the time to eat. After eating, with the time of year in mind, he or she might work until a point of time in the evening at which he or she would stop to eat again, or at a time just ahead of sunset. Everyday life required no particular focus on time as object – whilst he or she was in the moment – and the requisite information on the personal relevance of a particular point of time on the flow of events, is given by a particular event. For the most part we all live in the moment, and although we may have or less more demands on organizing our time than we would have had in the 13$^{th}$ or 14$^{th}$ Century it is not that often that we sit and reflect on our subjective experience of time passing. For most people time remains subject.

But the lack of necessity to measure the experience of 'nowness' does not mean it cannot be measured. Since Vierordt's (1868) experiment in time reproduction, the capacity for integrating sequential events into self-contained perceptual units that appear subjectively as occurring in the present is able to be determined experimentally. This experiment asks participants to reproduce as exactly as possible the duration of a test tone. The results reveal a slope of 1.0 (the reproduced tone is equivalent in duration to the test tone) up to test-tone durations of around three seconds. Beyond this, the slopes flatten because the reproduced estimates are increasingly underestimated relative to increases in the duration of the test tone. Pöppel (1988) interprets this in terms of a temporal limit in information processing, beyond which information may be referenced to the temporal limit (leading to the under estimations and the flattening of the slope of the reproduced estimate). And while Fraisse (1963) refers to this in terms of an upper limit in 'time perception of around three seconds, Pöppel

refers to this as the upper limit of 'nowness,' and also makes clear that the experience of 'now' does not allow for a non-extensive boundary between past and future events.

More recently, Wittmann (2015) has summarized psychological 'presence' in the now into three classes: The 'Funktionaler Moment' or 'functional moment' is of duration between 30-300 milliseconds (ms) during which the perceptual and derivative cognitive content structure of events occurring in that interval of time are processed, prior to the deployment of focal attentional mechanisms and prior to any articulate experience of the 'here and now;' an 'Erlebter Moment' or 'lived moment' is of between 300-3000 ms – Pöppel 's limit for experienced nowness – during which we are able to experience and coordinate with external event structure, and during which reflexive cognition such as attentional deployment to external events occurs. Finally, Wittmann identifies 'Mentale Präsenz,' a moment ranging between several seconds to a few minutes, which includes the use of explicit cognitive strategies (working memory), and which provides the temporal context (past/future) for a narrative self.

To some extent, measures supporting timing of the lived moment derive from the timing of successive states of introspection on stimuli such as reversible figures (Pöppel, 1988; Wittmann, 2015). These data are subjective, allow an approximate timing for the moment now and seem to suit the definition of time as subject. The shorter interval includes the interval originally measured by Brecher, who revealed a maximum time for the experience of events as co-temporal as 53 ms for humans (35 ms for fighting fish and around 300 ms for snails). Values between 50-60 ms using a paradigm similar to that described by Brecher have also been published from my own work (Elliott, Shi & Sürer, 2007; Elliott & Giersch, 2016). However, what is interesting with respects to this lowest class of 'nowness' is its identification with the neural process. There is now a very substantial body of evidence that shows that neural 'binding' processes, i.e. those processes responsible for the conjoint processing of different perceptual features of a multi-featured object, occur prior to attentional deployment, and may involve the phase synchronization of stimulus-induced neuronal oscillations, which settle at frequencies in the range 30-70 Hz (Singer, 1999), frequencies for which several cycles may be realized during the 30-300 ms time period, argued as necessary to be able to reject the perceptuo-cognitive outcome of spurious, one-off synchronizations.

Wittmann's 'functional moment' includes the period of time during which binding occurs and at one time, several attempts were made to establish whether or not 'perceptual synchrony' could be engineered by stimulus paradigms which could otherwise be interpreted in terms of neural synchrony. The equivalence between a perceived simultaneity and the synchronization of neuronal networks was considered sufficient that the former could be used as direct evidence for the latter; however, on closer examination, this leads to a problem that might not confine to the problem of establishing the validity of the binding by synchrony hypothesis. It certainly is a problem for establishing the function of the Funktionaler Moment.

The problem is founded on the fairly common observation that events may be reported as synchronous (or simultaneous, in so far as this is a case of synchrony when events occur at the same time) beyond the case where the two events occur at precisely the same time. As found by Brecher and then myself (Elliott, Shi & Sürer, 2007, also Elliott & Giersch, 2016), and depending upon stimulus conditions, two events may be judged to have occurred simultaneously even though they are separated by intervals of a few tens of milliseconds. Additionally, and importantly for this argument, there appears to be little or no difference between the perception of simultaneity following presentation of physically simultaneous events and perceptions that follow presentation of non-simultaneous events. Here, time as 'subject' allows for an interval of 'nowness' during which the physically non-simultaneous are confusable with the simultaneous. Time as subject is different to time as object.

So why is this problematic for the idea of a perceptual synchrony? The synchrony or *simultaneity problem* arises when we ask the question: "To what extent can we claim to have *experienced events as simultaneous*?" At the crux of the problem are events that are non-simultaneous but which we see as simultaneous and it might be considered an acceptable claim that, irrespective of the actual simultaneity of two events, in perception events can be considered simultaneous if that is how they seem to the observer (Kelly, 2005). However, the following logic modifies this consideration. Take any two events $A_1$ and $A_2$ that appear to the observer to occur simultaneously, in spite of which they are separated by some interval. Then take some third event that occurs at some time later than both $A_1$ and $A_2$ but is experienced as simultaneous with each. Using this method, a series of events from sets $\{A_1,, A_n\}$ may be experienced as simultaneous although the point may be reached at which $A_1$ and $A_n$ come to be experienced as non-simultaneous.

Perceived simultaneity is thus *non-transitive* (i.e. $A_1 = A_2$ and $A_2 = A_3$, but $A_1 \neq A_3$) and non-transitivity should, in principle, preclude a definition that includes *simultaneity* because simultaneity cannot be both *non-transitive* and an *equivalence* relation. It seems an obvious solution to circumvent the problem of transitivity two events may be defined as perceptually simultaneous if they appear to be simultaneous and if there is no third event with which one event appears to be simultaneous while the other does not. Indeed, this counter argument might be valid if it were not for the following corollary: although two events might *appear to be simultaneous* it is nonetheless impossible for the observer to conclude that they have *experienced them to be simultaneous* without reference to the third, non-simultaneous event. This event thus marks both the limit of perceived simultaneity and indeed the maximum interval of time between which the two key events would have been perceived as simultaneous. It also means the observers judgment of what was deemed to be 'simultaneous' is invalid and may only be valid when it takes into account the third, non-simultaneous event, at which point it is a judgment based upon criteria related to successiveness. On these grounds, perceptual synchrony seems little more than a non sequitur, and one which lacks construct validity unless taken to refer to the *interval of time* over which two or more events are seen to occur at the same time. It also means that asking experimental participants to judge the synchrony

or asynchrony of events is not possible with any true validity, because a-priori, they will be unable to make a correct judgment. Thus, and whilst subject to critical analysis (Arstilla, 2012), the problem really does remain that you cannot ask people to report the impossible.

At the lowest level of 'nowness,' at its functional level, it may be difficult to derive measures that allow us to do more than index the intervals of time over which two events appear to be non-simultaneous, because we cannot link this perception directly with the process states that are likely to be operating at this lowest level to bring about a state of perceived simultaneity. We have, once again, a problem objectifying time. This may not be a major problem for the models put forward by Pöppel and Wittmann, but again and as with the problem of psychological time as object, the logical impasse may make it impossible to find theoretical closure.

**Does anyone really see the emperor's new clothes?**

Perhaps the moniker 'time perception' predates Fraisse (1963), but by the time of writing the 'Psychology of Time,' Fraisse developed the idea that we perceive time. So, do we perceive time? The answer is 'no', we do not perceive time, so why raise this here? One question is whether we really have access to 'time as object' and if we do not, what is it that we are experiencing? There is no need appealing to the scientific literature to make the point that time as subject does not run evenly: if you are bored then things drag on and if you are happy things are over in an inconveniently short time. Time as object would appear somewhat mercurial (it could be that boring things last relatively shorter than enjoyable things), but it is not clear that time is at fault here, or for that matter, any perceptuo-cognitive faculty we possess that is related to the processing of time. There has accumulated a substantial literature on estimates of how long an event, or interval has lasted, summarized nearly 20 years ago by Grondin (2001). The reason to refer to Grondin's, now somewhat dated, review are the following points he makes: (i) in spite of the idea of a single clock mechanism, the results of time estimation experiments have rarely been found to correspond to Weber's law (The law states that the change in a stimulus that is deemed to be just noticeable is at a constant ratio of the original stimulus), and so time estimation does not scale along a single dimension. Here one could say that if there is an analog to objective time, it is not in a single processing system (ii) related to this perhaps are findings that Weber's law does not hold in situations involving sequences of intervals, explicit counting strategies or extensive training; further and most important (iii) the psychophysical functions relating judged to actual durations may be heavily skewed at extremes on the measurement scale. This means, not only is time estimation skewed by affective state, it is also skewed beyond certain estimable limits and because this occurs in the millisecond or tens of milliseconds range, this points to an issue of resolution (at least in this case) and possibly the capability of the cognitive system to adequately represent an interval of time that falls outside of the operational capacity of that same system. Time estimation starts to resemble an outcome of an attentional system; retrospective time estimation cannot avoid appeal to the product of our ability to accurately remember the duration of an interval or event. Of course, in the latter case we need to be reasonably accurate in our 'perception' of time such that the

memory can provide an accurate estimate for reproduction, comparison or report. Without going into detail, the take home point from Grondin's summary critique is that there is likely no single perceptuo-cognitive apparatus that provides for time sense and, while the clock metaphor remains substantively elusive, it is not properly accurate to conceive of time sense as a single or dimensionally unitary psychological experience, and certainly not something for which an anatomically singular physiological mechanism should be sought. In addition, it may be more parsimonious and scientifically less prone to mistake to refer to the outcomes of laboratory studies of time perception in terms of memory or attentional processes. Although this may in itself be equivalent to whitewashing the wall by painting it black.

## If time isn't time, where do we go now?

Time as object again defies definition in terms of time as subject, or in this instance, time as subject seems prone to enough alternative explanations and measurement issues that a description of what people experience as 'time flow' cannot be easily parceled out from the mixture of experimental instruction set and capacity limits on attentional and perhaps memory processes. None of these are time. In addition, time as subject is essentially the experience of nowness, which has the peculiar property of being by nature atemporal (Zeno's paradox), and if people by and large do not spend their time in a state of awareness of time flow (as I have argued they do not), one might question construct validity in terms of ecological validity, at least as this refers to the experience of time.

So, psychological time (time as subject), for various reasons, is not the same as physical time (time as object). In fact, not only is psychological time not a good measure of physical time it is often the case that we are interested in it precisely because it varies relative to physical time. Is it then really 'time?' It seems not, and perhaps we should stop referring to various experiential states, or experiential consequences of cognitive performance in terms of time: this may simply serve to mislead. So, we seem to have reached the point at which the argument requires retrieval. Or, put another way, can we measure the effect of physical time in psychological function?

All systems operate in time and the human bio-behavioral-interactional-social systems are no exception. It is possible that many of the principles defining dynamics at one level scale to other levels, not surprising in consideration of all such systems being physical, and so describable, systemically, according to the set of physical constraints that define their operation. What does this mean for psychological time? Well, time in psychological systems is undoubtedly one factor that defines the function of all of the dynamic systems that provide for cognitive and other psychological functions: it may be considered to provide a limit in so far as it is the medium within which the several components of any dynamic system interact to bring about a successful outcome. This limit is perhaps better understood though in terms of the extent to which a system or component of that system is able to function regularly, and interact regularly, successfully, with other components of the same system. Referring to one locus of this system, in cognition and the neural systems that support cognition, I have written elsewhere (Elliot & Du Bois, 2016) "*the organization of brain circuitry*

*into assemblies defined by their synchrony at particular (and precise) oscillation frequencies is important for the correct correlation of all independent cortical responses to the different aspects of a given complex thought or object. From the point of view of anyone operating complex mechanical systems, i.e. those comprising independent components that are required to interact precisely in time, it follows that the precise timing of such a system is essential – not only essential but measurable, and scalable. It must also be reliable over observations to bring about consistent behavior, whatever that behavior is. The catastrophic consequence of an absence of such precision, for instance that required to govern the interference engine in many automobiles, is indicative of how important timing is for the function of dynamical systems at all levels of operation.*"

Psychological time is in this view, unequivocally a *measure* of dynamic psychological systems. Given that such systems are now generally accepted to be instrumental in the representation of perceptual and other cognitive events, it is perhaps logical to draw reference back to von Uexküll and the idea that in the moment now, which is the only point at which we have access and may be able to properly measure time, 'nowness' is defined according to the content of Umwelt. In other words, defining time requires defining Umwelt, which in turn and given its representational nature, entails measuring the dynamic systems that bring Umwelt about. Psychological time, thus considered, is a descriptive analogy for the dynamic systems structure that brings about our immediate and continued experience of the 'moment now.' Taken together with the fact that dynamic systems are defined in terms of regular events, one can conclude that our experience of 'nowness' is the same as our experience of continued existence, both being based upon a structure of regular events and, perhaps ironically, both based upon dynamic systems structures that may share common patterns of regularity.

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