

# A few comments about temporality and anticipation in the neurosciences, psychology and psychiatry<sup>1</sup>

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Philosophers as well as psychologists, physiologists and psychiatrists have long been interested in temporal duration (temporality). This article presents an overview, the purpose of which is to demonstrate the value of philosophical ideas about the nature of time in relation to neurophysiology, neuropsychology and psychiatry. It consists of four parts. The first sets out the views of W. James and E. Husserl on anticipation. The second part deals with a still unpublished article by the famous French neurophysiologist P. Buser, and is devoted to physiological mechanisms of anticipating movements. The third and fourth parts examine the relationship between phenomenology and psychiatry, starting with the work of E. Minkowski – “Lived Time” – and ending with contemporary works on the perception of time in mental illness (especially schizophrenia). In conclusion, the author asks what is time, whether it is connected with the content of an experienced event, is it a fundamental atemporal framework of mental life, or one and the other.

**Keywords:** *temporality, atemporality, time perception, anticipation*

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The structure of human temporality, based on a kind of entanglement between past, present and future, had been for a long time a matter of great interest not only in philosophy but also in neuroscience, psychology and psychiatry. New developments are continuously taking place in these areas of research. The aim of this paper is to explore the relevance of philosophical ideas on time for psychiatry including contemporary psychiatry. I will first make some comments about the philosophical tradition (William James and Husserl), about what these philosophers could say and what they could not say about the issue of the future in human temporality. Second I will give some clues about neurophysiological mechanisms as they are presently understood, thanks to Pierre Buser’s discussions in several of his publications. Third I will go back to phenomenology and I will

give some comments on the interface between phenomenology and psychiatry in the older work of Eugene Minkowski about the experience of time (*Le temps vécu*, 1933). I will put some emphasis on schizophrenia. Lastly I will present some elements of discussion regarding temporality disorders in psychiatry and mainly in schizophrenia. So on the whole I will go from philosophy to physiology then to psychiatry.

## **What philosophers could say and what they could not say**

Let us begin with William James who may be defined as a philosopher-scientist. William James’s mixture of introspective method, of the evidence given in experimental psychology, and of clinical evidence is of great value regarding temporality issues and especially about time perception and about its neurophysiological correlates. I will take three hypothesis by James about time perception.

First, we are constantly conscious of a certain duration (the so-called specious present). The cause of this intuition cannot be the duration of our brain processes, that’s because, according to James, a succession of feelings is not a feeling of succession. What we really perceive is rather,

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<sup>1</sup> The article was written in English. This paper includes a section written by late Professor Pierre Buser on anticipation. The author is glad to include it as a tribute to this prominent neurophysiologist, who died at the age of 92 on December 29, 2013. A French version of this section is going to be published in a book on anticipation by A. Berthoz and C. Debru in 2015.

probably, due to the simultaneous presence of brain processes of different phases. It is the interval between phases, due to the fact that the basic brain process is oscillatory in nature. This cause fluctuates – hence a certain range of variation in the amount of time intuition [1, p. 603–604]. Indeed, we can observe a certain plasticity in time perception, in many different situations.

Second, about the distinction between the « substantive parts » and the « transitive parts » of the stream of thought: the Stream of consciousness is like a bird's life, it seems to be made of an alternation of flights (the transitive parts) and perchings (the substantive parts). According to James, «the main end of our thinking is at all times the attainment of some other substantive parts than the one from which we have just been dislodged» [1, p. 236].

Third, a (rather theoretical) proof of the existence of these «transitive parts» is given by the picture of the brain as an organ – I quote – «whose internal equilibrium is always in a state of change – the change affecting every part. The pulses of change are doubtless more violent in one place than in another ; their rhythm more violent at this time than at that (...) so in the brain the perpetual rearrangement must result in some form of tension lingering relatively long, whilst others simply come and pass. But if consciousness corresponds to the fact of rearrangement itself, why, if the rearrangement stops not, should the consciousness ever cease?» Anyway the swift consciousness corresponds to the so-called «transitive parts» or «feelings of relation». According to James – and this was not always recognized, «we cognize relations through feeling» [1, p. 239].

Fourth, indeed, according to James we have a feeling of direction and expectancy. We have a «sense of the direction from which an impression is about to come, although no positive impression is yet there» [1, p.243]. Moreover, «large tracts of human speech are nothing but signs of direction in thought» [1, p. 244]. The intention of saying a thing before having said it is according to James an absolutely distinct state of consciousness. These various states may be pictured in terms of brain action, in terms of dying and increasing excitements of brain processes. This is but an example of James's cerebralist viewpoint in his

Principles of Psychology in 1890. What we can say about James's theory is perhaps that this «sense of direction» is at least partly a finalistic concept, because according to him the whole idea of what we are going to say is present before we utter the corresponding sentence. This is a comment about the famous example he takes in the chapter on the Stream of thought, the sentence «the pack of cards is on the table» [1, p. 269]. The whole idea corresponding to the sentence is present in a way before we utter the sentence. Plus, the waxing and waning representation of the whole brain process gives a more physiological and perhaps even mechanical clue to this essential feature of the Stream of consciousness to include a sense of direction. Mechanism and finalism are linked to each other.

I will briefly mention Husserl as the second philosopher who put emphasis on the intricate structure of time consciousness which includes the immediate past (what he calls retention), the present and the incoming future, which he calls protention. In his famous lectures in 1905 he took the example of a musical melody in order to substantiate what he meant by « protention » [2, p. 51, 56]. If I hear the sequence of tones C – E, I expect G quite naturally. Plus, there is an intricate relationship between retention and protention. What is expected depends very much on what is retained in the fine structure of consciousness. So on the whole James's representation of the «specious present» and of the Stream of thought is basically in accordance with Husserl's phenomenological description of time consciousness. This is not surprising. Husserl read William James. This agreement has consequences regarding later neurophysiology and also psychiatry.

First, about neurophysiology. At time  $t$  we do not have a real perception of what is going to take place at time  $t+1$ , but only an « expectancy ». This expectancy should correspond to the waxing phase of the brain process. We can find a physiological equivalent in the idea of preparation as dealt with by Hans Kornhuber in his famous potentials of motor preparation (Bereitschaftspotentiale) [3, p. 52]. Here the issue of the unconscious (still not conscious) is obvious.

Second, James's idea to give a functional role to nervous oscillation as such in the fine

structure of consciousness is now ubiquitous. Norbert Wiener already put emphasis on this idea in order to understand the perception of time [4]. Ernst Pöppel stressed the need of a temporal physiological frame when he wrote, I quote – «One period of such an oscillation is hypothesized to represent the functional basis of an elementary integration unit within which temporally and spatially distributed information is automatically related to each other and integrated into a unit. Such units or system states are insensitive to the exact temporal occurrence of input data. Thus, they are atemporal and provide integration intervals within which information is created as co-temporal. There is plenty of experimental evidence for such systems in the domain of some tens of milliseconds » [5]. Let us notice that the term « atemporal » is also a term used by Husserl, a term which we will find again later.

Second, Pöppel pictures the so-called «specious present» as a « temporal window ». But the difference with James is that the «time window» is discontinuous. Pöppel goes back to Wilhelm Wundt's theory of the discontinuity of consciousness. Indeed, according to Pöppel, I quote, «the purpose for this omnipresent time window within the onceptual time frame presented here is the creation of a time zone within which the identity of a percept or a thought is created and maintained, but that a new identity may enter conscious representation when the temporal window is closed» [5]. Shorter temporal windows than the usual three seconds window emphasized by Pöppel in earlier writings are now very popular among physiologists.

To conclude this series of arguments : what James's psychophysiology and Husserl's phenomenology both show, is that it is easier to conceive of anticipation by referring to the past or to a kind of source-point, as if we could only anticipate what is beginning, as if we could only unroll what is preexisting or at least immediately preexisting in our mental microdynamics. In this respect, what philosophy could not say when it was based only on analytical, or introspective, or phenomenological methods, is what we call now unconscious information treatment, it means what happens just before I conceive of the idea « the pack of cards is on the table » and before I utter that sentence.

### Pierre Buser on anticipation

Let us go on with this kind of physiological considerations. The distinguished neurophysiologist Pierre Buser, in a forthcoming paper on anticipation, asked the question : when and how does the brain anticipate ? This section is based entirely on this paper, which deals mainly with motor action<sup>2</sup>. But first how to define anticipation ? Buser proposed the following definition. On the whole, anticipation consists of preparing the future occurrence of an event, and acting in accordance with this preparation. It therefore depends on the prediction of the immediate future. Anticipation and prediction are therefore not synonymous, prediction is the representation of a specific event to occur while anticipation prepares the action based on implicit or explicit prediction. Given a certain act to perform, the subject may thus display a preparatory phase, indicating anticipation. Anticipation episodes may also include a very important factor, namely *probability*. Waiting for an event to occur (and preparing a possible action) may include a knowledge of the event's probability of occurrence. More precisely, the probability may thus be conditional, that of an event A to occur in a given situation or after a given event of probability B. In other words it may be a Bayesian probability situation. More generally the question may be asked, whether any motor action is not always more or less prepared by an anticipatory process and an intentional drive created by a predictive model, the basic drive finally consisting both of intention and prediction-anticipation. The subject at any rate is not simply a reacting subject. It is hard to believe that even simplest beings may not in a way or another encounter some (maybe very elementary and basic) conditional probability situations while planning the movement that is just to occur.

Well, now, what happens in experimental conditions? We will start with human subjects anticipating and performing a given well controlled forelimb movement. Second, some investigations will concern movements that are much more complex to follow in their time-space coordinates, such as in sport games. Thirdly, animal bar pressing or motion and behaviours in a given

<sup>2</sup> Berthoz A., Debru C. (eds.). L'anticipation. Paris: Odile Jacob (in press).

experimental area will follow. In these three kinds of situations, we will briefly summarize classical electrophysiological evidence about the anticipatory phase.

Grey Walter, forearm movements in humans, and the so-called *contingent negative variation* [6]. In this first example we shall see how “expecting” to perform a movement is an important variable. Grey Walter submitted subjects to two successive sensory stimuli, a first called “advisory” not requesting any movement and the second one, following after a given period of time (a few seconds) called “imperative” was usually requiring a hand or arm movement (button pressing). The important point is the development, during the expectancy period, of a long-lasting monophasic scalp-recorded EEG negative wave named by Walter *contingent negative variation* (CNV). This activity could clearly indicate how “waiting to move” is accompanied by an active brain process.

Second evidence: Hans Kornhuber and so-called *readiness potential* (*Bereitschaftspotential*), which is a quite distinct kind of evidence bearing on voluntary movement. This potential is a brain process that develops during preparation of a *volitional* movement, meaning that in this case no external order was given to the subject who was left free to decide when to execute the movement. Kornhuber and his colleagues could thus show through scalp recording that about 1 sec. before the onset of the given voluntary arm movement, a long lasting monophasic negative wave termed by the authors *Bereitschaftspotential* (BRP, English translation “Readiness potential”) developed with its maximum over the sensori-motor cortex. Thus, even if there was no external “order” to initiate a preliminary phase of “preparing to act” and anticipate, an internal action did initiate a preparatory brain process with a certain time evolution.

Further in this readiness potential study : when does the subject become conscious of starting to move? Benjamin Libet later on sought an answer to this question in his well-known studies. He thus discovered that during about the first 200 ms of the occurrence of the readiness potential, the subject remained non-conscious of his decision to move. The existence of this preliminary episode during which the subject

had already started preparing his movement but was not conscious of his decision raised endless questions regarding the possible negation of “free will” [7].

A prevalence of brain activity as a preliminary to movement can even go further when asking subjects either to execute a given movement, or to “simply” imagine themselves executing the movement. According to Jean Decety for instance about 30% of the brain areas that are active during real movement show in fMRI studies activation during imagined movement [8]. Precisely, in another quite interesting brain imaging analysis, it was demonstrated that such motor areas activations also occur prior to observing someone else's expected action [9]. This suggests that the mere knowledge of an upcoming movement is sufficient to excite one's own motor system, enabling people to “anticipate, rather than react to, others' actions”.

Taking these four typical studies, one may conclude that anticipation of an ordered but delayed movement i.e. with a phase of expectancy, may be accompanied by a visible brain activity, with a 100% probability (no conditional probability existed in the above examples); the readiness potential shows that preparation of a movement only depending on an internal programming is also visible in brain structures; this preparation may in its first phase, not be conscious to the subject. Finally the fMRI data tend to confirm that a brain imaging of a performed movement may develop, providing a possible substrate to favor the internal development of anticipation and mental imaging of the future motor act.

Now about object catching movements.

Other anticipation studies have concerned more refined analyses of dynamic movement adjustments. How a movement performed in order to catch a moving object is prepared? How a subject could program and harmoniously perform such a movement in time — and so, through predicting the forthcoming events, remain capable of anticipating and controlling the successive positions of the moving body part, e.g. with respect to the position of a moving target.

A first theory has dominated, that the control of movements was essentially due to a control through proprioceptive reafferents, but it was soon replaced by the concept of a central motor

program, allowing all kinds of instant preparations and adaptations of the movement under way, to anticipate recapture or contact.

Some main features of this anticipation were carefully analysed fairly recently [10]. Two classes of nervous operations were involved in this anticipation process: First, a *motor anticipation*, the motor system itself anticipating the successive steps of the programmed motor sequence; secondly, a *perceptive anticipation*, a more complex process, that involves the visual system, in the sense of an *internal perception* of the motor execution itself by the visual system [11]. These anticipatory regulatory mechanisms may be of major importance to keep the motor sequence in a continuous and harmonious relation to its final aim.

An extension of these findings may probably be possible, to more complex self-guided activities such as exist in a variety of sports (ball-playing, etc.). This is the well-known “time to contact” problem. In these cases however, external information may also intervene, not only tactile ones but also and even essentially in some cases, direct visual and possibly auditory information, in order to reach contact. Here also two opposite theories were successively proposed about reaching and final contact (TTC time to contact); that it may either depend on the sensory information about position of the target(s) or on a knowledge, implicitly present in our brain, of the physical laws involved in target movements. In fact, in many conditions of reaching or recapture, it has been shown that the brain *doesn't wait* until the object has reached the hand to perform the necessary muscle contractions to receive the falling ball. This preparation of the brain for the final arrival was estimated to take about 300 ms.

A particular class of situations falling into this category of implicit knowledge, was shown to occur also in space flights. It was in fact noticed that this kind of control of recapture did almost not differ from normal, thus indicating the prevalence of internal models of Newtonian laws of gravity that allow for predictions. This knowledge may be due to early acquisition during childhood [12]. Other kinds of experiments, this time on animals, provide interesting data on anticipation.

First, in a typical pavlovian paradigm, the animal is given a warning (conditioned) signal

which is followed after a certain period of time by the absolute event (reward delivery etc) In the simplest cases, when the probability of reward is 1, the time lapse between signal and reward is most often accompanied by some characteristic electro-cortical activity (regular brain oscillations at various frequencies), presumably again reflecting a certain brain activity correlated with ‘preparation’ of the reward event and probably also corresponding to some (gross) anticipation whenever the animal had to perform a movement (to seize or get food, or avoid shock, or press bar, depending on the class of training).

Second, one of the interesting variables to consider is the probability of occurrence of the final event, after a preliminary signal had been delivered. This “Bayesian” paradigm may be found in a variety of experimental situations, set up in order to observe what would occur during the waiting period, depending on the probability values. In this line of thinking, let us consider an interesting set of observations performed on macaques with microelectrode recordings of dopamine neurons from deep hypothalamic brain structures involved in hunger and satiety. The monkey was trained to receive a first conditioned signal followed by a waiting period until a pressing for food delivery. The depending variable in these experiments was the probability of food delivery which varied at random (from 0 to 1) and was announced by a symbol in the signal. The recorded responses were ordered from  $p=0$  to  $p=1$ . The hypothalamic activity displayed two discharges, one brief, that increased monotonically with the probability of food, and a long lasting second discharge whose amplitude reached its maximum at *maximal uncertainty* ( $p=0,5$ ) [13]. Finally, this study is one indication together with others that there are structures in the brain that are coding for the probability of occurrence of a biologically significant event.

To conclude, anticipation of motion is found almost everywhere. We should be able to find it even with very short preparatory time. May be sometimes only within milliseconds. A purely reflexive, not anticipating animal, as has so often been postulated for a long time, is nowadays hard to imagine. The difference between anticipation and purely stimulus-driven behavior and learning is thus highly significant.

### **Phenomenological psychiatry : Eugen Minkowski's Lived time (1933)**

It is well known that there was a school of phenomenological psychiatry in Germany and also partly in France in the first half of the XXth century or so. The psychiatrist Eugene Minkowski wrote an influential book in 1933, *Lived time*, preceded by another book *La schizophrénie* in 1927. In his work on schizophrenia, Minkowski paid much attention to time (a move, which was quite original in psychiatry), and he took from Bleuler the distinction between «syntonie» and «schizoïdie». In *Lived Time*, he wrote : «La syntonie vise le principe qui nous permet de vibrer à l'unisson avec l'ambiance tandis que la schizoïdie, au contraire, désigne la faculté de nous détacher de cette même ambiance » [14, p. 67]. Of course this is a purely phenomenological description which is in need of a deeper explanation. Minkowski had some general philosophical comments on experienced time and expectancy before discussing different kinds of psychiatric disorders. According to him, the contrary of vital activity is not passivity but expectancy [14, p. 79]. Indeed, expectancy is just suspended activity. In activity we tend towards the future, in expectancy we just see the future coming to us and wait for it becoming present [14, p. 80]. This can be represented in a geometrical fashion by arrows in opposite directions [14, p. 83]. In its basic structure, expectancy is linked to anxiety. It corresponds to a kind of narrowing of activity, as different from normal activity which is a kind of expansion of the living being. These are some philosophical or phenomenological ideas which we can formulate by analysing ordinary experience. It is amazing to see how philosophical ideas like Bergson's ideas on time and duration , on «vital momentum élan vital» which Minkowski transfers into psychiatry as «personal momentum élan personnel» could at that time influence psychiatry. Now what's about Minkowski's ideas on pathological experience ?

Relying on clinical phenomenological evidence provided by some patients, Minkowski describes the sense of the future in mental illness as being blocked by two things : repetition without progression, and painful certainty of a terrifying event, possibly death, which prevents

any positive propulsive attitude towards life [14, p. 175]. Under this condition, the personal drive diminishes, the patient becomes unable to keep together the various aspects of his personality, there is a disaggregation, a disorganisation, the experienced time splits up into a succession of similar times, the attitude towards the human environment is just pain and hostility, persecution etc., so that the patient detaches himself from his environment. So one can see here how phenomenological descriptions of time perception can be introduced in psychiatry. One of the consequences of that is about the reciprocal attitudes of the doctor and of the patient, even in difficult situations, which should tend to restore a vital contact with reality, a kind of syntonie, of resonance between them (which is of course a very idealistic vision). Anyway Minkowski's basic vision of schizophrenia is the loss of vital contact with reality [14, p. 256], which manifests itself in a kind of fixity, of immobility, of static attitude, of the prevalence of the past in mental life. Even megalomaniac ideas are static in schizophrenics [14, p. 258]. Well as a matter of fact the importance of temporal aspects in psychiatry seems to be taken over again nowadays.

#### **Temporality in chronic psychiatric diseases**

As an introduction to this subject, I wish to make use of a paper by psychiatrist Vassilis Kapsambelis of the Centre Alfred Binet in Paris (a Centre which is quite famous for psychiatry) [15]. This paper puts some emphasis on schizophrenia. Certain patients with serious schizophrenic disorders are characterized by a disorganization of their temporal biological basic rhythms (sleep and wakefulness, meals, walking etc.) perhaps as a consequence of the pathological ideas which dominate them. Anyway, these patients can be improved in their daily life by regular stays in hospitals (let us say three days at the hospital, where they can recover a normal rhythm, and four days at home). However, it turns out that this kind of cure cannot be really maintained for a long time, because disorganization tends to reappear.

When doctors speak with these patients, they realize that this symptom of disorganized time is just an expression of something else, which is

more basic, which is the instantaneous character of their perception of things or beings : these things are considered as being or not being. There is no idea of a biological process, no idea of a progressive construction. It is a matter of « all or nothing ».. Temporality is something unbearable which has to be destroyed. Life has to be destroyed because there is something unbearable in the impulses they feel. If normal temporality as a progressive construction does not exist for these patients, in which kind of temporality do they live ? Contrarily to what has been maintained by certain authors, who speak of intemporality for these patients, the term atemporality seems to be more suitable. According to Notons qu'il s'agit d'un terme déjà élaboré dans la tradition philosophique, signifiant la pure répétition de la trame temporelle de base.: «We need certainly to consider the mental functioning peculiar to some schizophrenic processes, not in terms of timelessness, like we do frequently by a too rapid identification of these processes to unconscious processes (which are supposed to be uncovered in these pathologies), but rather in terms of atemporality : the issue is not the indomitable character of the drive, but indeed its unbearably living character. If timelessness represents the undestructible character of the drive, the atemporality of these patients is fed, on the contrary, by a phantasm of destruction of every drive. Between timelessness and atemporality, there would be a difference similar to the one between the infinite and nothingness (the «zero time» of Laurent – a young schizophrenic patient). It is probably this aspiration to «nothingness» which is shown in the most serious schizophrenic pathologies, which know so well how to match the most spectacular

ideas of world creation to a everyday life of a dreadful physical misery » [15, p. 249].

There are other forms of the disorder in the relationship of schizophrenic patients with time. «Investment of a word representation by a representation of a thing» (temporal fixism I would say : «eight months» is not an expression, it is a thing, as such it is not subject to change with the flow of time) – defense against a loss (a patient tries to get out of the hospital every Friday in order to meet his mother who died many years ago). Of course it is quite possible that the peculiar temporality in the hospital plays a role in the proper atemporality of the patient. These patients in hospitals, with their « atemporality », continue to exist but do not live really. The term «atemporality» needs some comment. It is used by Husserl in his analysis of time consciousness. It means a kind of perpetual nowness which is moving forward, without any novelty. A kind of «nowness» without «newness» if I may use these words which do not exist in ordinary English language. Anyway, in these patients, the particular temporal structure seems to be an emerging feature, rather than a basic structure. It is a symptom, rather than a cause. In order to deal with this disorder, the doctor and the patient have to enter in a common psychodynamical process. Schizophrenic patients, together with their doctors, have to go back to the time of adolescence – which is a completely individual and surely highly complex matter.

To briefly conclude : time as emerging, content linked process, or time as a basic, atemporal framework of our psychic life, or both ? These are questions which are more and more met in basic and clinical science.

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