# ФІЗИЧНІ, ХІМІЧНІ ТА ІНШІ ЯВИЩА,НА ОСНОВІ ЯКИХ МОЖУТЬ БУТИ СТВОРЕНІ СЕНСОРИ

# PHYSICAL, CHEMICAL AND OTHER PHENOMENA, AS THE BASES OF SENSORS

## ВІД РЕДАКЦІЇ

Відомо, що умовами успішної роботи фізичного сенсора є: по-перше,– можливість фіксації сигналу, і по-друге,– інтерпретація сигналу в реальних фізичних величинах.

Якщо абстрагуватися від конкретних фізичних сенсорів можна прийти до думки, що ідеальним специфічним сенсором може вважатися нейронна система, що формує людську підсвідомість. Дійсно, існують дослідження того, що саме підсвідомість допускає існування ірраціонального за межами матеріальної реальності і є відповідальною за породження ідей для великих творів мистецтва, музики, прози, поезії, великих наукових відкриттів і глибоких духовних переживань, що в кінцевому результаті трансформується в раціональну форму.

Для реального використання такого інструменту (сенсора) необхідно навчитися надійно користуватися доступом до нашої підсвідомості. Зокрема, окремим особам, як відомо, вдається досягати відчуття такого рівня у стані медитації. При цьому надважливим чинником успішної комунікації свідомості з підсвідомістю, подібно до роботи фізичних сенсорів, виявляється спроможність: по-перше,– усвідомити (впізнати) в певних психофізичних умовах цей діалог та, по-друге,– вірно його інтерпретувати.

У запропонованій дискусійній статті автором зроблена спроба розшифрувати окремі власні психофізичні відчуття і спромогтися завдяки досвіду фізика-експериментатора логічно ці відчуття документувати в зрозумілій математичній формі зв'язку зміни психологічного часу з температурою. Як показано в роботі, визначальним чинником для успішного вирішення завдання кількісної оцінки тривалості та швидкості зміни психологічного часу, є взаємодія двох компонентів мислення – свідомості та підсвідомості.

Стаття, на нашу думку, може привернути увагу дослідників до цікавих аспектів взаємодії свідомого і підсвідомого елементів (систем) мозкової діяльності за участі специфічної сенсорики.

Ще в перші десятиліття 20 віку G. Parker із Єльського університету при пошуках примітивної рефлекторної дуги встановив, що нейронні шляхи, з допомогою яких збудження генеруємо сенсорним стимулом, діючи на певну частину тіла може викликати рух. А суть роботи центральної нервової системи – головного і спинного мозку – є проведення вхідної сенсорної інформації до численних структур і конвергенція на нейронах. Були виділені групи сенсорних нейронів, від яких, зокрема, поступають сигнали з навколишнього середовища. Спроби, що мають місце, підключити мозок до комп'ютера, або створити розум в середині комп'ютера також розраховані на використання сенсорних нейронів або інших специфічних сенсорних систем. Успіхи, чи певні результати, практичного втілення таких ідей є біонічні протези, наприклад, рука, що керується силою думки на підсвідомому рівні, рука-протез, як звичайна робить необхідні рухи (електрик Джессі Саллівaн, США). І тут працюють нейронні сенсори.

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## ON THE PHYSICAL NATURE OF SUBJECTIVE PSYCHOLOGICAL TIME

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## ON THE PHYSICAL NATURE OF SUBJECTIVE PSYCHOLOGICAL TIME

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**Abstract.** A simple temperature dependence of rate changing a psychological time $t_{ps}(t_C)$ in human was suggested: $(\partial t_{ps}/\partial S_{ps})=D_{ps}\cdot\delta T$, where $D_{ps}$ is some constant, $S_{ps}$ is the psychological entropy, characterizing current human physical/mental state; $\delta T$ is the normalized body temperature $\delta T=(t_C - t_C^n)$, $t_C$ – the now temperature and $t_C^n$ – the normal temperature. This dependence as an empirical result of personal experience in "perception" of time intervals (~10 min) at high body temperature ($t_C \geq 38{,}2^0$C) was ascertained. It has been shown the determining factor to successfully finding the task of quantitatively estimating a duration and changing rate of the psychological time there is cooperation of two thinking components – consciousness and subconsciousness. The optimal physical conditions for involving the subconscious results in significant strengthening of the brain capacity (synergy effect) were found out. The possible application of the formulas obtained for analyzing the changes of psychological time with temperature and entropy was suggested. Using on the calculations performed the graphical temperature dependences $\delta T$, $\delta t_{ps}$ $(D_{ps}\cdot\Delta S_{ps})$ were plotted, that confirmed the expected growth of these parameters.

**Keywords:** time perception, psychological time, psychological entropy, subconsciousness

## ПРО ФІЗИЧНУ ПРИРОДУ СУБ'ЄКТИВНОГО ПСИХОЛОГІЧНОГО ЧАСУ

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**Анотація.** Запропоновано просту температурну залежність швидкості зміни психологічного часу $t_{ps}(t_C)$ у людини: $(\partial t_{ps}/\partial S_{ps})=D_{ps}\cdot\delta T$, де $D_{ps}$ – деяка константа, $S_{ps}$ – психологічна ентропія, що характеризує поточний фізичний/психічний стан людини; $\delta T$ – нормована температура тіла $\delta T=(t_C - t_C^n)$, $t_C$ – поточна температура і $t_C^n$ –нормальна температура. Встановлено цю залежність як емпіричний результат особистого досвіду «сприйняття» інтервалів часу (~10 хв) при високій температурі тіла ($t_C \geq 38{,}2^0$C). Показано, що визначальним чинником для успішного вирішення завдання кількісної оцінки тривалості та швидкості зміни психологічного часу є взаємодія двох компонентів мислення – свідомості та підсвідомості. Виявлено оптимальні фізичні умови для залучення підсвідомості, що призводить до значного посилення можливостей мозку (ефект синергії). Запропоновано можливе застосування отриманих формул для аналізу змін психологічного часу з температурою та ентропією. З використанням проведених розрахунків були побудовані графічні температурні залежності $\delta T$, $\delta t_{ps}$ $(D_{ps}\cdot\Delta S_{ps})$, які підтвердили очікуване зростання цих параметрів.

**Ключові слова:** сприйняття часу, психологічний час, психологічна ентропія, підсвідомість

## 1. INTRODUCTION

Time is the decisive factor in behavior of any living organism, but the nature of time itself remains one of the most mysterious problems of up-to-date science [1,2]. It appears that time is not a universal quantity but only some conditionality. This feature of *individual time* was known long ago. It is common knowledge that perception of identical time intervals determined using, for instance, a chronometer, can differ essentially for various persons as well as under different conditions [3,4]. This individual time perception is named by neurobiologists and psychologists as the "psychological time" ($t_{ps}$). This field of studying the features of individual time perception is essentially widened in recent decades [2,4,5,6]. How many efforts and methods were applied to study this phenomenon of time perception. They considered a lot of various influencing factors, namely: changing the condition of consciousness by using meditation, introduction of narcotics and specific conditions of humans – neurologic and psychiatric ones [4].

Indeed, results of the newest world studies of psychological time in the field of psychology and neurobiology are of great importance. The main regularities of this phenomenon were ascertained, and it was found that human time perception is affected by strong emotions, apprehensiveness, age, body temperature, isolation (information deficiency), as well as concentration [3,7,8,9]. However, up to date there is no commonly adopted theory explaining the coding mechanism (recording) of time duration, and unfortunately comprehension of this phenomenon remains at the qualitative level [10,11]. Up to date, researchers have no specific mathematical relations quantitatively estimating the duration of the psychological time $t_{ps}$ and predicting its changes under purposeful modification of ambient conditions. To eliminate this flaw, we suggested a simple formulation of the physical relation between the rate of time course and temperature (energy) in a separate biological system. The dependence has been formulated on the basis of considering subjective perception of specific time periods (~10 min) under condition of fever. We analyzed the physical conditions that contributed to the optimal inclusion of subconscious thinking to solve the task to mathematically describe the rate of changes in the subjective psychological time. A possible applications of the found dependence $\partial t_{ps}/\partial S_{ps} = D_{ps}\cdot\delta T$ ($D_{ps}$ is some constant, $S_{ps}$ – psychological entropy; $\delta T$ is normalized body temperature $\delta T=(t_C - t_C^n)$, $t_C$ – the current and $t_C^n$ – the usual normal human body temperature) were suggested to estimate duration of the psychological time under specific conditions.

## 2. EXPERIMENTAL

### 2.1.Equipment

Glass clinical thermometer to measure the body temperature; smartphone used as a chronometer.

### 2.2. Subject of investigation

Body temperature dependence of psychological time ($t_{ps}$)

### 2.3. Journal of events the personal experience in "perception" of time intervals

The experience was proceeded for approximately 8 hours, starting at 22:00 up to 6:00 o'clock of the following day. Painful feeling arose yet in the previous day. The preliminary measurement of temperature approximately at 14:00 indicated its increase up to $t_C$ close to 38.2 $^oC$. There arose a suspiction of the virus attack. Thereupon, the author used only folk remedies: localization, bed, water extract from medical plants with arrowwood and raspberries and without any antipyretics (as the increased body temperature helps to withstand virus attacks). To night, the temperature increased up to $t_C$ = 38.5 $^oC$ approximately at 22:00. Feeling of "heaviness in head", desire to sleep, thought about this "damned virus" did not leave. It is expedient here to remind that this experience was performed under Covid-19 pandemy, when the general psychological situation itself created atmosphere of an enhanced psychological pressure. Probably, it affected the initial information message to formulate the problem [12,13]. It is worth to note that all descendant this night was stored in

mind and made it possible to distinctly reproduce. Nevertheless, to understand what was happened, it was necessary to describe these events (to be exact, feelings) in more details, including dreams running all over the night. It should be emphasized that in this case dreams are considered as specific pictures that, first of all, reflect the emotional background of thinking. All these dream details, their geometry, shape – correspond to specific psychophysical processes in subconsiosness. It implies processes that form a final result [12,14].

In what follows, we shall intentionally adduce all the details of this psychophysical play that were stored in mind. As one can see from the following analysis (Chapter 2.3, 3.2), the very dream details ("The devil in dettails") inform us about subconsiousness content through original images (signs). The dream pictures were repeated especially persistently after brief waking up to measure the body temperature (without room lighting, using only the smartphone light). For these studies, it was reasonable to choose the time interval (~10 min) that could be controlled with the smartphone chronometer. The following development of events can be tracked using the journal records.

I woke up at 23:30 and began to measure temperature. I was perceiving a conscious desire for these 10 min to run as quickly as possible. Then, after recording the temperature ($t_C \approx 38.6$ °C), I fell asleep again. In fact, I was falling asleep immediately, and in dream I saw some voluminous spheres, ellipsoid dumbbell-like figures of rotation that were alternatively blown and shrink, at the same time both parts of dumbbells tried to approach each other, but something prevents this motion. In parallel with this approaching-tension, the thought arises in mind almost consciously: why time runs so slowly?

I woke up again approximately at ~01:30 to measure temperature and fix time by the smartphone, waiting the result of temperature measurement, and it seemed that the time to record temperature has already come (*i.e.*, 10 min have past), and I am looking at my chronometer. However, only ~5 min have slowly past. Two looks at the chronometer more, and at last, the 10-min period has past. I fixed the temperature – approximately 38.8 °C. I fell asleep immediately, and again I saw the same dream with me among spheres. In this condition, almost consciously the thought of slowly running time comes to me. And it is interesting, what is the exact way for changing the rate of time? There appears (it is realized) a professional desire to describe this time flow changes from the mathematical viewpoint, *i.e.*, to reflect in some manner the rate of time running. But how it can be made? The feeling comes that my head is blown up like to those spheres! I do not imagine how it could be made, but I am sure to do it, as the solution is close to me. Physisists got accustomed to express rate of all the physical quantiiies via derivates with respect to time, but here we have the time itself.

I woke up, fix the moment ~02:50, began to measure temperature. Again I wanted to make the measurement as quickly as possible. And I feel that time would be stopped, so I look at chronometer repeatedly for 4, 7 and, at last, 10 min. The thermometer indicates $t_C \approx 39.0$ °C. And again I fell asleep, that resembles me a jump from steep and dive to the same dream, where the spheres-dumbbels rotate and approach. However, in addition, there arise some fuzzy signs, formulas, Latin characters… For some reason, the great capital letter "*S*" slows down, which resembles these doubled spheres-dumbbels. At the background of this letter, these spheres become reduced, approached and assimilated in one figure that look so elastic and smooth that causes desire to stroke it. However, this letter *S* twinkled and became more and more clear. Almost consciously, there comes up the thought – what does it mean? In physics, this letter is used to designate the distance, the square… but not; something gives me a hint that usually in thermodynamics this designation is used for entropy.

It becomes easier, I don't know how yet, but already I feel that I will be able to write this "damned" derivative of time with respect to… what? Here, I cannot separate wether I am there in dream with spheres, or already awakened, but the term $\partial t/\partial S$ becomes to twinkle more and more brightly. Stop, and where should I use my suffered temperature $\delta T$? But it is already side by side,

as with increasing the temperature, the rate of changing my psychological time was increased, too! *I.e.*, $\partial t_{ps}/\partial S_{ps} \sim \delta T$. In what follows, it becomes obvious:

$$(\partial t_{ps}/\partial S_{ps}) = D_{ps}\,\delta T. \qquad (1)$$

Here, $t_{ps}$ is the psychological time, $D_{ps}$ – some unknown constant that characterizes the studied system, $S_{ps}$ –entropy; $\delta T$ – normalized body temperature.

That's all! Having sensed and clearly seen this relation, I fell asleep with relief, it seems without any dreams, being calm, without any fear to forget the suffered regularity. After some period, I woke up with "light" head, measure body temperature – $t_C \approx 36.6$ °C, it seemed to be suspiciously low. I measure temperature once more and get the same result. My chronometer indicates 06:40. I begin to analyze, what does it mean? Could it be real or only seems? What relation could take place between the time running rate and entropy? And what entropy should it be? And may be it is not the entropy? It was the morning. Recovery has come, the mind became clear. Temperature increase was not repeated neither in the same day nor in the following days. The high body temperature has done its work: allowed to (in the half-conscious condition) the simple form of an extraordinary important physical regularity indicating the quantitative relation of the time flow changes in a separate (biological) system with the energy (temperature) of this system.

## 3. RESULTS AND DISCUSSION

### 3.1. Consciousness and subconsciousness cooperation a decisive factor for successful solution of the problem

Having analyzed records in the journal of events happened that night, let us try to find out and describe those extremely delicate but so interesting and important basic details of the process concerning human thinking as well as cooperation of consciousness with the level of subconsciousness. We believe that the main process here is cooperation between two forms (phases) of thinking – consciousness and subconsciousness. Just this cooperation of both forms (in parallel) on the problem concerned by an individuum at the moment, essentially enhances abilities of the brain (synergistic effect). This cooperation becomes a decisive factor for successful solution of the problem, which is unattainable under each of these conditions separately. We use both of these categories consciousness and subconsciousness that via our thoughts are related to each other. The human mind is one and indivisible, however, it includes two phases interacting between each other, namely, consciousness and subconsciousness. The latter is the productive phase of mind, while the former – governing. Consciousness chooses what it wants to see in this life but is not be able to create that. Subconsciousness is a tool without which the choice cannot be made; we regularly see and hear some signals from our subconsciousness in the dream state. The only difficulty is to correctly decode the seen things.

This is not a tribute to mysticism, consciousness-subconsciousness is the subject of serious study of a number of sciences; we are forced to be properly awake and awake in a state of sleep. Sleep is a form of communication with subconsciousness. Such an analysis of dreams discloses the secret of human subconsciousness, dreams inform about the processes that develop inside the organism and outside, dreams give the most interesting information to those who try to understand symbols appearing in them [15]. The consciousness condition in its thermodynamical sense corresponds to the definition for "open systems" (human organism is the open system, since it can receive information on the body temperature $t_C$, on time $t_{cl}$ from the chronnometer). Concerning the subconsciousness condition, the situation is more complicated. Indeed, when exchange with ambient by the energy (and information) is inhibited (weakened) temporarily, this system can be considered as the isolated one (or quasi-closed). In our opinion, it is the dream condition that corresponds to this situation.

**3.2. Stages of solving the problem (task) of changes psychological time rate**

Appearance of an idea (setting the problem) about some dependence of individual time duration $\Delta t_{ps}$ for the chosen in the experiment time period $\Delta t_{cl} \approx 10$ min for temperature measurement was conscious, i. e., when observing the chronometer and thermometer readings. While solution of this task was realized in fact at the subconscious level. Consciousness formulates the task, controls the process of its solution and mobilizes subconsciousness to do it [14]. In its turn, subconsciousness "digs into depth" but all the time needs informational confirmation (support) to: i) not "turn to another way", and ii) be all this time "in contact" to transfer information to consciousness in a real time scale.

Let us follow these stages in more details. The revealed in the consciousness stage fact of deceleration of individual time was apprehended rather emotionally, so emotionally that it penetrated into the dream condition (*i. e.*, into subconsciousness). It may be interpreted as setting the task for subconsciousness. It was confirmed by appearance of dreams (see section 2.3:…*spheres, ellipsoids, dumbbell-like figures of rotation*…). However, this moment is very far from solution of the task yet. Generally speaking, it would be finish of this play. But attention! There is temporal re-switching into the consciousness stage (~01:30). As a result, another portion of information and a new emotional pulse are added. At the same time, the task is specified (…*what is the exact way for changing the rate of time?*…). In parallel, the reqirement to solve it is specified, too (…*to describe this change from a mathematical viewpoint*…), and motivation is enhanced (… *I am sure to do it, as the solution is close to me!*). Exactness of this delivery address is confirmed by continuation of the same dream.

It is important to emphasize the observed multiplicity (repetition and accumulation) of moments corresponding to formation of the same information and emotional requests that, in fact, appeared randomly but undoubtedly promoted successful solution of the task. The smooth transition between consciousness and subconsciousness stages (instant, without any dissipation of ehergy and growth of entropy) was favoured by quasi-closeness of our system (absence of any light and sound contacts with ambient medium, high body temperature as well as the condition of dream).

Re-switching to the consciousness phase took place again (at ~2:50). The further temperature increase was fixed, which should promote an energetic emhancement of work in the consciousness phase. Deceleration of individual time is perceived clearer, as a result, the same (but more intensive!) information and emotional pulses were sent again to subconsciousness. The dream and its pictures were very similar to the previous ones, but there appeared new important elements (…*arise some formulas… the capital letter "S"… spheres approach to each other…).* It means that there was formation of solution for the set task in some format accessible for the consciousness stage. In this process, both phases of thinking anticipate now practically simultaneosly (…*it is difficult to distinguish wether I am there in my dream, with spheres, or already waken up. But the term ∂t/∂S becomes to twinkle more and more brightly*…). And at this moment, the partially forgotten knowledge about entropy came out very timely. So, the final formula (1) is created in consciousness with not understandible designations yet: $\partial t_{ps}/\partial S_{ps} = D_{ps}\,\delta T$. Here, $\partial t_{ps}/\partial S_{ps}$ is the flow changes rate of psychological time with changing the entropy or changing the body temperature:

$$\delta T = (t_C - t_C^n), \qquad (2)$$

where $t_C$ is the current and $t_C^n$ – usual normal human body temperature (in general, it differs a little from one body to another). Let us take the mean value $t_C^n = 36.6$ °C.

Therefore, the subconsciousness coped with the set task, the quantitative relation between thermodynamic parameters has been obtained (…*spheres become reduced, approached and assimilated in one figure!).*

### 3.3. About terminology concerning "deceleration/acceleration of psychological time"

In what follows, for unambiguous terms, one should make some correction. It is reasonable to speak not about time in general but to deal with specific time intervals. The interval of subjective time as $\Delta t_{ps}$ in the consciousness phase differs from the measured data of chronometer (clock) $\Delta t_{cl}$, *i.*e., $\Delta t_{ps} > \Delta t_{cl}$. Formally, it looks like some delay in chronometer readings relatively to the chosen time interval in consciousness. This difference between $\Delta t_{ps}$ and $\Delta t_{cl}$ shoud be naturally named as individual deceleration/acceleration of the psychological time:

$$\delta t_{ps} = \Delta t_{ps} - \Delta t_{cl}\,. \qquad (3)$$

On the other hand, according to the formula (1):

$$\delta t_{ps} = \boldsymbol{D}_{ps}\,\delta S_{ps}\,\delta T. \qquad (4)$$

Here, $\delta S_{ps}$ is a corresponding change in the psychological entropy. Finally, from (3) and (4) we get:

$$\Delta t_{ps} = \Delta t_{cl} + \boldsymbol{D}_{ps}\,\delta S_{ps}\,\delta T. \qquad (5)$$

### 3.4. The thinking process and psychological entropy: the thermodynamics aspects

Let us consider the formulas (4 and 5) in more details. It is expedient to remined that the individual biological perception is defined by bio-psychological processes that go on in accord with their own laws. But the governing factor in these processes, as it was adopted intuitively (subconsciously) in our observation, can be entropy. Our consciousness cannot immediately perceive such a definition for "*S*", it cannot agree with this offer obtained from subconsciousness (…*How could the rate of time running depend on the entropy?)*. After deeper reflection, this rejection vanishes. Indeed, the brain, like to every molecular system, follows the second law of thermodynamics, where the categories of order and chaoc always play their role. Also, there are definitness and uncertainty, therefore, the entropy can be represented in various forms (thermodynamical, molecular, information) [14,16]. By [17] was proposed the idea of entropy use to the human information system to understand uncertainty-related anxiety. At the same time, in biological objects the entropy has another nature as compared with that used in Boltzmann's formula; in these objects it is not a measure of disorder. Rather it serves as an information memory that really defines the character of further development inherent to this system. This entropy defines possibilities for the system to exist and characterizes not only the momentary state but possible states in the future, [14]. Between the information amount $I_{ps}$ and entropy $S_{ps}$, there is an objective relation: both these quantities are the measure of organization in the studied biological system. By *I. Zeman*, accumulation of information means decelaration of time. In accordance with it, the time concerning information processes slows down; therefore, the rise of organization level in living organisms causes deceleration of its own time [16], *I.e.,* assuming the relation $\delta S_{ps} \sim \delta I_{ps}$, the equality (4) can be written as

$$\delta t_{ps} = \boldsymbol{D}_{ps}^{*} \cdot \delta T \cdot \delta I_{ps} \qquad (4^{*})$$

When analyzing the creative process of solution searching, we emphasized the role of such subconscious images as emotions, instant associations, dream pictures. The thermodynamical analysis of thinking process shows that considering the brain only as a biochemical cell and neurophysiological system, is not enough to explain fundamental properties of consciousness, namely: its capability to set a task, to find a definite solution for it, to create a special symbolics for these solutions, to code corresponding information. When realizing all these functions, the entropy acquires very low values that should be provided by a source of negative entropy to fully order some kinds of thinking products – logic conclusions, single-valued symbolic recording, and so on" [14,16]. As it was noted above, emotions slow down the time and increase the entropy, however, it takes

place in the consciousness phase of thinking. But the process of solving the task is mainly created in the subconsciousness phase: there is also selection of information material as well as its ordering. These processes lead to lowering $\delta S_{ps}$ [18] and, respectively acording (4), to decreasing $\delta t_{ps}$.

Let us consider the physical sense of the introduced parameter psychological entropy «$S_{ps}$». In general, application of the entropy conception to describe psychological processes looks as a most acceptible from the physical viewpoint [14,16,17]. However, it is necessary to remember that through extraordinary complexity of thinking all the components of this process (information, energetic…) cannot be comprised by this physical conception. First of all, it concerns with a high current physical/mental state. One can agree with [11], who introduced the psychophysical distinguishing character «$\underline{S}$» that *qualitatively* characterizes some physical/mental situation and can influence the rate of processes in the brain It is worth to note that such «$\underline{S}$» coincides with our designation of psychological entropy in its notation and, in fact, coordinates with our using «$S_{ps}$» as some *quantitative* mental parameter.

### 3.5. Application a deceleration/acceleration formulas of the psychological time

Let us come out of the frames limiting our "experimental method" that resulted in formulation of the dependences (1) – (4) and consider several examples of their possible application. The importance of these formulas are confirmed by their capability to formulate some quantitative relations between $t_{ps}$ and other system parameters. It is expedient here to remind the expression by *I. Kant*: "In each knowledge, there is so much truth, how much mathematics is".

#### 3.5.1. Why a high body temperature is necessary for appearance of "non-obvious" ideas?

Let us re-write the formula (4) $\delta t_{ps} = D_{ps}\, \delta S_{ps}\, \delta T$, *i.e.,* the change of individual psychological time is pro rata to the change in entropy. It is clearly seen from (4) "why a high body temperature is necessary for appearance of "brain-damaged ideas". If we assume that "hallucination" messages appear in the process of reading deeply hidden subconscious information accompanied by some thermal effect, then the necessity of an additional energy is understandable. The source of this energy (at the neuron level) can be increased of body temperature. Some portion of the negentropy (which lowers the entropy) provides the additional internal energy source, which according to (4) results in the increase of rate $(\partial t_{ps}/\partial S_{ps})$ fixed as a delay of external chronometer (phenomenon of deceleration $\Delta t_{ps}$). So, the amount of information read from the subconsciousness level of the system is a negative additional term to the total entropy: it is the negentropic principle of information transfer. To confirm this thought, it is reasonable to appeal to *E. Schrodinger* who put forward the hypothesis on the constancy of energy inherent to any living organism, explained by the negative entropy that arises due to "highly-organized" substances consumed by the organism. These substances have a low entropy, and being digested to a degraded form (with a high entropy) are removed into the ambient medium [18]. It turns out that arrival of negative entropy is caused not only due to the information flux accompaning the inflow of edible products but in other forms. At the same time, the nature of negative entropy is not clear yet and needs further investigations [10,17].

#### 3.5.2. Acceleration of the psychological time or its deceleration

It is worth to note that the formula (5) implies not only deceleration but acceleration of the psychological time in the system, too, in some definite conditions. Appearance of a negative value for $\delta t_{ps}$ can take place for $\delta T < 0$ (for example, if cooling the body $t_C < 36.6\,^{\circ}$C) or when $\delta S_{ps} < 0$. It follows that $\Delta t_{ps} > \Delta t_{cl}$, *i.*e., the acceleration of $t_{ps}$ is changed by deceleration [8].

#### 3.5.3. Body temperature and the human individual time

Let's consider formula (5) once more under conditions of changing the temperature. If the body temperature is constant and corresponds to the normal one $t_C^{\,n} = 36.6\,^{\circ}$C, then $\delta T \equiv 0$. In this case, accordingly to (3 to 4) $\delta t_{ps} = 0$ and $\Delta t_{ps} = \Delta t_{cl}$;

it means that under the normal body temperature there is no deceleration of human time. In confirmation of this let's appeal to *G. Whitrow* who emphasized "*…it is very probable that the constant body temperature is a decisive factor that relates the human individual time with the universal physical time and protects it from the excess instability*" [19]. This hypothesis was checked up by *M. Hoagland*. In his investigations of "*The chemical basis for our time perception*", he found out that the experiments aimed at estimation of time intervals by human with increased temperature confirmed acceleration of human biochemical chronometer, and the real physical time seems to be decelerated [7].

### 3.5.4. Influence of human psycho-emotional state on its body temperature

It is worth here to remind the known facts about increasing human body temperature $t_C$ in force majeure conditions of considerable emotion (information) loading. Herewith, when the nccessity of intensive energetic expences arises, one can observe a pronounced deceleration of its own time [3,7]. At the same time, according to formula (4), $t_C$ should also increase due to the increase in $\delta t_{ps}$.

### 3.6. Table and Figures

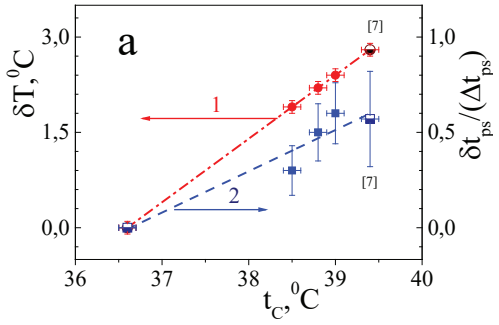
Using the formulas (2 to 4), let's analyze changes in psychophysical parameters with the increase of body temperature (it means our results from the Chapter 2.3 and the literature data [7]. Let's remember that seeming time in brain $\Delta t_{ps}$ = 10 min is the expected time interval chosen for plausible measuring the body temperature; $\Delta t_{cl}$ is the real physical time that corresponds to that seeming time interval; $\delta t_{ps}$ is the change in psychological time with temperature. Having made previous estimation of $\delta t_{ps}$ and $\delta T$ (columns 3 and 6 in Table), we can formally characterize the change in psychological entropy ($D_{ps} \cdot \delta S_{ps}$) with the accuracy up to some constant factor $D_{ps}$.

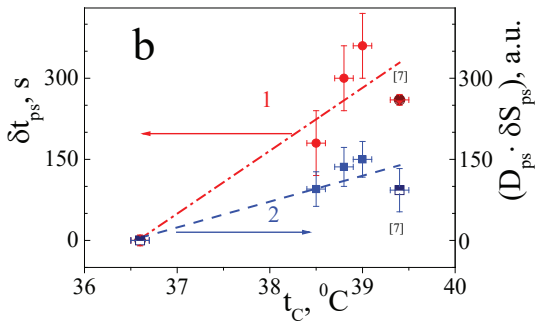
### 3.6.1. Table

The change of psychophysical parameters with the body temperature. Values of $\Delta t_{ps}$, $t_C$, $\Delta t_{cl}$ were taken from the experiment (Section 2.3 and data [7]. Calculation: $\delta T = (t_C - 36.6)$; $\delta t_{ps} = \Delta t_{ps} - \Delta t_{cl}$; $(D_{ps} \cdot \delta S_{ps}) = \delta t_{ps}/\delta T$.

| Parameters | $t_C$, $^0C$ | $\delta T$, $^0C$ | $\Delta t_{cl}$, s | $\delta t_{ps}$, s | $\delta t_{ps}/(\Delta t_{ps})$, a.u. | $D_{ps} \cdot \Delta S_{ps}$, a.u. | Data |
|---|---|---|---|---|---|---|---|
| 1 | 36.6±0.1 | 0±0.1 | 600±60 | 0±0.1 | 0 | 0 | 2.3 |
| 2 | 38.5±0.1 | 1.9±0.1 | 420±60 | 180±60 | 0.3±0.13 | 95±32 | 2.3 |
| 3 | 38.8±0.1 | 2.2±0.1 | 300±60 | 300±60 | 0.5±0.15 | 137±36 | 2.3 |
| 4 | 39.0±0.1 | 2.4±0.1 | 240±60 | 360±60 | 0.6±0.16 | 150±33 | 2.3 |
| 5 | 36.6±0.1 | 0±0.1 | 60±10 | 0 | 0 | 0 | [7] |
| 6 | 39.4±0.1 | 2.8±0.1 | 34±10 | 26±10 | 0.57±0.25 | 93±40 | [7] |

The results of these estimations are adduced in Figures *a* and *b*.



**3.6.2. Figure.** Dependences of psychophysical parameters on the body temperature. Figure a): $\delta T$ is curve 1; $\delta t_{ps}/(\Delta t_{ps})$ is curve 2. Figure b): $\delta t_{ps}$ is curve 1; $(D_{ps}\cdot\Delta S_{ps})$ is curve 2. Points are calculated from the experiment, lines is linear approximation. Our results from Section 2.3 and data (x 10) [7].

As can be seen in Table and Figures, not only $\delta t_{ps}$ but the product $(D_{ps}\cdot\delta S_{ps})$ increases with increasing the temperature, *i.* e., the entropy is expectedly increases, too.

### 3.7. Discussion

#### 3.7.1. Can the experience of the first person be convincing (determinative)?

Being joined to the discussion "…*whether the experience of the first person, independently of data obtained from the third person, be a sufficient basis for the theory of consciousness?",* which is profoundly considered in the brand new work [20]. Being based on our own experience, we can assume "*yes, it is".* However, it exists only when a honest-minded analysis of the original results concerning a subjective experience performed based on true scientific conceptions, which, in fact, belongs to the *third persons*. So, it taking place the increase the scientific level of results from the *first person*. Then the results of such analysis performed by researchers, including a *first person* as well, get the right to be considered "*the data from the third person*", which are lacking. Also, it is strengthed when the pure experience is accompanied not only by qualitative reports but specific quantitative measurements too.

#### 3.7.2. About the "two times problem" regarding the veridical and illusory nature of time [5]

Our analysis on the physical nature of quantitative dependence the psychological time changes allows to assume that there really is "*only one physical time*" in the mind, which is adapted in the brain in accordance with the current human physical/mental state. And the main biophysical force (motivation) of this specific adaptation can be precisely the "psychological entropy" as a certain quantitative characteristic that the *"two times problem*" formally may been reconcilesed. "*Feynman might agree that physics successfully crossed the bridge into the cranium*" [5].

## 4. CONCLUSION

Being based on the analysis of personal experience concerning perception of the specific time periods (~10 min), that took place under conditions of high body temperature ($t_C$ > 38 °C), the quantitative dependence of the psychological time changes on temperature $\delta t_{ps}(t_C)$: $(\partial t_{ps}/\partial S_{ps}) = D_{ps}\cdot\delta T$ was found (factor $D_{ps}$ is some constant inherent to every specific system; $S_{ps}$ is "psychological entropy", the parameter characterizing current psychophysical condition of the system, $\delta T$ is temperature). A new interpretation of the term "entropy" in the sense of "psychological entropy" as a parameter characterizing the human physical/mental state was introduced. It opens the possibility to apply quantitative (physical) methods to the biophysical problems.

The physical conditions that contributed to the optimal inclusion of subconscious thinking to solve the task to mathematically describe the rate of changes in the subjective psychological time were analyzed. It was shown that controlled cooperation of consciousness and subconsciousness considerably enhances functional capabilities of the brain (synergetic effect) being a decisive factor for successful solution of the problem, which is unattainable in any of these phases separately. Optimal physical conditions for drawing the subconscious thinking phase to solve important task arising in conditions of high emotional (physical) loading were found.

The possible application of the formulas obtained for analyzing the changes of psychophysical parameters with temperature and entropy was suggested for explaination of:

(i) the possibility for not only deceleration but acceleration of the psychological time in the system, too ($\delta S_{ps} < 0$ and $\delta t_{ps} < 0$);

(ii) the necessity of high body temperature for appearance of "unobvious" (subconscious) ideas;

(iii) increasing human body temperature in force majeure conditions of considerable emotion (information) loading.

Using the calculations performed, the graphical temperature dependences $\delta T(t_C)$, $\delta t_{ps}(t_C)$, $\delta S_{ps}(t_C)$ that confirmed the expected growth of these parameters were plotted.

It is noteworthy that, to perform more accurate calculaions of $t_{ps}$, it is necessary to apply the method for more adequate estimation of $\delta S_{ps}$ or $\delta I_{ps}$. As a matter of fact, our work has additional aim to attract resarchers' attention to quantitative study for the dependences of separate human psychophysical characteristics both with each other and with suitable for measuring physical parameters (temperature, time, potential, frequency, intensity, … frequencies of heartbeats, breathing, muscular tonus, diameter of vessels, *etc*). We guess that further investigations will enable to deepen understanding of the thinking process, in general, and acceleration/deceleration of psychological time, in particular.

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## 7. SUMMARY FOR THE NON-SPECIALIST (LAYMAN)

The study of human perception of time has a lack of mathematical dependencies that could describe quantitatively such phenomena. The author suggested the quantitative dependence of changes in psychological time on temperature in a particular biosystem and introduced a new interpretation of the term "entropy" in the sense of "psychological entropy" as a parameter characterizing the current physical/mental state. It opens the possibility to apply quantitative (physical) methods to the biophysical problems. The article substantiates the influence of the synergy of two modes of thinking: Conscious and Subconscious on the strengthening of the brain functional capacity and clarifies the conditions for effective involvement of the subconscious mode. Just the original nature of the research and a completely new result for quantitative characteristics of such a delicate object as consciousness are of great interest to researchers and contribute to deepening understanding of the thinking process in general and further involvement of physical methods. A major international journals in Philosophy, Psychology, and Neuroscience invite interdisciplinary research, including physical and biophysical ones. The paper fully consistent with this area. If we want to understand our consciousness, we must not be afraid to break new ground; just such new way gave new result.

## 8. LIST OF DESIGNATIONS

$t_{ps}$ is psychological (human) time
$\delta t_{ps}$ is deceleration/acceleration of the psychological time
$\delta T$ is normalized body temperature $\delta T=(t_C - t_C^n)$
$t_C$ is the current human body temperature
$t_C^n$ is the usual normal human body temperature
$S_{ps}$ is psychological entropy characterizing human psycho-emotional state
$\delta S_{ps}$ is changing of psychological entropy
$D_{ps}$ is some unknown constant that characterizes the studied system
$\Delta t_{ps}$ is the interval of subjective time as perception
$\Delta t_{cl}$ is interval measured data of chronometer (clock)

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# ON THE PHYSICAL NATURE OF SUBJECTIVE PSYCHOLOGICAL TIME

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**Summary**

A simple temperature dependence of rate changing a psychological time $t_{ps}(t_C)$ in human was suggested: $(\partial t_{ps}/\partial S_{ps})=D_{ps}\cdot\delta T$, where $D_{ps}$ is some constant, $S_{ps}$ is the psychological entropy, characterizing current human physical/mental state; $\delta T$ is the normalized body temperature $\delta T=(t_C - t_C^n)$, $t_C$ – the now temperature and $t_C^n$ – the usual normal human body temperature. This dependence as an empirical result of personal experience in “perception” of time intervals (~10 min) at high body temperature ($t_C \geq 38{,}2^0$C) was ascertained. It has been shown the determining factor to successfully finding the task of quantitatively estimating a duration and changing rate of the psychological time there is cooperation of two thinking components – consciousness and subconsciousness. The optimal physical conditions for involving the subconscious results in significant strengthening of the brain capacity (synergy effect) were found out. These are situations when the exchange of energy and information from the outside is temporarily essentially weakened, and the human can be considered as isolated; a rise in body temperature and sleep corresponds to this. The possible application of the formulas obtained for analyzing the changes of psychological time with temperature and entropy was suggested. In particular, the conditions for not only "slowing down" but also "acceleration" of psychological time were emphasized. Also, it has been explained why an emergence of "non-obvious" (subconscious) ideas needs for high temperature. Using on the calculations performed the graphical temperature dependences $\delta T$, $\delta t_{ps}$ $(D_{ps}\cdot\Delta S_{ps})$ were plotted, that confirmed the expected growth of these parameters.

**Keywords:** time perception, psychological time, psychological entropy, subconsciousness

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# ПРО ФІЗИЧНУ ПРИРОДУ СУБ'ЄКТИВНОГО ПСИХОЛОГІЧНОГО ЧАСУ

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**Реферат**

Запропоновано просту залежність зміни психологічного часу з температурою $\delta t_{ps}(t_{ps})$: $(\partial t_{ps}/\partial S_{ps})=D_{ps}\cdot T$ ($D_{ps}$ – Const, $S_{ps}$ – ентропія, параметр, що характеризує фізично-психічний (або: фізично-емоційний) стан людини; $T=(t_C - t_C^n)$, $t_C^n$ – нормальна температура тіла). Цю залежність встановлено на основі аналізу особистого досвіду (experience) сприйняття конкретних проміжків часу (~10 хв), які проявилися за умови високої ($t_C \geq 38{,}2^0$C) температури тіла. Показано, що співпраця паралельно двох фаз мислення – Свідомої й Підсвідомої, значно посилює функціональні можливості мозку (ефект синергії) і є визначальним чинником успішного розв'язання проблеми, недосяжного в кожній фазі окремо. З'ясовано оптимальні фізичні умови залучення підсвідомої фази мислення для розв'язку важливих завдань, що виникають в умовах високого емоційного (фізичного) навантаження. По-перше, це ситуації, коли тимчасово суттєво призупинено (послаблено) зовнішній обмін енергією й інформацією, а систему (людський організм) можна характеризувати як ізольовану; вважаємо, що стан сну відповідає такій ситуації. По-друге, це потреба додаткового допливу енергії до мозку; таким внутрішнім джерелом (на нейроннім рівні) може бути підвищення температури тіла. Розглянуто можливе застосування отриманих формул для аналізу температурних змін психофізичних параметрів; побудовано графічні залежності $T(t_C)$, $\delta t_{ps}(t_C)$, $(D_{ps}\cdot\Delta S_{ps})(t_C)$, які підтвердили очікуване зростання цих параметрів. Обговорено умови (обставини), за яких можливе не тільки «сповільнення», а й «прискорення» психологічного часу в системі, тобто $\Delta S_{ps}<0$ або $T<0$. Пояснено, зокрема, важливість (потребу) високої температури для появи «неочевидних» (підсвідомих) ідей.

**Ключові слова:** сприйняття часу; психологічний час; ентропія; підсвідомість.