

DECELERATION OF ELECTRON VELOCITY BASED ON THE WAVE-PARTICLE DUALITY LEADS TO RELATIVE TIME ACCELERATION: HYPOTHESIS OF INCREASED BIOPHYSICAL REACTION VELOCITY

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The high speed of biological processes such as photosynthesis, enzymatic reactions or neuronal activity cannot completely be explained on the basis of classic physical approaches. Different quantum biology effects such as tunnelling have been postulated. We hypothetically admit that deceleration of electron velocity based on light-particle duality of electrons leads to time acceleration. Deceleration from the status of light towards a status of a particle may therefore speed up biochemical or biophysical reactions in the atomic or molecular dimension. Electrophysiological and biological phenomena are discussed on the basis of the hypothesis. *Acta Medica Medianae* 2013;52(1):43-47.

Key words: time acceleration, biological relativity, atomic space, macroworld, Lorentz factor

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Introduction

During the last decades, mankind learnt much about the molecular secrets of life such as photosynthesis, metabolism and enzymes, energy transfer or nervous system function. However, some biological phenomena, especially concerning the speed of biological processes, can be hardly explained by means of pure mechanical (classical) physical considerations (1-7). In a previous paper, different examples such as photosynthesis and bamboo growing, biochemical evolution, neuronal processes, physiology of smelling or pharmacodynamics of inhalation anaesthetics have been mentioned and discussed (8,9).

The present paper proposes a more different new approach to explain relativistic phenomena in biophysical and biochemical processes. The basic assumption is that apparent relative time acceleration occurs if the probability of matter being a particle, in contrast of having the status of light, increases dramatically according to the Lorentz relation.

Theoretical aspects

According to Einstein's theory (which is not a theory but a fact) high speed is associated with time dilation (10). The well-known corresponding formula (11) is given as follows:

$$\Delta T_{app} = \Delta T_0 / \sqrt{1 - v^2 / c^2} \dots 1$$

where ΔT_0 denotes the (proper) local time interval and ΔT_{app} the time interval in a moving system. v and c are speeds of an object and light, respectively. The ratio $1/\sqrt{1 - v^2/c^2}$ is also called the Lorentz factor γ (H. A. Lorentz, 1853-1927) and allowed Sir J. Larmor (1875-1942) already in 1897 to predict time dilation in moving objects. High speed, i.e. more than 10 % of speed of light can cause relevant time dilation, 50 % even marked dilation as one day in a space ship corresponds to 1.15 days for an observer on earth. On the other hand, this implies that high speed processes which are slowed down apparently accelerate due to relative time compression.

Since de Broglie (L.-V. de Broglie, 1892-1987) inaugurated matter waves in 1925 (12), we know that every particle has an inborn wavelength Λ which is given as follows:

$$\Lambda = h / p \dots 2$$

where h denotes the Planck constant and p the relativistic impulse (momentum). The latter is given by the following equation:

$$p = M_0 * v / \sqrt{1 - v^2 / c^2} \dots 3$$

M_0 corresponds to the mass at rest, v stands for the particle's velocity and c the speed of light in vacuum. So far, we have accepted that in quantum mechanics a moving object can have both properties of a wave and a particle, i. e. the so-called wave-particle duality.

Now we come back to the equation of relativistic time dilation or compression, depending on the view of the observer. For this purpose, gravitational effects on time structure should not be of relevance in the atomic dimension. We admit that an electron has a certain probability to exist as particle and certain probability to exist as wave. Note that this probability is not identical to the probability of the electron of being at a position x (which is given by the squared wave function). We denote the probability of being a wave as P_w and the probability of being a particle as P_p . As consequence, we agree that $P_p + P_w = 1$. We then can compose the relativistic velocity v of a particle of two components: $V = V_w + V_p$, that depends on the current state. We admit that the V_w of a particle is almost the speed of light c ($3 \cdot 10^8$ m/s) – it does have the nature of a wave indeed – and V_p less, respectively. For an electron in an atomic orbit it may be up to $2.3 \cdot 10^6$ m/s (13). The total velocity V of the electron is then – in the end – depending on the probability of the particle being a wave or not:

$$V = P_w * c + P_p * V_p .$$

We now may insert this relation into the basic equation of time dilation, with respect that the proper time of the observer refers to the moving electron and the apparent time to stationary system – when the electron is involved in a biophysical or biochemical process – and we then get:

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (P_w * c + P_p * V_p)^2 / c^2} \quad 4$$

or

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (P_w^2 * c^2 + 2 * c * V_p * P_w * P_p + P_p^2 * V_p^2) / c^2} \quad \dots 5$$

We see that change of time characteristics depends very much on the probability of existing as a wave P_w . We admit, to demonstrate this effect, that $P_w = P_p = 0.5$. Then we should get:

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (0.5 * c + 0.5 * V_p)^2 / c^2} \quad \dots 6$$

If we further admit that the particle moves with approximately $2 \cdot 10^6$ m/s and the speed of light is about $3 \cdot 10^8$ m/s, we may insert the rough values and obtain

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (1.5 * 10^8 + 1 * 10^6)^2 / 9 * 10^{16}} \quad \dots 7$$

and, as the second factor within the brackets is a quantité négligable

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (1.5 * 10^8)^2 / 9 * 10^{16}} \quad \dots 8$$

that is

$$\Delta T_o = \Delta T_o / \sqrt{1 - 2.25 * 10^{16} / 9 * 10^{16}} \quad \dots 9$$

or

$$\Delta T_o = \Delta T_{app} / \sqrt{1 - (0.25)} = \Delta T_o / \sqrt{0.75} \approx \Delta T_o / 0.56 \quad \dots 10$$

and therefore

$$2 * \Delta T_{app} \approx \Delta T_o$$

The theoretical time compression (or acceleration) factor is in this special case about 2, i. e. biochemical or biophysical reactions in the atomic dimension may proceed with double velocity compared to macroworld.

Experimental evidence for accelerated processes in cat visual neurons

Apart from the experimental findings mentioned in the introduction section, between 1990 and 1994, several electrophysiological studies have been performed in cat visual cortex with regard to motion detection (2,7). In addition to the study of the mechanisms underlying motion detection, they gave first evidence that reaction acceleration due to time compression could play a substantial role in the brain. The experimental method was thoroughly delineated in the citations. In brief, cats got a standardized anaesthesia, were positioned in a stereotactic apparatus and craniotomized above visual areas 17, 18 and 19. Stainless steel multi-element – i. e. comb-like – microelectrodes with a distance between electrodes of approximately 1.2 mm were step by step advanced into visual cortex using a hydraulic microdrive. Spike trains were amplified, assessed audiovisually for quality and stored as PSTHs (Peri-stimulus-time-histograms) on a personal computer. Visual neurons were stimulated – correlated with signal recording – using light bars flashed on-off or moved forward and backward (32 to 64 stimulus presentations) with different velocities, orientation or direction on a screen 1m in front of the animal. The borders of receptive fields were determined on the screen using the minimum response field method with a frond and then marked on the screen. Latencies (L) of visual neurons following stimulation with moving light bars were defined based on psth by an investigator. Generally, the psth amplitude (spikes per bin) should have reached half-peak response (Figure 1). Bin width of psth for determination of latencies was reduced down to 10 ms per bin.

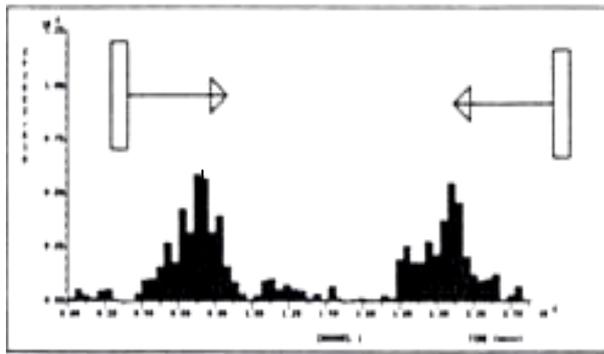


Figure 1. Original recording of a visual neuron stimulated with a light bar moved forward and backward (velocity: 24 degr/sec, overall stimulus time 2500 ms). The latency was determined at 550 ms.

In Figure 2 the distribution of latency differences ($\Delta L = L_{psth} - L_{theor}$) with regard to minimum response fields of 196 visual neurons are depicted. The spike trains were taken from Koch (2). Clearly, at least 10% of the neurons revealed negative differences, which stand for an advanced onset of firing – measured as onset of cell firing in the psth - compared to theoretical latency (L_{theor}). The latter is defined physically by means of receptive field position on the screen

and stimulus velocity. This corresponds to an accelerated response with regard to an external stimulus. As L_{psth} is shorter than L_{theor} , the apparent velocity of moving bars on the cortical surface ($V_{app} = \Delta X_{cort} / \Delta L_{psth}$; ΔX_{cort} distance on the cortex) must be faster than the given velocity of the external stimulus.

In Figure 3a, latencies of another 49 visual cells were stimulated with different bar velocities. As expected, the latencies (L_{psth}) decreases smoothly as the velocity of the stimulating light bars increased. Now, if the L_{psth} -values were referred to the lowest velocity of the applied bars, namely 10 deg/sec, the normalized ratios of latencies should exceed the value of 1 ($L_{20} * 2 / L_{10} >= 1$, $L_{30} * 3 / L_{10} >= 1$, etc.). However, if this ratio is smaller than 1, the visual cell fires relatively earlier after stimulation with faster bars (20-40 deg/sec) compared to stimulation with 10 deg/sec. In other words, the relative latency decreases with increasing bar velocity. This result is in keeping with the previous findings that the apparent velocity on the cortex exceeds the velocity of the stimulating bar. In conclusion, both experiments support the view that brain processes may run faster in the cortical network than an external observer would have expected.

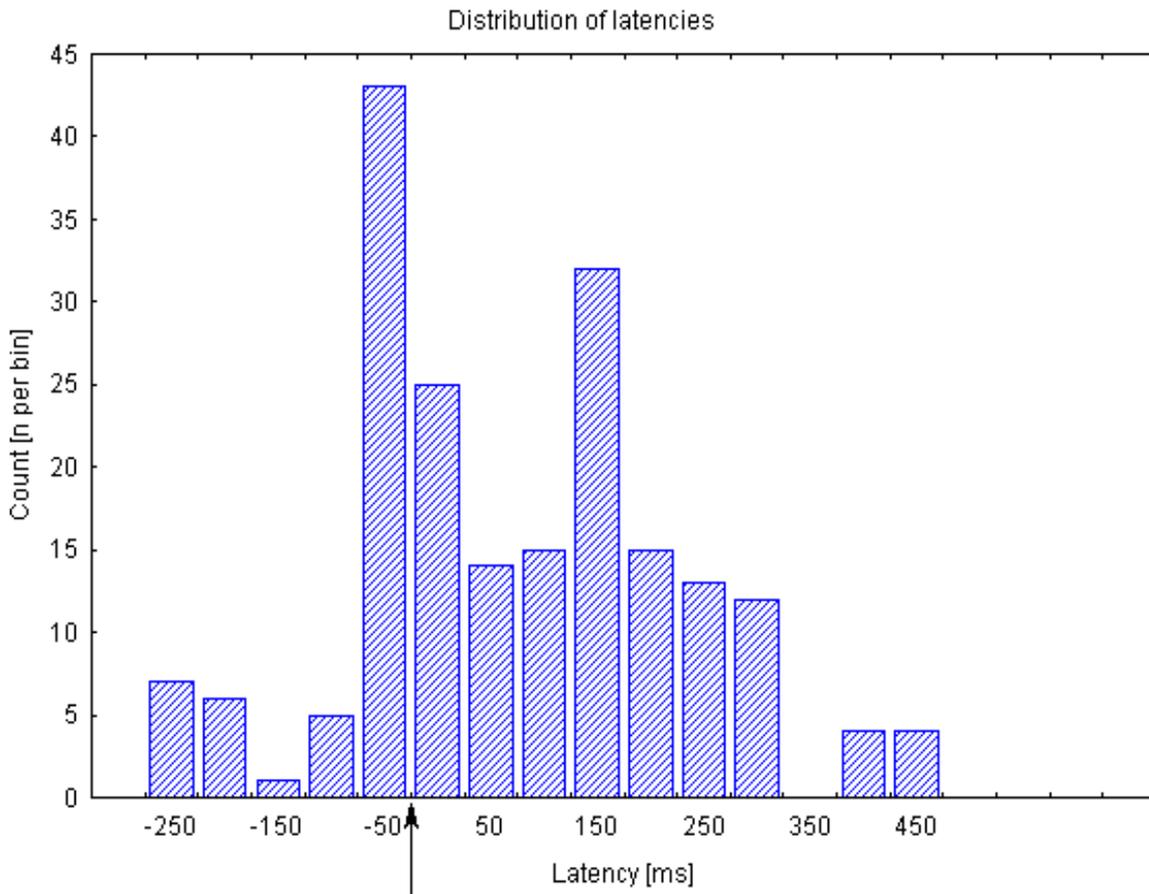


Figure 2: Latency differences with regard to minimum response fields of 196 area 17/18 neurons following stimulation with moving light bars. About 10 % of the neurons fire more than 50 ms before expected latency.

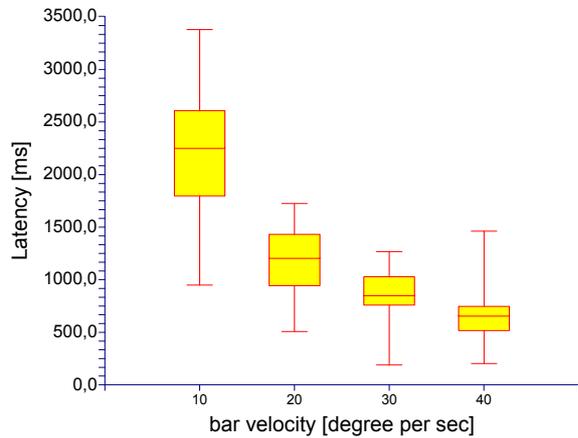


Figure 3a: Latencies of 49 visual neurons as a function of bar velocity.

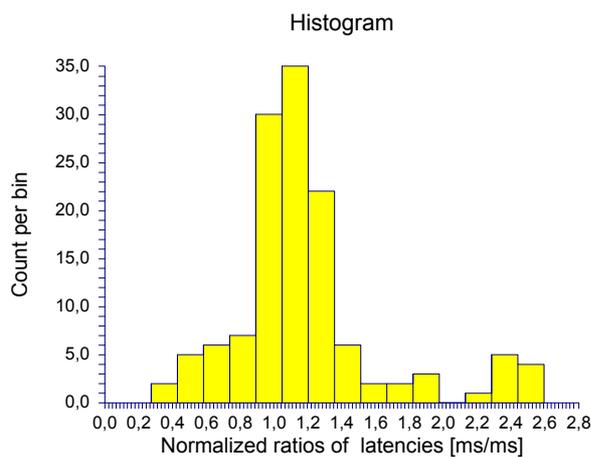


Figure 3b: Normalized latency ratios referred to a stimulating light bar moving with 10 deg/sec. 20 ratios were lower than 0.8, which speaks in favour of accelerated onset of latencies.

Interpretation and biophysical relevance

What does that mean with regard to apparent time acceleration? $\Delta T_o / \Delta T_{app}$ is - for the à priori conditions admitted roughly 2 or the "proper time" is about double the length of the "compressed time", provided the probability of both states - wave or particle - is 50 %. The apparent velocity of a process, given as $\Delta V_{app} = \Delta S / \Delta T_{app}$, S being the substrate, - or as analogously in our example $\Delta V_{app} = \Delta X / \Delta T_{app}$, speeds up twice, if time is accelerated or compressed. The maximum deceleration potential is roughly form $3 \cdot 10^8$ m/sec - speed of light - to approximately $2 \cdot 10^6$ m/sec, which even may increase the apparent time acceleration or reaction velocity even much more. In a recent paper Hagura et al. (14) found that subjective passage of time is slowed down, if an action is prepared, a phenomenon which is also reported if humans experience an event very intensively. If, on the one hand, brain is able to provide such a subject experience of slow motion, i. e. a process is perceived clearer and in more detail, the central nervous system on the other hand must be able to process the underlying neuronal information much faster.

The basic result and interpretation is that apparent velocity of any process in the atomic or molecular dimension is faster than the real (proper) velocity we expect hence: $\Delta S / \Delta T_{app} \geq \Delta S / \Delta T_o$. That is, chemical or biochemical reactions, signal transduction processes happen much faster than expected for a macroworld observer compared to an atomic world observer. In conclusion, the duality between light and particle properties of electrons could lead to a "relativity gap of time" in the atomic dimension.

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USPORAVANJE BRZINE ELEKTRONA KOJE JE ZASNOVANO NA DUALITETU ČESTICA TALASA DOVODI DO UBRZAVANJA RELATIVNOG VREMENA: HIPOTEZA POVEĆANJA BRZINE BIOFIZIČKE REAKCIJE

Horst Koch

Velika brzina bioloških procesa poput fotosinteze, enzimskih reakcija ili neuronskih dejstava ne može se u potpunosti objasniti na osnovu klasičnih fizičkih pristupa.

Potrebni su različiti biološki efekti poput tuneliranja. Naša pretpostavka je da usporavanje brzine elektrona, zasnovano na dualitetu elektrona lakih čestica, dovodi do vremenskog ubrzanja. Usporavanje od lakog stanja do stanja čestice može, dakle, ubrzati biohemijske ili biofizičke reakcije u atomskoj ili molekularnoj dimenziji. Na osnovu ove hipoteze, razmatraju se elektrofiziološke i biološke pojave. *Acta Medica Medianae* 2013;52(1):43-47.

Ključne reči: vremensko ubrzanje, biološka relativnost, atomski prostor, makrosvet, Lorencov faktor