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Human Enhancement Projects: Challenges, Opportunities and Implications on Space Exploration

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Abstract

Einstein special relativity suggests that no signal can cause an effect outside the source light cone, and nothing can move faster than light through a vacuum. Brain operations are traditionally expected to be unable to reach the speed of light. Based on a rough calculation, it had been estimated that velocity of neural integration in the cortical paths in human brain may be close to the speed of light, which is an extreme overestimation and highly non-feasible. However, there is strong evidence from clinical trials and experimental studies suggesting that the velocity of information exchange within the brain can be enhanced considerably through the genetic modifications and pharmacological drugs, or by non-pharmacologic measures, e.g. transcranial helmets, nanodevices, and gadgets. Building on the recent empirical evidence across scientific disciplines, the theoretical paper formulates and discusses the possible implications that human enhancement may have for

- **Definition of human observer in biological physics,**
- **Understanding human perceptual abilities and their biological limits including the velocity of neural information transfer, and**
- **General relativity and quantum physic.**

A scenario-based method was used to illustrate the implications that human enhancement may potentially have for magnetoreception and the possibility of selective electromagnetic enhancement in humans. Furthermore, a potential of future human enhancements project for the understanding of human cognitive capacity including a priori and a posteriori reasoning is discussed. These theoretical discussions will have implications in future space explorations.

Keywords: Human enhancement; Human observer; Biological physics; Quantum physics; Information processing

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Introduction

Recent fundamental discoveries in human enhancement projects call for an in-depth exploration of their impact for contemporary science. The potential of upcoming exponential discoveries in this area and also future development of related technologies will inevitably influence some basic definitions in biological physics, Special Gravity Theory (SRT), General Relativity Theory (GRT) and quantum physics, and also in sciences about man. The distinguishing between ordinary and enhanced human observers (HOs) which have done Selective Cognitive Enhancement (SCE), Selective Electromagnetic Enhancement (SEE), Selective Sensory Enhancement (SSE) operations, or have taken pharmacologic or non-pharmacologic enhancement, is one of the most exciting incentives that calls for new re-definitions of past scientific concepts.

Recent advances indicate that the selective sensory, cognitive and electromagnetic enhancement of HOs by a technological solution can be expected in future. The recent discoveries have both explicit and implicit implications for SRT, GRT, and quantum physics and also in sciences about man. In this situation, we have all good reasons to update our understanding of terms like HOs, and enhanced HOs.

Building on recent empirical research findings across scientific disciplines, the main aim of the present study is to formulate the implications for the debate about definition of HO within the framework of recent theoretical biological physics involving understanding of constructive-perceptual. ability of HOs within the GRT, SRT (mainly Minkowski spacetime) and quantum physics interpretation and design of experiments.

There are also opportunities for biological physics following Human Enhancement Projects (HEPs), some of them are currently practical and some are theoretical at present, but shall be practical in future. These opportunities have explicit and implicit implications for GRT, quantum physics and also in sciences about man. We structured the paper in such way that after showing the challenges faced to some current practices and definitions; theoretical and practical opportunities will be presented as a consequence of HEPs, followed by a brief implication for future.

In doing this job, we will have to use scenarios, examples, thought experiments and asking direct questions from general readership to demonstrate how cognitive, electromagnetic, or visual enhancement projects can dramatically change our current understanding and interpretation of physics in a critically thinking way. Design of any experiment is stemmed from human perception and its interpretation is inevitably and deeply interconnected to our perception and language and our daily understanding from classical concepts of physics. Enhancement projects directly or indirectly will affect the perception and constructive perception.

All those aforementioned concepts, parameters and variables are inextricable and we will have to briefly introduce some basic concepts about perception, language, interpretation bias, and superior pattern processing, because they are different dimensions of same entity, i.e. constructive perception in Section 1. Then, in Section 2 will review briefly definitions of Observer (O), GRT and quantum physics, plus a quick survey on interplay between observation and interpretation and cognitive biases. Section 3 is the main part of the paper which is concerned with theoretic consequence of some HEPs which may challenge the definition of HOs, second law of thermodynamics and negentropy. To the best of our knowledge, this is the first paper to systematically investigate information processing, consciousness, light cone interpretation, second law of thermodynamics and negentropy from a human enhancement perspective. In Section 4, we summarize findings of HEPs challenging not only the standard physics based picture about perception and cognition but also general relativity (based space-time concept) and quantum physics in its recent form. Paper ends with Conclusions. The approach to sensory perception and cognition relying on GRT and quantum theory in its standard form has several problems as we will show below.

Section 1

Understanding of human observer in biological physics

The involvement of observers in physical measurement was a key element in the formation and explication of theories in physics. On a general level of analysis, HO is understood as a kind of living biological system. This system is settled in particular time and space and has also boundaries, e.g. skin, that enable to distinguish observer from its external environment, i.e. "world outside". HO is equipped by various sensory organs that enable to perceive the inputs from its external environment. During the act of observation, stimuli from external environment of an observer are entering the internal environment of an observer where some of them are processed by human cognition. In physical terms, the HO is a person who observes and recognizes directly or indirectly an outcome of measurements, an eigenvalue [1].

For theoretical physics, merely the role of HO at the moment of observation is of special importance. According to standard quantum measurement theory formulated by von Neumann, the state of an object under experimental observation is actualized by the agency of an observer, e.g. a human subject. Observation requires measurement interaction between observer and object. By the act of observation itself, the state of an object jumps into one of the eigenstates, i.e. possible states of the observable.

What the quantum physical correlates of attention and recognition are is not clear. If sensory organ is the seat for quantum measurement(s), recognition could be assigned to what possibly happens in the subsequent sensory processing. If attention is not properly directed, recognition does not happen at all. Attention costs metabolic energy and the well-known 5 ± 2 rule states that only a finite number of mental images recognitions - are possible simultaneously. A rivalry about metabolic energy between potential percepts is suggestive.

One must bear in mind that quantum measurement theory is the black sheep of quantum theory and plagued by a paradox: the non-determinism of state function reduction is in conflict with the determines of unitary time evolution. This has led to numerous interpretations trying to escape this paradox. The problem is analogous to the problem caused by the fact classical physics does not allow free will so that one ends up to physicalism. Therefore, the mainstream theoretical physics cannot provide any coherent scenario for biology and consciousness theory.

Also the notion of observer is far from obvious. Von Neumann raises human observer in special position but leaves it outsider to the physical system. Conscious observer would induce the state function reduction. But what systems can serve as observers? Can any system serve as observer as the observed decoherence justifying for instance thermodynamical description suggests? Should one bring observer a part of physical system? This would require a genuine quantum theory of consciousness.

As is apparent from the above-mentioned, human sensory organs play an essential role in the definition of HO. Thus, the proper understanding of human perception may require a modification of the recent views about quantum measurement theory and even of General Theory Of Relativity (GRT) providing the recent view about space-time time. For instance, GRT does not suggest any idea about the physical correlates for the experienced division of the world to parts interior and exterior to the biological body. Also the decomposition of physical world to well-defined objects might require a modification of the space-time concept.

Because enhancement of human sensory organs may change the quality of percepts available to cognitive processing, a change of definition of HO is inevitable when accepting the perspective of enhanced HO. In the following section, a short outline of impacts of enhancement of human sensory organs is provided.

The potential of enhancement of human sensory organs and cognition: Instrumental and medical enhancements may significantly change the quality (or sensitivity) of human sensory and cognitive capacities. In this section, a selective outline of

impacts that various enhancements may have on human sensory organs and cognition is provided. Several instances of human enhancements are considered, namely SEE, SCE, and SSE, (such as Selective Visual Enhancement or SVE).

Contrary to some animals, that are able to perceive pre-seismic precursors and electromagnetic wavelengths, natural human sensory organs are not able to perceive these kinds of signals. Hypothetical SEE can be preliminary defined as enhancing electromagnetic perception of humans based on necessity in a selective manner to perceive a pre-defined spectrum of electromagnetic signals. Techniques like the transcranial electromagnetic detectors, devices, gadgets, pharmacological drugs or non-pharmacologic measures can be expected to enable HO permanent or temporary capability to perceive electromagnetic wavelengths beyond current human physiologic capacity of human species in future.

Place cells, time cells and grid cells are neural cells that represent time, place and space-time in hippocampus, respectively [2-6]. Soon or later people will be able to alter or qualitatively change their function. In future, there will be great potentials to improve or modify different sensory modalities in selective and specific manners. This type of SSE project may include selective visual or acoustic enhancement. Synesthesia is a neurological condition in which stimulation of one sensory or cognitive pathway (for example, hearing) leads to automatic, involuntary experiences in a second sensory or cognitive pathway (such as vision) [7]. It is an example of abnormality that may inspire a future development of a technology that can be used for sensory enhancement in future.

Very recently, Palczewska and colleagues conducted a novel study and showed that human infrared vision is triggered by two-photon chromophore isomerization [8]. Their study, in addition to resolving a long-standing question about the ability of humans to perceive near Infrared Radiation (IR), identified a quantum mechanical model for the energetics of two-photon activation of rhodopsin in human IR vision. Furthermore, results of a recent study demonstrated that mice with ocular injectable photoreceptor-binding upconversion nanoparticles or nanoantennae could not only perceive Night Infrared (NIR) light, but also see NIR light patterns. These nanoparticles anchored on retinal photoreceptors as miniature Night Infrared (NIR) light transducers to create NIR light image vision with negligible side effects. Excitingly, the injected mice were even able to differentiate complex NIR shape patterns. Moreover, the NIR light pattern vision was ambient-daylight compatible and existed in parallel with native daylight vision. Mammals, including humans cannot see light over 700 nm in wavelength [9]. Their study is promising in sense that developing abilities that do not exist naturally, such as miniature nanoscale devices and sensors designed to intimately interface with humans may come true soon.

SCE may be defined as enhancing cognitive states and superior pattern processing capacity and capability of humans based on a pre-defined necessity in a selective manner. Savant syndrome is a neuropsychological condition in which someone with a significant mental disability show an extraordinary cognitive ability, e.g. rapid calculation, artistic ability, or map making [10,11]. Besides, in ordinary observers, sensory organs, brains, genomes and all other pattern-encoding structures that underlie learning are finite. The sense of vision is constructed from a limited number of cone and rod cells; the sense of hearing uses information from a limited number of hair cells, each of which responds to a narrow band of acoustic frequencies; brains contain a limited number of connections; genomes a countable number of bases, etc [12]. There is a hypothetical opportunity to develop pharmacological drugs with selective and defined pattern of action, with a short half-life in future for some SCE and SSE purposes either by will and/or by choice, which may enable HOs to neurologically and cognitively function in an extraordinary manner.

Finally, superior pattern processing is the essence of the evolved human brain and can be considered as the fundamental basis of most, if not all, unique features of the human brain including intelligence, language, imagination, and invention. Superior pattern processing involves the electrochemical, neuronal network-based, encoding, integration, and transfer to other individuals of

perceived or mentally-fabricated patterns [13]. Our brain has evolved to construct patterns (real or fake), seeks expected patterns; and on the contrary may lose some real patterns while they do really exist; merely because we (as observers or researchers) did not expect to find or see such patterns due to our imperfect perception, conception, and lack of prior knowledge or expectations. Thus, some real patterns and results may lost, which in turn may lead to false positive or false negative results both in physics as well as other disciples of science as a general rule [14,15].

Thus, it will be quite helpful if by means of some HEPs, pattern processing capabilities (qualitative facet) and information processing capacity (quantitative facet) of HOs and researchers could be improved [16-19]. Hence, there is a generic implication for HEPs in all disciplines of sciences including the physics (**FIG. 1)**.

FIG. 1. **The classic dalmatian dog photograph (by R. C. James) is initially difficult to See because interpolation is mostly absent, and the shape must be cognitively inferred (or "abstracted") from a few local elements (Keane 2018).**

Spacetime intervals, light cone and consciousness: There are three basic types of spacetime intervals (light-like, time-like, space-like) that are defined by the light cone, which interact to create spacetime and its properties . According to Sieb, human conscious experience is a four-dimensional spacetime continuum created through the processing of spacetime intervals by the brain; spacetime intervals are the source of conscious experience (observed physical reality) [20].

One can criticize the view of Sieb for identifying experienced (subjective) time with the time of physicists, which is purely geometric notion. These times are very different and only the correlation between these two times justifies their identification. In quantum theories of consciousness, it would be natural to assign the subjective time to sequence of quantum jumps if they are identified as building bricks of conscious experience.

Concepts of spacetime intervals and their relation to light cone and consciousness have been extensively discussed by Sieb before which we reproduce verbatim [20].

'In three-dimensional space, the separation between two objects is measured by the distance between them (the distance is purely spatial and always positive). In spacetime, the separation between two events is measured by the invariant spacetime interval between the events, which takes into account not only their spatial separation, but their temporal separation as well. Spacetime interval may be formulated as follows: the spacetime interval "s" is equal to the difference between the space coordinates "Δr" of two events minus the difference between the time coordinates "$c\Delta t$" of the two events (in practice the square is utilized as the sign

of the spacetime interval “s” is indefinite-positive, negative, or zero; “r” is a displacement vector):

spacetime interval=

$S2=\Delta r2-c2\Delta t2$ or $s2=\Delta r2-\Delta t2$, if c=1.

There are three types of space-time interval, namely "Light-Like Spacetime Intervals" which may help determine the nature of conscious events by carrying the defining information about the events to the eyes, "Time-Like Spacetime Intervals", which could account for the observation (experience) of conscious events at the same spatial positions, but at different times (this can occur only with time-like separation of the events), and "Space-Like Spacetime Intervals", that could account for the observation (experience) of conscious events simultaneously, but at different spatial positions (this can occur only with space-like separation of the events) [20].

Regarding Time-Like Spacetime Intervals, which is the topic of our discussion, If the difference in the time coordinates of two events is greater than the difference in the space coordinates of the events ($\Delta t2>\Delta r2$), the events fall inside a light cone (A and B in **FIG. 2**) and the separation is called a time-like spacetime interval. There is a reference frame where two events with time-like separation may be observed at the same spatial position, but not at the same time. The events may be observed at the same spatial position, but at different times (the events are separated only by time). Notice that the conscious events separated by time also have cause-effect and past-future relations. Separation in time gives rise to causality and past-future relationships [20].

Because signals and other causal influences cannot travel faster than the speed of light, light cones define the concept of causality (**FIG. 2 and FIG. 3**). For time-like spacetime intervals (inside light cones), there is enough time between the events that signals or information can travel between the events at less than the speed of light. Hence one event can influence or be influenced by the other event, by signals or information that does not need to travel faster than the speed of light. One event could be the cause or effect of the other event. If b causes a, b exists in the past history (in the past light cone) of a (**FIG. 3)**. The past light cone of an event represents the boundary of its causal past and the future light cone the boundary of its causal future. Events with time-like spacetime interval separation may be said to have a past or future relation [21]. For more in depth mathematical calculations, see [22]. **FIG. 2** and **FIG. 3** show the light cone model.

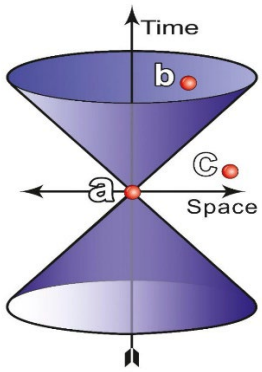

FIG. 2. **A simple light cone model.**

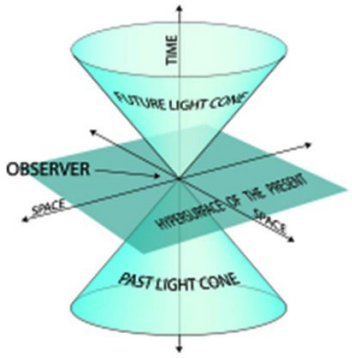

FIG. 3**. Light cone model with further details**.

In Section 1 we presented a useful introduction to some reasons that suggest why and how science in general, as well as biological physics and quantum physics in specific, is interconnected to our constructive perception and conceptual structure as a human observer.

Section 2

In this part, we define some basic concepts borrowed from GRT and quantum physics, plus some opportunities that HEPs may offer to post-modern physics which may change our understanding from physics as well as improving the quality of experimental designs.

GRT

Light cone model and observer issue: In physics, currently, it is commonplace to define past and future by light cone model applying in Special Relativity Theory (SRT) and generalizing to a local concept in GRT. The light cone is constructed as follows. The light cone is constructed as follows. Taking as event past p a flash of light (light pulse) at time t0, all events that can be reached by this pulse from p form the future light cone of p, while those events that can send a light pulse to p form the past light cone of p. Given an event E, the light cone classifies all events in space-time into 5 distinct categories:

- Events on the future light cone of E.
- Events on the past light cone of E.
- Events inside the future light cone of E are those affected by a material particle emitted at E.
- Events inside the past light cone of E are those that can emit a material particle and affect what is happening at E.

All other events are in the (absolute) elsewhere of E and are those that cannot affect or be affected by E. The above classifications hold true in any frame of reference; that is, an event judged to be in the light cone by one observer, will also be judged to be in the same light cone by all other observers, no matter their frame of reference. This is why the concept is so powerful.

This picture relies on the notion of classical point-like particle. A more abstract approach applying in field theories relies on causality of field equations formulated as Lorentz/Poincare invariance. The violation of light-cone causality would mean tachyons [22]. For instance, in Higgs mechanism free Higgs would be tachyon but Higgs mechanism of standard model makes it non-tachyonic.

Observer and possibility to predict an event on the future light cone of E: As there is an interplay between vision, knowledge, perception and conception , it might be conjectured that any visual enhancement in O, will influence either O's knowledge or vision, or perception (but most probably) conception and cognition about light cone interpretation of past and future events and quantum experiments or interpretations [23]. At present, the impact of visual enhancement in HO on their conception about past and future events can be predicted only theoretically. However, past research in experimental psychology brought evidence showing that changes in internal neurocognitive environments of human subjects can influence their predictions of near future events.

In the series of experiments, Armor and Sackett examined how the nature of future events influence the participants´ predictions about their future performance in different tasks [24]. In Study 1, half of participants were informed that they will complete a scavenger hunt task, i.e. finding particular objects at the university campus during 30 minutes, whereas second half of participants were not informed. Thus, the expectations of participants were manipulated in terms of real versus hypothetical future events and this manipulation also causes different changes in internal neurocognitive environments in each half of participants. The participants were asked to “How well will you do on the scavenger hunt?” or “How well would you do, if you were asked to complete the scavenger hunt?”. After that, all the participants completed the scavenger hunt task and their predictions were compared with their real performance in this task. Strikingly, participants who did expect to complete the task predicted their own performance quite accurately. In contrast, participants who believed that the task is only a hypothetical future event showed much higher prediction-performance discrepancy, i.e. they were not able to predict their future performance accurately. These findings were replicated also in Study 2, where another kind of task was used (a completion of test used for Graduate Record Examination).

Despite the authors of this study were quite surprised by obtaining these results and labeled them as "seemingly anomalous findings", this evidence is very inspirative for the present study. If we rephrase this finding in the context of Minkowski spacetime, a change in internal neurocognitive environment of HO was shown to be able to influence the conception about future events. In other words, an event on the past light cone of E caused changes in HO and these changes improved HO´s ability to predict an event on the future light cone of E.

Here one can consider several explanations.

- It is worthy to remind here the relationship between light cones and causal relations. In classical GRT, the causal structure is the structure of light cones of the space-time metric [25,26]. As the matter-energy degrees of freedoms determine the metric through Einstein’s equations, the causal structure of a region of space-time is dynamical: it depends on the state of the matter energy in its past light cone [27]. It is however difficult to understand the observations in this framework.
- Also a general quantal explanation comes in mind. Quantum measurement provides basically answer to a question - that is provides information. Now the participants, who were told about the experiment to be done gained information. This should have involved state function reduction of some kind meaning projection to a new quantum state.
- One can consider also explanation in terms of precognition based on future-to-past communications requiring change of the arrow of time and therefore also violation of standard thermodynamics [28]. Maybe both b) and c) are involved.

Is time quantized in some sense?: It should be reminded that for Minkowski, spacetime is considered as a continuous parameter. While, in the brain, time is discrete because of the existence of quanta of time (i.e., a time granularity that simplifies brain function [29,30]. Quanta of time exist for both motor execution and sensory perception [31]. This creates an opportunity to selectively

enhance time perception using techniques such as gene-editing (or pharmacological drugs) of time cells in the hippocampus.

Of course, the existence of time quanta at the level of perception need not mean discretization of geometric time: this would lead to grave difficulties concerning the understanding of basic symmetries like Poincare invariance. A proper understanding of how conscious experience gives rise to perception of time and space is needed [32]. Also the finiteness and discreteness of cognition is probably related to the apparent quantization of time (**TABLE 1)**.

Can the brain be relativistic in some sense? : As we have discussed elsewhere, there are different bottlenecks, wherein the velocity of brain information exchange can be enhanced. However, the sum of these separate enhancements could never reach the speed of light, even if these synergisms are combined. The brain cannot be relativistic.

New physics involving macroscopic quantum coherence and possibly both arrows of time could however allow even instantaneous integration of neuronal information (**TABLE 2)**.

TABLE 1. **Shows a summary of randomized controlled trails which alter time perception in humans. some pharmacological drugs cause time dilation and some cause time contraction.**

Pharmacological Drug (dose)	**Participant/subjects**	**Main effect**
Dexamphetamine (0.45 mg/kg)	Healthy volunteers	Proportion of long-to-short responses and reaction times in the dexamphetamine condition was changed, but no association with working memory was seen, consistent with an overestimation of durations in the timing of shorter intervals and a increase in the speed of an internal pacemaker. An interaction between dexamphetamine, working memory, and performance on the estimation and production tasks was seen, whereby increasing digit span scores were associated with decreasing interval estimates and increased produced intervals in the placebo state, but were associated with increased interval estimates and decreased produced intervals after dexamphetamine administration.
Methylphenidate (10 mg)	Healthy volunteers	Methylphenidate did not affect task performance ($p > 0.05$), but it increased the time interval underestimation by over 7 s ($p < 0.001$) with a concomitant decrease in absolute alpha band power in the ventrolateral prefrontal cortex and dorsolateral prefrontal cortex and parietal cortex ($p < 0.001$). Acute use of methylphenidate increases the time interval underestimation, consistent with reduced accuracy of the internal clock mechanisms. Furthermore, acute use of methylphenidate influences the absolute alpha band power over the dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, and parietal cortex.
Three microdoses of LSD (5, 10, and 20 μg)	Older adults	LSD conditions were not associated with meaningful changes in self-report indices of mentation, perception or concentration. LSD caused

		over-reproduction of temporal intervals of 2000 ms and longer with these effects most pronounced in the 10 µg dose condition. Hierarchical regression analyses showed that LSD-mediated over-reproduction was independent of marginal differences in self-reported drug effects across conditions.
Zolpidem (10 mg)	Older adults	Zolpidem enhanced reaction time in all conditions (zolpidem 407 ± 9 ms vs. placebo 380 ± 11 ms; $p < 0.001$) and error rate in just incongruent trials (10.2 ± 1.1% vs. 7.8 ± 0.8%; $p < 0.01$) in the Simon task and enhanced time perception variability ($p < 0.001$). Zolpidem meanwhile changed postural parameters (e.g. center of pressure area, zolpidem 236 ± 171.5 mm2 vs. placebo 119.6 ± 59 mm2; $p < 0.001$). Apnea-hypopnea index and mean arterial oxygen saturation ($p > 0.05$) were not effected but sleep quality improved ($p < 0.001$). Symptoms of acute mountain sickness and sleepiness were increased ($p < 0.05$).
Single dose of L-DOPA (250 mg L-DOPA/62.5 mg benserazide)	Patients with Parkinson disease (PD)	Results indicated increased LI in PD-off and decreased latent inhibition in PD-on relative to the control subjects. After the administration of L-DOPA, we observed a significant decline in latent inhibition in PD. L-DOPA elevated perceptual experiences (changes in subjective feelings in time perception, thinking, mental "highness"). Greater reduction in latent inhibition was associated with enhanced perceptual experiences. A single dose of L-DOPA has a significant psychotomimetic effect, which is associated with decreased latent inhibition, a behavioral marker of psychosis-like experiences.
Either oral or inhaled administration of Δ^9-tetrahydrocannabinol (THC) (IV THC was administered at doses from 0.015 to 0.05 mg/kg	Healthy volunteers	All doses induced time overestimation and underproduction. Chronic cannabis use had no significant effect on baseline time perception. On the contrary, infrequent/nonsmokers showed temporal overestimation at medium and high doses and temporal underproduction at all doses, frequent cannabis users showed no differences. THC effects on time perception were not dose-dependent.
7-s and 17-s peak-interval timing procedures following d-amphetamine (20mg-oral), haloperidol (2mg-oral)	Healthy volunteers	d-amphetamine revealed proportional leftward shifts of the timing functions whereas haloperidol caused proportional rightward shifts. Symmetrical pattern seen suggests that clock speed is regulated by the effective level of dopamine, i.e., d-amphetamine elevated clock speed and haloperidol decreases clock speed. The second pattern was the opposite of the first pattern and was revealed by d-amphetamine producing proportional rightward shifts of the timing functions wheras haloperidol produced no significant effect..

Oxycodone, a popularly used opioid for treating pain, (15 mg, orally) over six outpatient sessions	Healthy volunteers	Oxycodone significantly lengthened time estimations for the two longer intervals compared to the placebo arm. Opioids may change temporal processing for intervals greater than 1 s, raising questions about the effect of these substances on the valuation of future consequences.
Ketamine (100 ng/ml blood plasma level)	Healthy volunteers	Ketamine significantly distorted the subjective time perception as measured by the Clinician-Administered Dissociative States Scales. More importantly, ketamine meanwhile impaired accuracy on the perceptual timing task while having no significant effect on performance of the color perception task. Although ketamine did not damage the ability to use prelearned temporal (or spatial) cues to predict target onset (or location), it did slow reaction times at long delays following non-informative neutral cues, indicating an impaired ability to use the unidirectional flow of time itself to make anticipations.

TABLE 2. **Illustrates summary of genetic modifications in different disease models at the current state of technological advance in neuroscience.**

Researchers	**Model**	**Intervention**	**Results**
Park et. al [96]	Mouse models of Alzheimer's	*in vivo* neuronal gene editing via CRISPR-Cas9 amphiphilic nanocomplexes	Potential application of CRISPR-Cas9 systems to neurodegenerative diseases.
Matsuda. al [97]	Mouse model	NeuroD1 direct neuronal conversion from mouse microglia both *in vitro* and *in vivo*	**NeuroD1:** occupies bivalent domains for neuronal gene induction. alters the epigenome to control neuronal conversion from microglia. initiates the neuronal program prior to suppressing the microglial program. converts microglia into neurons in the adult mouse

			striatum.
Zhang et. al [98]	Wild-type mouse	Depleting METTL3 in mouse hippocampus	Reduction of memory consolidation ability. Direct impact and role of RNA m^6A modification in regulating long-term memory formation, and indicates that memory efficacy difference among individuals could be compensated by repeated learning
Ebbert et. al [99]	Human cerebellum and frontal cortex tissues	RRBS Alignment, Annotation, Duplicate Removal, and Bioinformatic Analysis, RT-PCR and qRT-PCR Combined RRBS and RNASeq analysis and validation Hierarchical clustering	Differentially methylated cytosines are abundant in ALS patient brains c9ALS and sALS patients may have distinct, but overlapping brain methylome profiles. Combined methylation and transcriptome data identify genes with both DMCs and differential transcriptome defects. SERPINA1 (and other genes) are differentially expressed and methylated in the cerebellum and frontal cortex. Genes exhibit alternative cassette exon splicing and methylation.
Porlan et. al [100]	Lateral ventricle (LV) in human embryonic kidney 293T cells	*in vivo* method for the stable genetic modification of adult mouse ventricular-subventricular zone (V-SVZ) cells that takes	LV-mediated gene delivery system may be used for the long-term in vivo transduction in the adult mouse V-SVZ, allowing their tracking and genetic

		advantage of the cell cycle-independent infection by LVs and the highly specialized cytoarchitecture of the V-SVZ niche	modification during proliferation, migration and differentiation.
You et. al [101]	Mouse	Forebrain-specific inactivation of the mouse Brpf1 gene	Hypoplasia in the dentate gyrus (DG), including underdevelopment of the suprapyramidal blade and total loss of the infrapyramidal blade. Brpf1 loss deregulates cell cycle progression, neuronal migration, and transcriptional control, thereby causing abnormal morphogenesis of the hippocampus.
Zhang et. al [102]	Mouse hippocampus	*in vivo* DNA methylation profiling of Notch1, Hes1 and Ngn2 promoters	The number of Notch1 or Hes1 (+) and BrdU (+) cells decreased in the subgranular zone (SGZ) of the DG in the hippocampus following TBI. Nevertheless, the number of Ngn2-positive cells in the DG of injured mice was markedly higher than in the dentate gyrus of non-TBI mice. Suggesting the possibility that Notch1, Hes1 and Ngn2 were regulated by changing some specific CpG sites of their promoters to further orchestrate neurogenesis *in vivo*.

Anliker et. al [103]	Lentiviral vectors specific for human CD105(+) endothelial cells, human CD133(+) hematopoietic progenitors and mouse GluA-expressing neurons.	A flexible and meanwhile highly specific targeting method for lentiviral vectors based on single-chain antibodies recognizing cell-surface antigens	Lentiviral vectors targeted to the glutamate receptor subunits GluA4 and GluA2 showed more than 94% specificity for neurons in cerebellar cultures and when injected into the adult mouse brain. This approach allowed targeted gene transfer to many cell types of interest with an unprecedented degree of specificity.neurogenesis *in vivo.*
Hackl et. al [104]	Hindbrain (RH) of En1(+/Otx2lacZ) transgenic mice	Amphetamine-induced rotation conducted after cell transplantation into the unilaterally 6-hydroxydopamine-lesioned rat striatum.	Rats with transgenic RH-derived DA grafts exhibited functional recovery similar to transgenic and wild-type ventral mesencephalon (VM)-derived DA grafts. Morphological analyses indicated equivalent numbers of surviving DA neurons from both homotopic VM- and ectopic RH-derived grafts from transgenic donors with low numbers of surviving serotonergic (5-HT) neurons. On the contrary, grafts derived from wild-type donors contained predominantly surviving DA neurons or 5-HT neurons when they were prepared from the VM or RH, respectively. The study suggests the pattern of survival and functional

			potential of ectopic DA neurons derived from the RH of En1(+/Otx2lacZ) transgenic mice and that cell transplantation is an very instrumental neurobiological tool to characterize newly generated DA neural stem cells *in vivo*.
Kuzumaki et. al [105]	Mouse	Evaluation of the age-related changes in the expression of doublecortin, which is a marker for neuronal precursors, along with epigenetic modification in the hippocampus of aged mice.	In the hippocampus of aged mice the expression level of doublecortin mRNA was significantly decreased. Under these conditions, a significant increase in H3K27 trimethylation and a significant decrease in H3K4 trimethylation at doublecortin promoters were observed with aging without any changes in the expression of their associated demethylases and histone methylases in the hippocampus.
Dodge et. al [106]	Mouse	Symptomatic amyotrophic lateral sclerosis (ALS) mice received of insulin-like growth factor-1 (IGF-1) through stereotaxic injection of an IGF-1-expressing viral vector to the deep cerebellar nuclei, a region of the cerebellum with extensive brain stem and spinal cord connections.	Delivery IGF-1 to the central nervous system reduced ALS neuropathology, improved muscle strength, and significantly extended life span in ALS mice. IGF-1 is potently (2 neuroprotective and attenuates glial cell-mediated release of tumor necrosis factor-alpha and nitric oxide
Kodama et. al	Parkinsonian model rat	High titer	High titer retroviral vector

[107]		retroviral gene transduction to neural progenitor cells to establish donor cells for neural transplantation to parkinsonian model rats.	for gene transduction could be used to prepare neural progenitor cells for transplantation to hemi-parkinsonian model rats. However, functional recovery after transplantation of HTH-1 gene-transduced NPCs was incomplete.

Quantum physics

Qunтum physics and observer/interpretation issue: According to Philippe Allard Guérin and Časlav Brukner,'the observer-independent localization of events in general relativity the fact that events can be modelled as points on a space time manifold that is common to all observers is not suffice to describe the causal structure of events, but the causal reference frame corresponding to each event, which can be interpreted as an observer-dependent time according to which an observer describes the evolution of quantum systems; proposed is quite instrumental; assuring the consistency condition guarantees that the global causal structure is still observer-independent'. These authors 'do not preimpose a well-defined global ordering of the events; they tolerate that according to one event's causal reference frame, the other events might not necessarily be localised in the future or in the past. Instead, they require a weaker consistency condition: all observers should agree about the evolution connecting the state in the distant past to the state in the distant future'.

According to 'the causal reference frames of non-causal processes, such as the quantum switch, time-localisation of events in such processes is in general observer-dependent as well, although "these processes have a different structure than that of the quantum switch: for example one process has the property that in the causal reference frame of one event, the other events are arranged in such a way that they appear to be localised in the past (the past evolution depends linearly on the other parties' operations), while still having a non-trivial influence in the future; suggesting that the causal reference frames formalism can be a way to distinguish processes with a stronger form of noncausality (as witnessed by the violation of causal inequalities), from those whose non-causality is of a more benign nature such as the quantum switch and causally ordered processes [33].

The notion of causal reference frame is however problematic. In special relativity one can assign to a system rest frame in which its 3-momentum vanishes. In classical GRT this is not possible since one Poincare symmetry is lost and therefore also the conservation laws since Noether's theorem does not apply anymore. Usually this problem is not regarded as serious but the failure to quantize GRT suggests that this is not the case [34].

It is known that for sensory perception the order of events separated by time interval below the sensory time quantum about 0.1 seconds is not well-defined. Could quantal effects be important for sensory perception and explain the loss of well-ordering? Whether standard quantum physics allows to understand the situation, is not clear. Furthermore, in quantum gravity one cannot presumably speak of single classical space-time so that the attempts describe the time ordering anomalies in terms of space-time geometry can be challenged.

Quantum physics, interplay between observation and interpretation: Quantum mechanics is one of the most successful

physical theories and has been experimentally confirmed extensively. However, there are many crucial questions still left unanswered. For instance, the operational definition of minimal physiological and psychological and biomedical requirement of conscious HOs in quantum physics is still neither clear nor completely understood.

In other words, an observer independent quantum state is not necessarily the basic description of a quantum system; rather there are many experiments whose result not only implies, but strictly necessitates that quantum theory should be interpreted in an observer-dependent way [35]. This has a profound meaning and implication both in terms of locality and the very nature of the observer. In other words, cognitively enhanced observers and interpreters may change the conventions and rules of the physics.

The process of observation must necessarily include some kind of measurement and information and at least some kind of organisms as one observer; and currently, HOs are the ultimate observers that perform the measurement and/or interpretation which are correlated to consciousness in a multifaceted manner. If these assumptions are true and if we posit that "consciousness causes collapse", then HEPs will have brilliant implication in quantum physics interpretation, since enhanced HOs may possess enhanced and improved consciousness as well [36-38].

In von Neumann's approach conscious observer is in a very special role and essentially outsider to the measured system. The observation of decoherence in all scales justifying kinetic and thermodynamical descriptions suggest that any system can act as observer under some conditions. The future quantum theory should bring observer a part of physical system. This would however require genuine quantum theory of consciousness in which HO would not be in any special position [39].

Observer and possibility to predict an event on the future light cone of e in a quantum mechanical model: When we synthesize these two relevant experiments, it can be easily expected that soon or late similar techniques by using implants and devices, targeting modalities of electromagnetic perception (like a sophisticated intracranial electromagnetic sensors to detect non-damaging electromagnetic wavelengths outside current human physiologic perception), hearing (like a hearing aid or sensor to hear beyond the current human hearing limit), seeing (such as an intraocular nanoparticles or specialized eyeglasses to see outside the visible light), or some higher cognitive models focusing on improving integrating multisensory perceptions and/or pattern processing capabilities of observers and researchers, will be used in humans as enhancement projects; of course after meeting ethical, technical, practical and biological requirements and considerations (for example no one expect a NIR enhancement for humans, as we know that infrared light is photodamaging humans or doing an electromagnetic enhancement without considering health effects of radiofrequency electromagnetic energy [40].

It is very important at this point to remind that there are subtle interconnections between vision, knowledge, perception, conception, planning, decision making and interpretation in humans [41-45]. Thus, it might be even hypothesized that logical and mathematical deductions and inductions exploited from past presumptions/experiments, and interpretations of some physical models may be dramatically change after selective cognitive, electromagnetic or sensory enhancement projects such as visual enhancement.

Marwaha and May define precognition as an atypical perceptual ability that allows the acquisition of non-inferential information arising from a future point in spacetime [46]. They have proposed a Multiphasic Model of Precognition which identifies two distinct phases: The first is the physics domain, which addresses the question of retrocausation and how it is possible for information to traverse from one spacetime point to another. They suggested that the solution might be found within entropic considerations. The second is the neuroscience domain, which addresses the acquisition and interpretation of retrocausal signals. They proposed that this occurs across three stages:

- Perception of signals from an information carrier, based on psychophysical variability in a putative signal transducer;

- Cortical processing of the signals, mediated by a cortical hyper-associative mechanism; and
- Cognition, mediated by normal cognitive processes, leading to a response based on retrocausal information.

Tressoldi has argued that System 1, (the mental processing system mainly involved in the processing of unconscious information) in contrast to System 2, (mainly involved in the processing of conscious information), processes not only local information conveyed by sensory organs, but also nonlocal ones, that is, those beyond the detection range of sensory organs. According to Tressoldi, the striking similarities observed between the characteristics of local and nonlocal information processing by System 1, offer the possibility of using most of the experimental protocols used to investigate local information for the nonlocal information [47].

On basis of numerous observations and reports, one could ask whether human brain has ability to transfer information with effective speed faster than the speed of light; one might consider intuition as a probe of nonlocality [48-54]. In fact, there are numerous studies demonstrating the existence of extrasensory perception in humans. See for some famous meta-analyses in this regard [55,56].

On the other hand, one can argue that genuine superluminal speeds are not needed. As already explained, there are several mechanisms allowing effective superluminality. For instance, if the arrow of time can vary, effective super-luminality becomes possible. This makes also possible precognition based on signals propagating from future to past. Here one must however carefully distinguish between experienced time and geometric time in order to avoid total confusion. The recent physics identifying these times does not allow this.

If macroscopic quantum coherence is possible, the quantum system of macroscopic size can behave like single quantum coherent unit and biological systems indeed seem to do so, at least at control level. Phase transitions increasing the scale of quantum coherence could effectively correspond to information transfer with superluminal speed.

In Section 2 we presented a quick introduction to some basic definitions of GRT and quantum physics. Below, in Section 3, using some challenges to definitions and presenting some scenarios we will show why some of these well-accepted definitions may change after HEPs, and how different perception of HOs (depending type of SCE, SVE, SEE projects, either pharmacologic or non-pharmacologic), may change robustness of light cone model interpretation and perhaps interpretation of some findings in quantum physics.

Section 3

Challenges to the definitions of Ho

Challenges to definition of observers: Observer is a term that most often mistakenly understood in physics and recent discoveries have potential to amend and expand the definition of observer from ordinary human or conscious agents who just observe by means of visible light to a modern definition as a enhanced observer who can comprehends and enjoys electromagnetic wavelengths, and/or have enhanced visual and cognitive capacity; who enables his/her to have a broader and deeper understanding from cause-effect relationship, and earlier or preceding perception of past-future events.

In SRT, GRT and quantum physics there is always a talk about O! In one of the best attempts to define O, Chris Fields investigated the consequences of replacing the Galilean observer traditionally employed in interpretations of quantum theory with an observer that fully satisfies the requirements of classical automata theory and Philippe Allard Guérin and Časlav Brukner revisited observer-dependent locality of quantum events [57,58]. Remind that Bohr's view is that "The observer has rather only the function of registering decisions, i.e. processes in space and time, and it does not matter whether the observer is an apparatus or a human being

[59,60]

A scenario challenging definition of observers

Consider two Monozygotic (MZ) or identical twins (Bob and Bobbie) who have sat side by side in a single room, i.e. identical frame of reference or same light cone. Bob has done a SEE that allows him to enjoy a magnetic sensitivity (similar to that of magnetic orientation and magnetoreception in birds and other animals, albeit magnetic sensitivity in humans and animals might be different, or a SCE by gene-editing or any genetic technique (such as using transgenic lines, grafting from transgenic animals, using neural stem cells of such birds or animals, etc., that allows him to perceive impending danger (similar to some birds such as crow and raven that have foresight ability 1 day-2 days earlier than his sibling Bobbie [61-63]. This scenario illustrates that there is a good chance that identical observers who are in same frame of reference/same light cone, have perception, and thus, different interpretation and understanding form light cone causality.

Despite Bob and Bobbie are in same frame of reference or same light cone, Bob perceives impending danger earlier than his sibling Bobbie, and such a situation challenges light cone interpretation. Based on light cone interpretation, if two observers are in same light cone, then, they should have observed (or perceived) the impending danger like each other, i.e. simultaneously. Implicit to this classic interpretation is that physics presupposes that observers are similar in terms of their perception. Here one must remember that genetic identity does not imply that Bobbie and Bob are exact copies perceiving in the same manner. They have lived in different environments, which have affected them. Genetics only determines boundary conditions, not the fate.

However, we explain and argue that how and why some kinds of enhancements such as SEEs, helps O1 to observe (or feel danger, etc.) far earlier than the other ordinary O2 who has sat just beside, i.e. in exactly same frame of reference and same light cone. That is why we claim that new/modern definition of observer, should consider such novel phenomenon or upcoming technologies. We purposely supposed that Bob and Bobbie are identical twins and their mere difference is that Bob has done selective electromagnetic enhancement.

Challenges to definition of past and future: If by genetic modifications, or any other way including microdevices, intraocular or intracranial nanoantennae, etc., we selectively enhance Os in such a way that they perceive electromagnetic waves-to a level similar to dog's or toad's electromagnetic perception that perceive seismic precursors and electromagnetic activities some 2 days to 3 days earlier than of our current human perception- does this situation means that second law of thermodynamics is violated [64-71] ?

Let's answer this question by using a scenario:

Consider that we have two Os:

Bob is a native man who lives in an island which is located on a seismic belt near ocean with frequent seismic waves (such as Primary (P) waves, Trapped (T) waves, or Secondary (S) waves or other seismic signals). Since Bob is a native, he expects occurrence of earthquakes in the island some fortnightly or so. We have also Bobbie who is an identical twin i.e. monozygotic twin of Bob, with exactly identical electromagnetic perception.

The point is that Bobbie has grown up in London since he was a kid and he knows nothing about the island and the occurrence of the earthquake etc. After years, Bobbie finds his brother Bob and comes to the island as a tourist, with no prior knowledge about the history of earthquakes; therefore he has no expectation to feel/observer/perceive a stimulus such as pattern of earthquake or a similar event [72]. Bob and Bobbie have sat beside the ocean and are drinking their lemonade, thus they are in the same frame of reference and same light cone.

In such a scenario, we can assume both Bob and Bobbie are under similar electromagnetic field and correspond to same light-cone

in GRT based picture. Bob and Bobbie need not however have identical electromagnetic perceptions. They have identical genes but different gene expressions dictated by environment via epigenesis. Since Bob and Bobbie have lived in different environments it is natural that they have developed different sensitivity to earthquakes.

Now let's proceed by bringing some empirical facts:

Bobbie's mind is flooded with heterogeneous demanding and undemanding activities and he doesn't expect occurrence of an earthquake (said differently, he don't expect a pattern like an earthquake from very beginning, and thus he doesn't recognize any unconscious received T or S or P wave [or other types of signal] as a sign of earthquake, i.e. he doesn't recognize the signals as an information). However, Bob perceives the signals and recognizes same signals as a sign of an impending earthquake.

There are indeed compelling evidences and reports proving human perception of earthquake signals in seismic belt inhabitants but not by tourists (who have not prior knowledge or expectation) [73-75]. Thus, inhabitants of seismic belt do expect earthquakes and they may have a better chance of conscious perception of the pre-seismic signals and patterns.

Since Bobbie doesn't expect an earthquake, the probability that a stimulus like earthquake signal gain access to his conscious awareness is extremely low and hence the chance of Bobbie to interpret unconscious perception of earthquake signals as an information is just zero or near to zero.

Second piece of data relates to metabolism related to sensory perception. According to several studies, perception of different electromagnetic signals impending to an earthquake do not cost any ATP in animals; rather there is possibility that extremely low frequency oscillations (10 Hz-70 Hz) may even enhance ATP synthesis during the earthquake in mammals [76].

Furthermore, ATP synthase has the capability to extract electromagnetic energy from a volume much larger than the volume, which itself occupies [77,78]. Intriguingly, experimental measurements using Blood Oxygenation Level Dependent (BOLD)-fMRI in human brain neurons suggest that the changes in energy expenditure associated with conscious perception are much smaller than those associated with the unconscious representation of incoming sensory information, for which the increase in blood flow associated with neuronal activity will be more important [79]. In addition, there are two well-conducted human studies in support of our hypothesis that earlier conscious perception of a stimulus like a pre-seismic signal, because of prior knowledge and frequent experience of such events, costs no further energy. One study examined how swiftly prior knowledge impacts the neural processes giving rise to conscious experience, and the other study which consisted of five consecutive experiments, including one specific experiment to find out whether clearly perceiving a stimulus on a recent occasion increases the probability that a similar stimulus will gain access to conscious awareness [80,81]. There is also a well-known physiologic phenomenon stating that if a stimulus is repeated frequently, it leads to neuronal plasticity; and afterwards results in enhanced mitochondrial energy production (ATP levels) and lower neural ATP consumption [82,83].

Remember that Bob is both an experienced native and professional guide. Therefore, selective SEE might further enhance his conscious perceptions of some signals that otherwise could not gain access to conscious level, costing no further energy or ATP. Getting information without necessarily further energy consumption is kind of violation of second laws of thermodynamics in its standard form allowing only single arrow of time [84,85].

These findings suggest that standard form of the second law of thermodynamics could fail in these situations:

- Fantappie has long time ago suggested that the arrow of time can change in bio-matter and has proposed the notion of syntropy as an analog of negative of entropy but which reversed arrow of time. Second law would still hold true but with reversed arrow of time [86].

- Time reversed entropy would be decreasing rather than increasing in standard direction of time leading to breaking of second law: such as development of gradients (say temperature gradients) and structures and long scale coherence. The change of arrow of time could even lead to a view about self-organization as consequence of second law with reversed time direction and understanding of the necessary energy feed as dissipation of energy in opposite time direction.
- Physical scales form a hierarchy and a possible explanation for the breaking of second law could be based on temporary change of the arrow of time at some level of hierarchy. If this level controls bio-matter it could induce effective change of the arrow of time also at this level. Dark matter is known to form most of matter but there is no generally accepted identification for it. Could dark matter correspond to this level?

Consider now the earthquakes from this perspective. Suppose that earthquake indeed involves a change of arrow of time at some level. The ELF signals might be caused by earthquake and only apparently precede it. They would propagate in non-standard direction of time. Since second law would hold true with reversed arrow of time, the utilization of the metabolic energy to perceive the ELF signal with non-standard arrow would look like receiving metabolic energy and this could give rise to the generation of ATP.

Remember that Bob is both an experienced native and professional guide. Therefore, selective electromagnetic enhancement in HOs, might further enhance HO's conscious perceptions of some signals that otherwise could not gain access to conscious level, costing no further energy or ATP. Getting information without necessarily further energy consumption is kind of violation of second laws of thermodynamics in its standard form allowing only single arrow of time. Getting information without necessarily further energy consumption is kind of violation of second laws of thermodynamics.

One can also as whether consciousness involves negentropic entanglement; interested readers are referred to some theories proposed in this regard [87,88].

Challenge of different visual capacity of Os: Human visual system detects light from approximately 380 nm (red limit) to 760 nm (the violet limit), so called visible light. Ultraviolet (UV) light occupies the spectral range of wavelengths slightly shorter than those visible to humans [89,90]. Because of its shorter wavelength, it is more energetic (and potentially more photo damaging) than 'visible light', and it is scattered more efficiently in air and water [91]. On the other hand¸ human infrared vision is triggered by two-photon chromophore isomerization which poses further limitations to HOs. In other words, if a HO cannot detect the photon due to its physiologic limitation to perceive some wavelengths, there will be no perception, no information processing, and consequently no interpretation or understanding of the causality.

Therefore, when interpreting which events fall in the past or future of a light cone, or which occasions have a cause and effect relationship, this physiological ocular limit (or on the contrary, enhanced visual capability) inherently dictates the degree of signal transmission reception and thus, wholeness/correctness of any universal or physical interpretations of outside events. SVE projects might one day widen spectrum of visible light (without photodamging) and change our perception form picture of outside world. Similar line of reasoning may apply to other sensory limitations in specific situations.

Challenge of different electromagnetic perception of Os: It has been established that even humans are sensitive to extremely low-frequency magnetic fields at vanishingly small intensities, on the order of tens of nT [92-95]. The interesting point here is that there are intra-individual differences in electromagnetic perception and hypersensitivity. An investigation was made by Lebedeva and Kotrovskaya of the individual reactions of human subjects exposed to electromagnetic fields. Experiment was performed on 86 volunteers separated into two groups. The first group was exposed to the electromagnetic field of infralow frequencies, whereas the

second group was exposed to the electromagnetic field of extremely high frequencies. It was found that the electromagnetic perception of human beings is correlated with participants' individual features, such as electroencephalogram parameters, the critical frequency of flash merging, and the electric current sensitivity. Human subjects who had a high-quality perception of electromagnetic waves showed an optimal balance of cerebral processes, an excellent functional state of the central nervous system, and a good decision criterion[96-100].

As for difference visual capacity and IQ score among Os, we propose that difference in electromagnetic sensitivity or hypersensitivity may further disturb the interpretation of light cone causality and probably quantum physics.

Here, the magnetic sense is just one more addition to other sensory modalities including the visual, olfactory, touch, acoustic and taste components. There is possibility that in future some SEE projects enhance human's electromagnetic perception to a level that is enough to perceive patterns in pre-seismic electromagnetic emissions profiles prior to major earthquakes and it might be expected that certain types of SEE projects will offer much greater capacity to perceive the near future without violating second laws of thermodynamics[101-105].

Now, it is time to present some hypothetic examples for future[106,107].

Section 4

Hypothetical example of opportunities for selective HEPs

We realize and posit that any HEP shall meet ethical and technical requirements.

It is instrumental to learn that effects of HEPs could be

- temporary, for example by using some wearable devices, taking pharmacological drugs such as sublingual pills,
- mid-term (such as some cognitive models)
- permanent, for example by genetic modification.

Furthermore, soon or late we will be able to alter the function of place cells, time cells, and grid cells which are neural cells that represent time, place and space-time in hippocampus, respectively. So, in future there will be great potentials to improve or modify different sensory modalities in selective and specific manners.

We appreciate that this is not the place to present the experimental and medical details. However, just to show the huge potential of some HEPs such as genetic or pharmacological interventions, below we present two unique cases called synesthesia, and savant syndrome purposely. These two cases are considered abnormal situations and if there are HEPs opportunities in abnormal situations, there might be even further chances waiting us in extraordinary talented and intelligent persons. Visuo-spatial synaesthesia and savant syndrome are just chosen examples from numerous cases of psychological and genetic situations which might be used for cognition enhancement in future.

Logical analyses of such scenarios enable us to test whether the standard physics is able to describe these findings. For instance, can one understand enhanced abilities in terms of faster communications based on nerve pulse signaling or whether signals with light velocity are required (bio-photons) and whether also macroscopic quantum coherence is involved. HEPs raise also the question about physics based definitions of conscious intelligence and information (negenropy): "physicalistic" physics does not provide them. Multiple enhancements such as simultaneous visual and cognitive enhancements plus electromagnetic enhancement projects may currently seem as a fiction, as once were current rhinoplasty operations considered as a fantasy just some decades before **(TABLE 3)**.

TABLE 3. **A simplified picture to enhance spatiotemporal resolution, and information exchange velocity via correction of brain's structural and functional bottlenecks.**

Cells	**Human**	**Potential/Risk Hazard Ratio**	**Cost-benefit ratio**	**Pharmacologic approach: Applicability/feasibility/effects**	**Genetic approach: applicability/feasibility/effects**		**Strictly Phenotypic**
Time cells	Animal			**Long Term, Mid Term, Short Term,**	**Techniques used**	**Gene editing** • Zinc finger Nucleases • Gemin al heritable/ • TAL effector / nucleases • Genetic Mutation • CRISP R/Cas9	
Grid Cells	Invivo/invitro			Serotonergic	Gene editing		Somatic Non-heritable
Place Cells	Model			Anti-serotonergic	Embryonic stem cells		
Cells interventional level	Ethics			Dopaminergic	/induced pluripotent stem cells		
	Relatedness			Anti-dopaminergic	Gene targeting		
				Other	Transgenesis		

Conclusion

We predict that dimensions of HEPs will inevitably influence findings of physics in general, with a profound informational and causal (as well as retrocausal) consequences in GRT and quantum physics in specific and eventually will directly impact space exploration. It is not at all obvious whether GRT and quantum physics are enough for quantum biology and quantum consciousness and the question is what biology can give to physics.

We will need to start to redefine minimal and/or maximal biomedical, psychological and physiological requirements of HOs. If HEPs affect HOs perception and functions (such as designing, interpretation, generalization, analyzing, etc); then physics may have to revise its experimental procedures by integration and borrowing some of experimental procedures from psychology and medicine (such as performing experiments in a double blind or randomized controlled manner and consider the cognitive and negative and positive interpretational biases affecting its findings and the meaningfulness or meaninglessness of its results, and paying attention to inclusion/exclusion criteria of some HOs). HEPs, needless to say, are unlikely to get a chance like general and global vaccination programs, and most of the population may never get privilege of enhancement projects (except for some cheaper and more available ones). Apart from ethical considerations and issues and consequences, what will happen to the future of "reality" then? Do "reality" changes or "we" change?

We predict our presented view will open new veils of research on neglected capacity of human enhancement.

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