

Research Essay

# On Emotions as Sensory Percepts of the State of Magnetic Body

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## Abstract

What are emotions, how emotions are created, and how are they represented - In the brain, body or somewhere else? Emotions can be divided into lower level emotions and higher level emotions. What do the levels of emotions correspond to?

1. TGD inspired answers to the questions are that emotions are sensory percepts about the state of magnetic body (MB) and sensory-motor loop generalizes: Various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output.
2. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks. They are accompanied by flux tube networks giving rise to tensor networks as quantum coherent entangled structures serving as correlates of mental images and allowing classical signalling with light velocity using dark photons.

In a similar manner, hormones give rise to networks of ordinary cells implying, in particular, that emotional memories are realized in (biological) body (BB). Nervous system gives information about the state of these networks to brain. Hypothalamus serves as the analog of motor cortex excreting hormones controlling the excretion of hormones at lower level glands.

3. The hierarchy of Planck constants defines a hierarchy of dark matters and  $h_{eff} = n \times$  defines a kind of IQ. The levels of MB corresponding to large/small values of  $n$  would correspond to higher/lower emotions.

MB decomposes to two basic parts: The part in the scale of BB formed by networks having cells and larger structures as nodes (forming a fractal hierarchy) and the part in the scales larger than BB.

1. In the scales of BB (short scales), the dynamics involves topological dynamics of the flux tube network and sensory percepts can be accompanied by conscious-to-us desire to change the state of MB and thus of BB and could be seen as intentions induced by the comparison between what happened and what were the expectations. The outcome would be state function reduction replacing the behavioral pattern with a new one giving better hopes for achieving the goal. In zero energy ontology (ZEO), behavioral pattern is represented as quantum superposition of 4-D MBs so that time aspect is naturally involved with emotions.
2. In the scales larger than that of BB (long scales), the change of the topology is not easy and the dynamics involves oscillations of MB - analogs of Alfven waves - and analogs of ordinary motor actions changing the shape of flux tubes but leaving its topology unaffected.

Alfven waves with cyclotron frequencies and generalized Josephson frequencies assignable to cell membrane as Josephson junction would be involved. The size scale of particular onyon-like layer of MB corresponds to the wavelength scale for cyclotron frequencies and is proportional to  $h_{eff}/h = n$  for dark photons. For instance, alpha band in EEG corresponds to the scale of Earth but the energy scale of dark photons is that of bio-photons.

The TGD inspired model of music harmony gives as a side product a model of genetic code predicting correctly the numbers of codons coding for amino-acids for vertebrate code. The model allows to see sensory percepts about the dynamics in large scales as analog of music experience. The notes of 3-chords of the harmony correspond to light as dark photons and frequencies defining the notes of the chord: cyclotron radiation and generalized Josephson radiation from cell membrane would represent examples of dark light. Music expresses and creates emotions and music harmonies would correspond to various emotional states/moods realized at the level of

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DNA and its dark counterpart (dark nuclei represented as dark proton sequences). MB would be like a music instrument with flux tubes serving as strings. It is difficult to assign any specific desire to large scale sensory percepts about MB and the interpretation as higher emotions - or rather feelings - makes sense.

**Keywords:** Emotion, sensory percept, magnetic body, brain, body, mind.

## 1 Introduction

What are emotions, how emotions are created, and how are they represented. One can consider these questions from the point of view of neuroscience, endocrinology and quantum physics. Emotions can be divided to lower level emotions accompanied by intention/need/desire (hunger is accompanied by the need to eat) and thus distinguishing them from sensory qualia whereas higher level emotions like catharsis and the experience of beauty not accompanied by any desire. What does this division correspond to?

TGD inspired answers to the questions are as follows:

1. Emotions are sensory percepts about the state of magnetic body (MB) and sensory-motor loop generalizes: Various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks. They are accompanied by flux tube networks giving rise to tensor networks [24] as quantum coherent entangled structures serving as correlates of mental images, and allowing classical signalling with light velocity using dark photons. In a similar manner hormones would give rise to active networks of ordinary cells accompanied by tensor networks. Nervous system gives information about the state of these networks to brain and hypothalamus serves as the analog of motor cortex sending hormones controlling the excretion of hormones at lower level glands.
2. Emotions are sensory percepts about the state of magnetic body (MB) rather than those of biological body (BB). Also sensory-motor loop generalizes: various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output.

Consider first neuronal level. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks (flux tubes associated with axons in the case of nervous system) and accompanied by flux tube networks giving rise to tensor networks as quantum coherent structures serving as correlates of mental images and allowing classical signalling with light velocity using dark photons. These tensor networks represent our mental images only if they correspond to our sub-selves [32].

In a similar manner hormones would give rise to tensor networks of ordinary cells accompanied by flux tube networks giving rise to quantum coherent structures, tensor networks serving as correlates of emotional mental images. Nervous system mediates information about the state of these networks to brain. Hypothalamus serves as analog of motor cortex excreting hormones controlling the excretion of hormones at lower level glands.

3. The hierarchy of Planck constants defines a hierarchy of dark matters and  $h_{eff} = n \times h$  defines a kind of IQ. The levels of MB corresponding to large/small values of  $n$  would correspond to higher/lower emotions.

MB decomposes to two basic parts: The part in the scale of BB and formed by networks having cells and larger structures as nodes (forming a fractal hierarchy) and the part in the scales larger than BB.

1. In the scales of BB (short scales) the dynamics involves topological dynamics of the flux tube network and sensory percepts can be accompanied by conscious-to-us desire to change the state of MB and thus of BB and could be seen as intentions induced by the comparison between what

happened and what were the expectations. The outcome would be state function reduction replacing the behavioral pattern with a new one giving better hopes for achieving the goal. In zero energy ontology (ZEO) behavioral pattern is represented as quantum superposition of 4-D MBs so that time aspect is naturally involved with emotions.

2. In the scales larger than that of BB (long scales) the change the topology is not easy and the dynamics involves oscillations of MB - analogs of Alfvén waves - and analogs of ordinary motor actions changing the shape of flux tubes but leaving its topology unaffected (these actions might represent or serve as templates for ordinary motor actions in body scale [13]).

Alfvén waves with cyclotron frequencies and generalized Josephson frequencies assignable to cell membrane as Josephson junction [12, 9] would be involved. The size scale of particular onion-like layer of MB corresponds to the wavelength scale for cyclotron frequencies and is proportional to  $h_{eff}/h = n$  for dark photons. For instance, alpha band in EEG corresponds to the scale of Earth but the energy scale of dark photons is that of bio-photons.

The TGD inspired model of music harmony [20] gives as a side product a model of genetic code predicting correctly the numbers of codons coding for amino acids for vertebrate code. The model allows to see sensory percepts about the dynamics in large scales as analog of music experience. The notes of 3-chords of the harmony correspond to light as dark photons and frequencies defining the notes of the chord: cyclotron radiation and generalized Josephson radiation from cell membrane would represent examples of dark light. Music expresses and creates emotions and music harmonies would correspond to various emotional states/moods realized at the level of DNA and its dark counterpart (dark nuclei represented as dark proton sequences). MB would be like a music instrument with flux tubes serving as strings. It is difficult to assign any specific desire to large scale sensory percepts about MB and the interpretation as higher emotions - or rather feelings - makes sense.

## 2 Background

### 2.1 Some background from evolution

It is good to list some basic data from evolution of nervous system (see <http://tinyurl.com/yabtffh4>) first.

- Bacteria have no nervous system but already they are capable of simple sensory perceptions. Bacteria can move to the direction where the concentration of nutrients increases so that they probably perceive the concentration of nutrients. The feelings of hunger and satiety are perhaps the most primitive emotional states, one can think that these emotions/feelings were possessed also by bacteria. The need to get food is associated with hunger and it seems that the lower emotions induce desire/intention leading to goal directed behavior.
- Ladder-like nervous system is a primitive nervous system possessed by invertebrates and has at its end a bulge - ganglion - representing primitive brain. Anthropods, which include insects, belong to this class of animals.
- Brainstem and cerebellum developed from the ganglion and gave rise to what is called lizard brain. Brain stem controls the functioning of heart, lungs, stomach and other organs and cerebellum controls motor activities. Since the cortex allowing to decompose visual field into objects is missing, vision must be very primitive - including however detection of motion and distance for the target of attention. Maybe there is just the target of attention instead of the decomposition of the perceptive field into objects. Olfaction, hearing, and vision work together to identify the target of attention.
- Chordata (see <http://tinyurl.com/63af3ag>) consist of urochordata and cephalochordata preceding vertebrates.

**Remark:** Vertebrates have EEG, which must be a significant difference. In TGD framework scaled up variants of EEG are in principle with higher frequency ranges are possible with similar structure and correspond to smaller value of  $h_{eff}/h = n$ .

- Limbic system (see <http://tinyurl.com/ny2e8ff>) defines what is known as emotional brain. It contains hypothalamus as an analog for the highest motor areas in cortex. Hormone excretion is the tool of control. Using this tool hypothalamus controls the hormone excretion of lower level glands in brain and body in turn controlling the state of body. Hormone levels correlate strongly with emotions [7].
- At the top is cortex containing sensory, motor and associative regions.

## 2.2 Some background from neuroscience and endocrinology

Also some data bits in neuroscience and endocrinology dealing with the endocrine system, its diseases, and its specific secretions known as hormones are in order. Endocrine system forms only part of cell signalling (see <http://tinyurl.com/yckwaaob>). One can classify the signalling according to the range of signals. Intracrine signals stay in target cells, autocrine signals affect the cell itself or of nearby cells via receptors. Juxtacrine signals affect adjacent (touching) cells. Paracrine signals target cells in the vicinity of the cell: nerve pulses correspond to this kind of signalling. Endocrine signals target distance cells and hormones reaching their target via blood stream serve as signal molecules.

**Remark:** In TGD framework the term "signal molecule" is misleading. Signal molecules bound to receptors would only serve as bridges/relays giving rise to networks in which dark photon signals would propagate and make possible classical communications. Also quantum entangled structures - tensor networks - would be formed.

1. Limbic brain (see <http://tinyurl.com/ny2e8ff>) would be the neural part for the system behind emotions and serve as the analog of cortex participating the neural processing related to emotions. Neural information would arrive from body to brain via nervous system and the analog of motor response from limbic brain would be based on endocrine system using hormones as a control tool (<http://tinyurl.com/l2pstuv>).
2. Endocrine system (see <http://tinyurl.com/l2pstuv>) involves several feedback loops via hypothalamus and pituitary. Hypothalamus plays a role analogous to that of the highest motor areas in cortex. Emotions are expressed via excretion of hormones by hypothalamus (see <http://tinyurl.com/hdt5t8g>) and the hormones from hypothalamus control the excretion of hormones by lower level glands. Besides hypothalamus also pituitary gland and pineal gland are brain glands.

The four most important glands outside brain are pancreas, ovaries/testes, thyroid gland, parathyroid gland, and adrenal glands: together with 3 brain glands this makes altogether 7 glands. Interestingly, this happens to be the number of chakras in the Eastern medicine. Besides this there are many other hormone secreting organs. The so called diffuse endocrine system involves hormone emitting cells heart muscle and epithelial cells in gut. Immune system excretes hormone and also skin can be regarded as a gland.

3. Hormones (<http://tinyurl.com/znk4tzn>) are used to communications between organs and tissues for physiological regulation and behavioral activities. Hormones have diverse chemical structures, most of which belong to 3 classes: eicosanoids, steroids, and amino acid/protein derivatives (amines, peptides, and proteins).

All vertebrates possess hypothalamus (see <http://tinyurl.com/hdt5t8g>). Hypothalamus is located below thalamus and serves as a link between neural system and endocrine system and regulates certain metabolic processes and other activities of the autonomic nervous system. Hypothalamus

synthesizes and releases neural hormones in turn stimulating or inhibiting the secretion of pituitary hormones in turn controlling the secretion of hormones in lower level glands.

Hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviors, fatigue, sleep and circadian rhythms. Hypothalamus consists of several nuclei. Hypothalamic-pituitary-adrenal axis is a complex set of direct influences and feedback between hypothalamus, pituitary and adrenal glands located in kidneys. Delta waves (in EEG) with frequencies in the range (.5,4) Hz - usually thought to arise either in cortex or thalamus - controls excretion of neural hormones from hypothalamus.

**Remark:** In TGD framework delta waves would be associated to the control by MB. Note that delta waves do not correlate directly with the contents of consciousness.

Endocrine system controls physiology and there are good reasons to think that at least some hormones are closely related to the control of simple emotions such as satiety, pleasure, hunger, fatigue, fear, aggression, and rage. Not all emotions involved need to be conscious to us. For instance, at the neural side autonomic part of the neural system is unconscious to us.

**Remark:** TGD inspired theory of consciousness [32] predicts self hierarchy. The sub-selves of self give rise to mental images of self. Sub-sub-...-selves contribute a diffuse background to the experience of self. Emotions could correspond to this kind of background.

The book "*Molecules of emotion*" by Candace Pert [7] gives a nice representation about peptides as molecules of emotions. Dopamine is one peptide acting both as both neural transmitter and hormone and positive emotions accompany its excretion.

## 2.3 What emotions are and how do they emerge?

### 2.3.1 Basic facts about emotions

One learns from Wikipedia (see <http://tinyurl.com/7m17vcs>) that there is almost endless variety of theories of emotion. For instance, in Scherer's components processing model of emotion, five crucial elements of emotion are said to exist:

- Cognitive appraisal: provides an evaluation of events and objects.
- Bodily symptoms: the physiological component of emotional experience.
- Action tendencies: a motivational component for the preparation and direction of motor responses.
- Expression: facial and vocal expression almost always accompanies an emotional state to communicate reaction and intention of actions.
- Feelings: the subjective experience of emotional state once it has occurred.

This definition of emotion includes as its aspects cognitive processing (neural feedback), physiological correlates (hormone excretion), action tendencies (intentions/needs/desires/drives), bodily expression of emotion, and feeling. This classification assigns physiological activation patterns to all emotions (what about "higher" emotions?). Feeling forms only one aspect of emotion.

It has been also proposed that there are 6 basic emotions: anger, disgust, fear, happiness, sadness and surprise. One can wonder why pleasure and psychological pain are not counted as basic emotions: maybe they are associated with happiness and sadness. Neither hunger and satiety are included: since hunger induces goal directed behavior, it would seem natural to count it as emotion rather than sensory experience. It seems possible to assign to emotions positive/negative coloring, which would allow to see them as pairs analogous to pairs of color and complementary color.

Personally I would call emotions inducing desires primitive emotions perhaps possessed already by the simplest organisms - even those without nervous system. Certainly I would not try to reduce higher level emotions such as experience of beauty to these primitive emotions.

One can also distinguish emotions using as a criterion the time scale involved: feelings, moods, temperament, personality describe these time scales in increasing order.

1. Primitive emotions represent information in a very concise form. Just a single bit represented as emotional coloring of experience as positive or negative is enough and if it is negative/positive it induces an intention to change/continue the behavior. A very complex unconscious information processing can give rise to this bit and intuition and emotional intellect could summarize the outcome of this kind of processing.

**Remark:** In TGD framework this unconscious information processing could be assigned to the levels of self hierarchy below sub-selves identified as mental images.

2. It seems that simple emotions induce the need or desire to do something, an intention. This would naturally relate to the comparison of the expected state to the perceived one. If the result is not expected, the desire to change something is created: hunger → need to eat. Computer scientist would tend to see us as collection of behavioral programs (habits and routines) and emotional coloring would suggest how to change the routine to possibly achieve the desired result.
3. Low level emotions are holistic meaning that the physiological correlates cannot be localized in particular body part. One might however argue that a person fallen in love localizes this feeling with heart. Also hunger (if counted as emotion rather than sensory experience) can be localized to stomach. In any case, emotions as mental images would be holistic and physiologically assignable to a rather large part of body. One can argue that higher level emotions such as feeling of beauty cannot be localized to body.
4. There are also experiences what one might call higher level emotions and they perhaps relate to emotional intellect and intuition. They can be created in by many manners: say by art: catharsis - experience of beauty - or by meditation - experience of bliss. It is difficult to associated this kind experiences with particular physiological events. Interestingly these emotions do not seem to induce any desire or intention.

Music creates this kind of emotions. Simplest emotions are feeling of joy and sadness correlating with the harmony of music but in general music harmony defies characterization in terms of language and in terms of emotions of real life. To my opinion this correlation is a valuable guide line as one tries to understand correlates of emotions and feelings.

### 2.3.2 Are emotions percepts or analogs of motor actions?

Concerning the generation of emotions there has been debate between proponents of two alternative visions.

1. Brain expresses emotions using body as a tool so that emotions (e-motion) would be analogous to motor activities. The problem is that emotions are not intentional actions and one cannot control them. The explanation could be that the activities generating emotions are unconscious to us. This argument might make sense: we have autonomic nervous system too.

**Remark:** In TGD framework self hierarchy could solve the problem. An action unconscious would be conscious at some lower level of the self hierarchy. Emotions would be our perceptions about what has happened at lower levels of self hierarchy and the outcome would be statistical.

This view is supported by the existence of endocrine system. Glands excreting hormones would generate the emotions as analogs of motor actions. Hormones diffuse via blood circulation and induce

emotional expression. Hormones serve as molecules of emotion and information. Hypothalamus plays the role of the highest motor area controlling by hormones the hormone expression of lower glands.

Hypothalamus, pituitary, and pineal gland are brain glands. The glands in body can also control emotions. In particular, heart muscles and epithelial cells in gut could independently express emotions by emitting hormones. Reflex action serves as an analogy for this.

2. Philosopher James proposed an alternative interpretation: body produces emotions and brain perceives them: this would explain why emotions are not under volitional control. This interpretation as such has been shown to be wrong by an experiment in which the generation of physiological correlate of emotion was prevented in gut: the emotion was however felt. It is however true that there is neural feedback giving information about the physiological state.

Candace Pert proposes in her book [7] a compromise between these views. There is the analog of sensory-motor loop involved and one cannot actually say that emotion would be associated with brain or with body: it is assignable to both of them.

**Remark:** Quite recent observation (see <http://tinyurl.com/pzfhw9d>) is that so called vagus nerve traverses all organs and couples nervous system, endocrine system, and immune system together. In TGD picture this nerve would build bridges between neurons of these systems and couple them to single quantum coherent system and allows communications with dark light between these organs.

### 3 TGD based interpretation for emotions

In TGD framework the interpretation of the transmitters involved (such as hormones) would not be as signal but as a tool creating the channels making signals propagating with light velocity (dark photons transforming to ordinary photons identified as bio-photons) and giving rise to quantum coherent active networks of cells (tensor networks) giving rise to conscious entities at some level of self hierarchy and possibly our mental images as sub-selves.

Signal molecules bound to receptors would act as small bridges connecting existing pieces of network to larger networks. These pieces would be flux tubes associated with axons in the case of nerve pulse transmission and neurotransmitters would give rise to the bridges. Synchronous neuronal firing would be a signature of the connected flux tube network. In [28] and [27] TGD inspired view about nervous system is discussed. This view has a natural generalization to the case of other signalling systems.

The dynamics for the topology (reconnections, braiding) of MB would induce the dynamics of biomolecules, cells and larger structures at the nodes of the fractal network.

#### 3.1 Basic notions of TGD inspired quantum biology

It is good to list the basic notions of TGD inspired biology once again. They are magnetic body (MB), dark matter as  $h_{eff} = n \times h$  phases of ordinary matter with  $n$  having non-standard value having first principle description in terms of adelic physics [30], and zero energy ontology (ZEO).

1. The basic distinction between TGD and Maxwell's electrodynamics and gauge theories is that every system as field identity in TGD Universe as separate space-time sheets, topological field quanta correspond to magnetic flux sheets or tubes and also to electric field has topological quanta. This follows from the notion of induced gauge field. In Maxwell's theory fields of different systems interfere, in TGD they correspond to separate space-time sheets but particle experiences the sum of the forces caused by them since it touches these space-time sheets.

This forces the replacement organism + environment  $\rightarrow$  magnetic body (MB) + organism + environment. MB receives sensory input from biological body (BB) and controls BB. Sensory input to

MB can be in terms of generalized Josephson radiation from cell membrane acting as generalized Josephson junction and coding nerve pulse patterns to frequency modulations. The control by MB can be realized in terms of cyclotron radiation to DNA (accompanied by what I call dark DNA [22]).

2. The hierarchy  $h_{eff} = n \times h$ ,  $n = 1, 2, 3, ..$  of Planck constants gives rise to a hierarchy of dark matters.  $h_{eff} = n \times h$  labels the onion like layers of MB. The size scale of give layer is by uncertainty principle of order of cyclotron wavelength  $\lambda \propto m/eB$  and thus proportional to particle mass  $m$ . The value of Planck constant determines the hierarchy level:  $n$  measures the complexity of the algebraic extension associated with the dynamics as dimension of extension of rationals involved with the dynamics at basic level, and serves as a kind of IQ. Evolution corresponds to a gradual and unavoidable increase of  $h_{eff}/h = n$  in statistical sense.
  - (a) At the atomic level the value of  $n$  seems to be  $n = 6$  rather than  $n = 1$  [29, 25]. For valence bonds the value of  $n$  is already larger and increases along the rows of the periodic table being largest for the molecules containing atoms towards the right end of the period: biologically important atoms C, N, O, S, P are examples associated with valence bonds with large  $n$ .
  - (b) For protons at hydrogen bonds the value of  $n$  is much higher than for electrons of valence bonds and the generation of hydrogen bonds could be seen as a crucial aspect of bio-chemistry. Metabolic energy is measured as the difference of the energy of bond for ordinary value of  $h_{eff}$  from the real one and one can say that metabolic energy provides for the system ability to increase its negentropy. Metabolic energy increases  $h_{eff}$  resources: this is why we must eat.
  - (c) An important additional hypothesis generalizes the notion of gravitational Planck constant due to Nottale [2]. The hypothesis [17, 18] states that at the flux tubes mediating gravitational interactions (propagation of gravitons) one has

$$\hbar_{eff} = n\hbar = \hbar_{gr} = \frac{GMm}{v_0} ,$$

where  $M$  and  $m$  are the masses associated with the ends of the flux tube and  $v_0 < c$  has dimensions of velocity. This formula holds true if  $Mm/v_0$  exceeds Planck mass squared and implies that the coupling parameter  $GMm$  in perturbation series is replaced with  $v_0/c < 1$  so that one achieves convergence.

For large values of  $M$  the value of  $h_{gr}$  can be very large, which means that long range gravitational interaction can give rise to systems with very high cognitive resources. This hypothesis generalizes also to other interactions in rather obvious manner and the phase transition increasing the value of  $h_{eff}$  leads to dark phase in which perturbation theory converges (the value of the coupling strength  $\alpha \propto 1/\hbar_{eff}$  is reduced).

The value of  $M$  depend on the state of the network defined by the flux tubes mediating gravitational interaction. At the limit of ordinary quantum gravity  $M$  would be mass of elementary particle. There is however entire dynamical fractal hierarchy of gravitational flux tubes completely analogous to those postulated flux tube hierarchies in neural system and in endocrine system. For instance, the fountain effect of superfluidity could correspond to a situation involving large value of  $h_{gr}$ . In living matter the mass of large neuron is of order Planck mass and defines kind of critical mass in the sense that gravitational interaction between two large neurons could correspond to  $h_{gr}$ .

3. Zero energy ontology (ZEO) essential for TGD inspired theory of consciousness is the third basic notion. In ZEO quantum states have as classical correlates 4-D space-time surfaces rather than time=constant snapshots of time evolution as in standard physics. They can be identified as



preferred extremals of action principle analogous to Bohr orbits. Following biologists and neuroscientists one could speak about the generalization of the notion of behavioral pattern or biological function. Computer scientist talks about programs.

The act of free will is analogous to a replacement of a deterministic program with a new one in ZEO. ZEO is actually forced by the acceptance of the fact that we have free will which must be consistent with the determinism of field equations. At quantum level, classical program as preferred extremal is replaced with a quantum superposition of classical programs, which in some resolution cannot be distinguished from each other.

System must have sensory percepts about the state of MB. If the percept is not consistent with the expectation, the perception is accompanied by negative emotional coloring.

### 3.2 Sensory perceptions as artworks

TGD view about neural system differs in several aspects from that of neuroscience.

1. Sensory organs are assumed to serve as carriers of sensory percepts: qualia [10] are not associated with sensory areas but with sensory organs [26, 28]. ZEO providing a new view about time and memory allows to solve the basic objection related to phantom limb phenomenon: pain in phantom limb would be sensory memory and realized as 4-D sensory percept having contributions from geometric past.
2. The distinction between experienced time - identified as a sequence of small state function reduction identifiable as analogs of weak measurements (generalized Zeno effect) - and geometric time identifiable as distance between the tips of causal diamond (CD) is essential for understanding this view about memory [8].
3. The assumption that sensory percepts are artworks rather than passive records of sensory input requires virtual sensory input from brain to sensory organs and build-up of the final standardized percept by pattern recognition - an iterative procedure involving very many forth-and back signals. Nerve pulse transmission is quite too slow process to allow this and dark photon signals propagating with maximal signal velocity between brain and sensory organs are suggestive [28]. Dark photons decay to ordinary photons in energy conserving manner and identifiable as bio-photons and having energy spectrum in visible and UV range [15, 16].
4. Nerve pulses and neurotransmitters would not represent real communication but give rise to temporary intra-brain communication lines along which communications as dark photon signals would take place with maximal signal velocity using dark photons (characterized by  $h_{eff}/h = n$ ) transforming to biophotons in an energy conserving manner. Neurotransmitters and also other information molecules (hormones, ..., messengers) attached to receptors would serve as bridges fusing permanent but disjoint communication lines along axons to a connected temporary communication line for dark photons to propagate. Nerve pulses would also generate generalized Josephson radiation allowing communications between biological body (BB) and magnetic body (MB) using EEG. Meridian system would be permanently connected system of communication lines.
5. This picture leads to a concrete proposal [26, 28] about the roles of DMT and pineal gland concerning imagination and dreams and hallucinations. Pineal gland would indeed serve as third eye (it serves quite concretely as an eye in some lower organisms) but receives dark photon radiation from MB. This give rise to imagined sensory percepts. DMT attaching to the receptors can lead to continuation of flux tubes down to sensory organs and this in turn would generate sensory percepts identifiable as dreams, hallucinations, psychedelic experiences, mystic experience, even encounters with extraterrestrial life-forms.

### 3.3 Emotions as sensory percepts about the state of MB

The model of emotions relies on the identification of sensations as sensory percepts about the state of magnetic body so that the same mechanisms would be involved. In particular, the percepts at the level of brain would involve iterative fourth-and-back signalling using dark photons building emotions as standardized mental images.

Consider first the view about sensory perceptions and motor actions.

1. One can argue that ordinary sensory percepts are basically observations about the state of BB. For instance, retina is part of body affected by the incoming light signal. Nerve pulses from sensory organs generate transmitters, which produce bridges connecting existing flux tubes to connected flux tube networks assignable to networks of active neurons. The activity manifests as synchronous firing. This makes possible communications with light-velocity and quantum entanglement for the network possible so that it become tensor network [24]. These network give rise to sensory mental images representing objects of the external world.

**Remark:** Cortex is essential for this process: this would mean that organisms without cortex should not be able to decompose perceptive field to objects. Is midbrain able to achieve targeted attention to some feature of perceptive field and how much does the information processing in retina contribute? Note that frogs have no cortex and are able to perceive only the motion of the target and presumably also its distance.

2. Motor action can be seen as a response to sensory percept. In ZEO motor action has interpretation as time reversed sensory perception mathematically. This is suggested by Libet's classical discovery [6] that the decision to perform motor action is preceded by neural activity in brain. TGD based interpretation is that the decision induces a classical signal proceeding to geometric past or that it replaces superposition of space-time surfaces with a new one so that the "average" geometric past changes.

This view generalizes to emotions.

1. Emotions would be seen as sensory percepts about the state of MB rather than that of BB. For the part of MB inside BB the topology of MB is under continual change and lower level emotions would characterize the state of this part of MB. Not all these emotions need be conscious to us and this might relate to diffuse de-localized character of emotions. The most important contribution to the bodily emotion would come from the dynamical pattern for the topology of MB regarded as 4-D object in ZEO.

Also now emotional mental images would be assignable to MB and would naturally be artworks involving forth-and-back signalling with light-velocity.

2. Hormones as molecules of emotion excreted to blood flow as an analog of motor response would replace neural transmitters and serve as bridges allowing to build networks of cells and possibly larger structures. Hormones would serve as tools for changing the topology of the network in body length scales and the topology would depend on the distribution of hormones. One would have the analog of sensory-motor loop involving feedback in terms of neural signals.

Hypothalamus would serve in the role of motor area in cortex and control other glands by excreting hormones controlling their hormone excretion. The neural input to brain and eventually to limbic brain would lead to the hormonal response of hypothalamus and other glands. Also MB would control the response.

As already noticed, delta waves in frequency range  $[.5,4]$  Hz (not correlating directly with our conscious experience) are involved with the control the excretion of hormones from hypothalamus. Neuroscientist would assign these waves to cortex and thalamus, In TGD framework these waves

would come from appropriate layer of MB but could have also brain counterparts since the interaction between MB and BB requires resonance and therefore same frequencies [33].

3. The connected networks of cells - or more precisely, their 4-D time evolutions as space-time surfaces analogous to Bohr orbits - would give rise to emotional mental images. The 4-D nature of basic objects could explain why emotions involve temporal aspect. Their size scale of networks would be typically rather large so that emotions or more precisely feelings associated with them would be holistic and would not allow localization to any part of body. In smaller scales they would be probably unconscious to us: this could provide an alternative explanation for the diffuse nature of emotions. Besides transmitters and hormones there are also other information molecules responsible for the generation of tensor networks inside cell and in the vicinity of cells.
4. There are also sensory percepts from the part of MB outside BB. There are no nodes defined by cells or larger structures of organism and the dynamics could involve motions of biological body perhaps representing this dynamics as a template or mimicry.

**Remark:** Since the magnetic bodies of organisms can have sizes of order Earth size and even larger different organisms - in particular those of the same species - could appear as nodes of flux tube network. This might related to the findings of Sheldrake [4, 5] about species learning [23].

Also oscillations of this part of MB - analogs of Alfven waves (see <http://tinyurl.com/7ekxqt2>) propagating with light velocity and analogous to oscillations of strings in the case of flux tubes - should contribute to sensory percepts about MB. EEG and its possibly existing fractal counterparts at higher frequency scales have natural identification as the analogs of Alfven waves and cyclotron frequencies are favoured frequencies in the control of gene expression by MB as also their differences modulated by nerve pulse patterns in the case of communication of sensory data from cell membrane to MB [12]. These oscillations could correspond to higher emotions since these parts of MB have the largest values of  $h_{eff}/h = n$ . In feelings generated by music time is indeed essentially involved and one can say that these experiences are non-local in time.

It would seem that emotions, which do not involve any obvious goal or desire - such as happiness or sadness - correspond to higher level emotions assignable to the part of MB outside MB. Note that the parasympathetic part of autonomic system - rest-and-digest mood - involves also goals/needs/desires such as sexual arousal, salivation, lacrimation, urination, digestion, and defecation so that these emotions do not correspond to "higher" ones. The sympathetic part - fight-or-flight mood - obviously involves desires and goals.

**Remark:** One of the basic paradoxes related to time is how it possible to become conscious of entire music piece in single moment as for instance Mozart did. The explanation relies on the distinction between subjective time and geometric time.

The idea the part of MB with the scale of BB stores emotional memories raises interesting questions. Could also immune system involve flux tube network? Could the meridian system of Chinese medicine (see <http://tinyurl.com/cwggkw>) be a flux tube network having acupuncture points as nodes. Is this network rather static and based solely on signalling with dark photons? The reports that heart transplants can transfer the memories of the donor to the receiver conform with the proposed vision. The claim that eating meat causes violent nightmares is supported also by my own experiences.

### 3.4 Emotions and information

It is known that emotions correlate strongly with information although emotions and rational thinking are often seen as diametrically opposite to each other. One however speaks of intuitive feelings and emotional intelligence is now a generally accepted notion.

1. Negentropy is a measure for the amount of conscious information having no counterpart in standard physics, where one can define only ensemble entropy and entanglement entropy. Entanglement negentropy is defined in p-adic sectors of the adèle and although it obeys generalization of Shannon formula it can have positive values unlike the negative of the ordinary Shannon entropy.

**Remark:** Adelic physics [30, 31] fuses real number based physics for sensory experiences (physics of matter) and various p-adic physics as physics of cognition to single structure.

2. The values of  $h_{eff}/h = n$  for given system is bound to increase in statistical sense since there exists infinite number of extensions with dimension higher than given extension and only finite number of them with dimension smaller. The increase of  $n$  does not imply increase of negentropy: it only gives prerequisites for generating larger negentropy and the system can decide whether to do this.
3. Metabolic energy feed provides system with molecules having valence bonds with values of  $n$  larger than for atoms. Hydrogen bonds and their generalization have even larger  $n$ . To gravitational flux tubes one can assign even larger  $n$ . Reality as zero energy state wants to understand itself and this leads to an increase of its negentropy in statistical sense and at the same time makes reality algebraically more complex giving rise to evolution in this manner. Note that metabolic energy does not generate negentropy as I have claimed earlier - it only makes possible to generate negentropy.

Emotions - at least those assigned to BB in the proposed model - have positive/negative coloring. What could be the interpretation of this bit.

1. Could this bit tell whether the state function reduction meaning a replacement of zero energy states as a kind of behavioral pattern with new one led to increase or decrease of negentropy?
2. Or could the color of emotion tell whether the state function reduction led to the increase or decrease of  $n$  characterizing the ability to generate negentropy.

### 3.5 "Higher" emotions and music

Music expresses emotions and also create higher level emotions. As all art, it also induces experience of beauty. Since  $h_{eff}/h = n$  serves as a kind of IQ in the evolutionary hierarchy, there are good reasons to expect that the emotions/feelings induced by music and other art forms are assignable to MB.

The dynamics of MB involves oscillations characterized by frequencies and in EEG frequencies are of key importance for the part of MB outside biological body. The communications from cell membrane to MB involve modulation of EEG frequencies identified as generalized Josephson frequencies by nerve pulse patterns [12] and would define a coding of sensory data to higher level emotions. The control signals from MB via DNA inducing gene expression would use dark photons at cyclotron frequencies to control BB.

#### 3.5.1 Model for music harmonies and genetic code

For few years ago I ended up with a model of music harmonies leading also to a model of genetic code as a side product [20].

1. The idea was that the 12-note scale could allow mapping to a closed path (octave equivalence) going through all vertices of icosahedron having 12 vertices and not intersecting itself. Also the idea that the triangles defining the faces of the icosahedron have interpretation as 3-chords defining the notion of harmony for a given chord deserves study. The paths in question are known as Hamiltonian cycles and there are 1024 of them [1]. There paths can be classified topologically by the numbers of triangles containing 0, 1, or 2 edges belonging to the cycle representing the scale. Each topology corresponds to particular notion of harmony and there are several topological equivalence classes.

2. In the article [21] I introduced the notion of Hamiltonian cycle as a mathematical model for musical harmony and also proposed a connection with biology: motivations came from two observations. The number of icosahedral vertices is 12 and corresponds to the number of notes in 12-note system and the number of triangular faces of icosahedron is 20, the number of amino-acids. This led to a group theoretical model of vertebrate genetic code and replacement of icosahedron with tetra-icosahedron to explain also the 21st and 22nd amino-acid and solve the problem of simplest model due to the fact that the required Hamilton's cycle does not exist. The outcome was the notion of bio-harmony.
3. All icosahedral Hamilton cycles with symmetries ( $Z_6, Z_4, Z_2^{rot}$  and  $Z_2^{refl}$ ) turned out to define harmonies consistent with the genetic code. In particular, it turned out that the symmetries of the Hamiltonian cycles allow to predict the basic numbers of the genetic code and its extension to include also 21st and 22nd amino-acids Pyl and Sec: there are actually two alternative codes - maybe DNA and its conjugate are talking different dialects! One also ends up with a proposal for what harmony is leading to non-trivial predictions both at DNA and amino-acid level.
4. The conjecture is that DNA codons correspond to 3-chords perhaps realized in terms of dark photons - music of light - or even ordinary sound. 256 different bio-harmonies are predicted and these harmonies would give additional degrees of freedom not reducing to biochemistry. Music expresses and creates emotions and a natural conjecture is that these bio-harmonies are correlates of emotions/moods at bio-molecular level serving as building bricks of more complex moods. Representations of codons as chords with frequencies realized as those of dark photons and also sound is what suggests itself naturally. This together with adelic physics involving hierarchy of algebraic extensions of rationals would explain the mysterious looking connection between rational numbers defined by ratios of frequencies with emotions.
5. In fact, also the emotions generated by other art forms could be realized using music of dark light. Dark photons in various wavelength ranges and correspond to various values of  $h_{eff}$  would correspond to various sensory qualia and are represented at pineal gland ("third eye") as imagined sensory percepts [28]. They can be transformed to real sensory percepts at sensory organs by using DMT molecules as bridges allowing the propagation of dark photons (or the bio-photons resulting in their energy conserving transformation to ordinary photons) to sensory organs, where they generate genuine sensory experience identified as dream, psychedelic experience, hallucination, etc...

### 3.5.2 How to realize emotions as music of genes concretely?

How to realize the music of genes represented as sequences of 3-chords of dark light as a communication tool between dark and ordinary DNA/RNA and possibly even dark and ordinary variants of tRNA and amino-acids?

1. Communication between ordinary and dark matter levels must be possible. This is guaranteed if the transition energy spectra at different levels of  $h_{eff}/h = n$  hierarchy contain common transition energies so that a resonant interaction by exchange of dark photons becomes possible. This condition is extremely demanding and could explain why basic bio-molecules are selected amongst numerous alternatives [33] - this is indeed one of the hen-egg problems of pre-biotic evolution.
2. A hypothesis worth of studying is that the cyclotron transition energies of both ordinary DNA and RNA nucleotides and their dark variants represented as dark proton sequences are same [33]. Cyclotron transition energies should cover several octaves and the natural proposal is that magnetic field strength associated with the flux tube codes for the notes. In music experience roughly 10 octaves are needed corresponding to the range of audible sounds.

3. The cyclotron frequencies of DNA nucleotides A, T, C, G are very nearly the same and near 1 Hz for  $B = B_{end} = .2$  Gauss since their masses do not differ much. Since the nucleotides are negatively charged, also the cyclotron energies for codons and codon sequences are around 1 Hz.  $h_{eff} = h_{gr}$  hypothesis states that the cyclotron energies of DNA are in the energy range of bio-photons in visible and UV.

There should be correspondences between a) the 64 ordinary DNA codons and allowed 3-chords and b) 64 dark variants of DNA codons and allowed 3-chords. These correspondences fix that between ordinary and dark codons. One would have triality.

1. To realize music of genes one the value of  $B$  must have values in a range of several octaves. The magnetic field strengths  $B$  associated with the flux tubes accompanying DNA strand should have a spectrum given by 12-note scale. Both 64 dark DNA codons and  $4^3 = 64$  ordinary DNA codons should correspond to  $20 + 20 + 20 + 4 = 64$  allowed 3-chords formed from the notes of 12-note scale.
2. Dark codons correspond to entangled states of 3 dark protons. The positions of dark protons are different so that permutations of the positions of dark protons are involved. The invariance of 3-chord under permutations of notes would correspond to fermionic statistics. These permutations are lifted to braidings if dark protons are connected by flux tubes to some other system, for instance ordinary DNA.

If the dark protons are ordered linearly along flux tube, it would seem that these these positions correspond to those of ordinary code letters. This does not make sense. If the letters of codon are connected to the dark protons by flux tubes, the permutations of dark codons induce braiding of the flux tubes but do not affect the order of the letters of the ordinary codon. Braiding would become an essential part of the correspondence between ordinary and dark codons.

3. One should understand the correspondence of dark codons with the allowed 3-chords of a given harmony and also with the ordinary DNA codons. Bio-harmony is defined as a composite of 3 harmonies with 20 allowed 3-chords and having symmetries  $Z_6, Z_3$ , and  $Z_2$  and of tetrahedral harmony with 4 chords. Tetrahedron can be regarded as disjoint object or attached to DNA, and this gives two variants of code.

How could these the icosahedron Hamilton cycles relate to the physical realization of dark proton triplets? Each icosahedron cycle should give rise to 20 dark proton triplets. Why the icosahedron geometry with Hamiltonian cycle should make itself manifest in the quantum physics of dark proton triplet?

4. Could icosahedron geometry quite concretely correspond to a tensor network? The vertices of the icosahedron would be connected by a sequence of flux tubes connecting nearest neighbors to form a Hamiltonian cycle. Dark proton triplets would quite concretely be localized at the triangular faces of the icosahedron.

Braided triplet of flux tubes would emerge from the vertices of an icosahedron triangle defining 3-chord and would connect it to the nucleotides of the corresponding ordinary DNA codon. Magnetic field strengths at these flux tubes would correspond to the notes of 12-note scale as defined by the Hamiltonian cycle in question. The permutations of the dark proton states at the vertices of the triangle would induce braidings of the flux tube triplet actually defining minimal braid in topological quantum computation (sic!) The braiding accompanying the states of 3 dark protons would make the correspondence with ordinary ordered DNA codons possible.

Note that each dark proton triplet could be also connected (without braiding) to its conjugate dark proton triplet by a triplet of flux tubes so that one would obtain closed flux loops and one could speak of knots instead of braids.

**Remark:** Braiding brings strongly in mind the many TGD inspired proposals for DNA as topological quantum computer [?, ?]: maybe DNA as topological quantum computer could be (also?) realized in this manner.

What physical objects could the 20 vertices of icosahedron correspond to? Hydrogen bonded water clusters give rise to both tetrahedral and icosahedral structures. Could one associate dark proton triplets to the dark parts of these structures? Could one try to experimentally identify possible sequence of icosahedral water molecule clusters with vertices connected by hydrogen bonds associated with the DNA sequence? If the hydrogen bonds correspond to flux loops as suggested, they can be rather long (proportional to  $h_{eff}/h = n$ ) so that even distant water molecules can become hydrogen bonds and one could have a fractal hierarchy of icosahedra.

5. Resonance condition suggests that at the level of ordinary DNA double strand the cyclotron energies of dark protons associated with the hydrogen bonds connecting DNA nucleotides correspond to those of flux tube triplets connecting ordinary and dark DNA codons. The magnetic field strengths associated with the dark flux tubes accompanying hydrogen bonds would correspond to those associated with the triangles of icosahedral triangle. This would make possible communication between the two dark sectors by dark-photon triplets as music of genes.

This leaves unanswered questions.

1. Why the  $20+20+20=60$  3-chords from 3 harmonies with different icosahedral symmetries ( $Z_6, Z_3, Z_2$ ) and 4 chords from tetrahedral harmony would combine to form single bio-harmony with 64 chords? This requires the presence of 3 Hamiltonian cycles with different symmetries. Why all three different symmetry types for DNA and RNA? Could the 20 amino-acids correspond to single symmetry type? Could tRNA codons correspond to two symmetry types?
2. How the 3-chords of dark photons could be played? 3-chord should be a collective effect affecting both dark and ordinary codon by inducing emission of 3-photon state like - like playing a chord by string instrument. The notes of the light chord need not emerge simultaneously but as arpeggios. Could there be a pulse travelling along the Hamiltonian cycle and picking all the cyclotron notes at the vertices containing dark proton and sending a cyclotron signal along flux tubes to ordinary DNA codon. This pulse would travel along dark DNA and play the music defined by dark DNA sequence.

### 3.6 Support for the view that information molecules serve as bridges in flux tube networks

I have discussed information molecules from TGD point of view for for the first time about two decades ago [11]. It was amusing to find that this discussion highlighting the interpretational problems related to information molecules is still very topical. These strange findings give direct support for the view that information molecules serve as bridges making possible the formation of networks of cells interpreted in terms of flux tube networks in TGD framework. For this reason I glue below the earlier discussion followed by the recent comments.

*"Central nervous system (CNS), endocrine system and immune system are three basic systems involved with bio-control and -communication. The work of Candace Pert and other neuroscientists has led to a general notion of information molecule described in popular manner by Candace Pert [7]. Neural transmitters and modulators associated with CNS are only special cases of information molecules. Also neuropeptides and various hormones are involved. It has become clear that emotions are closely related with the activity of information molecules and that both brain, endocrine system and immune system communicate intensively with each other. One could regard even brain as a big gland. Of course, one could also consider various glands and organs as mini-brains.*

*The interactions of the information molecules involve the formation of receptor-information molecule complex either at cell surface or in the cell plasma inside cell. Receptor-information molecule complex inside cell can move to genome and induce gene transcription. In case that the complex is formed at the surface of cell, second messenger action is involved. One can also speak about N:th messenger action. There are many poorly understood aspects related to the mechanisms of information molecule action [3].*

- 1. There are only few second messenger pathways and relatively few receptors but large number of different functions. This phenomenon is known as pleiotropy or multi-functionality. For instance, given second messenger causes different effects depending on the hormone that activated it (the phenomenon is somewhat analogous to the phenomenon in which message can be understood in several manners depending on the state of receiver). At purely chemical level the problem is how second messenger knows what hormone activated it? In steroid action the complex formed by information molecule and receptor in turn activates some gene. Now the question is: How the activated RNA polymerase knows which gene has to be activated? Pleiotropy appears also at level of hormones. Same hormone can have multiple effects and the border between hormone, neuropeptide or even neurotransmitter is unclear. For instance, hormone which by definition transmits long distance communications, can have effects in nearby cells and thus acts like a neuropeptide. How hormone knows what function it must perform? Also drugs and treatments can have different effects and side effects.*
- 2. There is also functional redundancy: the same function is performed by several second messenger molecules. For instance, glucagon, growth hormone, adrenaline and corticosteroids elevate glucose levels. This suggests that there is deeper level of communication involved and that second messenger molecules are more like computer passwords than subprogram calls. Now the question is: What these subprogram calls do correspond physically?*
- 3. Biological functions can be initiated also in non-chemical manner. The phenomena of healing by touch and the effects of meditation and biofeedback are examples of biological self-organization processes are initiated in non-chemical manner. Even other treatments like massage, acupuncture or meditation can decrease or inhibit pain. These observations suggest that chemical level is not the deepest level involved with biological functions and the question is: What is this deeper control level?*

*Simple lock and key mechanism cannot provide answer to the questions raised above. Rather, computer password might provide better metaphor for the second messenger action whereas receptor-information molecule complex would effectively generate subprogram call perhaps carried by the second messenger molecule or possibly broadcasted. It seems that information molecules act more like signs or symbols rather than being purely chemical agents. These symbols are interpreted by cell level intelligences and the interpretation depends on context.”*

The mysterious looking finding is that the cell activated by information molecules somehow knows, which information molecule did the activation. This can be understood if the information molecule attached to the receptor serves as a bridge so that the cell becomes part of a flux tube network to which information molecule characterizes. The recent interpretation is in terms of a generation of a flux tube network. Information molecule characterizes the network which is formed. The information storage capacity of these networks - allowing quantum entanglement - is exponentially large than that of state of the nodes: hence the naive AI based idea about copying consciousness to diskette by assigning a bit to each neuron is extremely unrealistic.

### **3.7 Getting memories by eating those who already have them**

While writing this article I learned about extremely interesting findings. I have already earlier written about the finding that both pieces of a split planaria inherit the memories (identified as learned skills or conditionings) of the original planaria [14]. One possibility is that the bodies rather than brains of the



planaria carry the memories. Second possibility is that the splitting of planaria involves the replication of its magnetic body carrying at least some of the memories. The news at this time was that planaria get the memories of planaria that they have eaten!

To begin with, one must carefully distinguish between genuine memories and memories as behavioral patterns (conditionings, skills).

1. Cognitive memories as behavioral patterns are assumed to be due to the strengthening of synaptic contacts (long term potentiation (LPT, see <http://tinyurl.com/yafzovyk>) giving rise to nerve circuits, which are active or easily activated.

In TGD framework activation means formation of flux tube network giving rise to quantum entangled state with neurons at the nodes: neural activity generates transmitters serving as bridges between flux tubes associated with axons and create flux tube network carrying a conscious mental image. A quantum coherent entangled tensor network is formed and also classical communications using dark photons are possible in this state. These neurons are firing synchronously. Nerve pulses would not be signals between neurons but would induce communications to magnetic body in scales even larger than body.

2. Genuine memories - say episodal memories - would in TGD (zero energy ontology, ZEO) correspond to neural activities in geometric past: kind of seeing in time direction. These are typically verbal memories but also sensory memories are possible and can be induced by electric stimulation of brain.

Consider now the experiments discussed in the popular article "*Somewhere in the brain is a storage device for memories*" (see <http://tinyurl.com/y8ejpcho>). They all relate to the identification of memory as a behavioral pattern induced by conditioning and are therefore emotional memories.

1. In one experiment sea slugs learned to avoid painful stimulus. This led to a generation of synaptic contacts between neurons involving increased synaptic strength - long term potentiation (LPT). Then some drug was used to destroy the LPT. The problem was that the lost contacts were not those formed when the memory was formed!
2. In second experiment mice were used. A conditioned fear (LPT) was induced in mice and again the generation of synaptic contacts was observed. Then the contacts - long term potentiation - was destroyed completely. Memories as conditioned fear however remained!

It was an amusing accident to learn about this just when I was building a model for emotions as sensory percepts about the state of magnetic body (MB) fundamental in TGD inspired quantum biology.

1. In the recent case the memories are definitely emotional memories and in TGD framework they would be naturally at the level of body and generated as mental images associated with large numbers of ordinary cells appearing as nodes of quantum entangled flux tube networks giving rise to tensor networks [24]. Hormones would be the tool to generate and modify these networks.
2. Emotional memories would be represented by the conditioning and analog of LPT at the level of body rather than at the level of brain! Hormones like also other information molecules would act as relays connecting existing pieces of network to larger ones! The neural activity would be involved only with the generation of memories and induce hypothalamus to generate the fear network using the hormones controlling hormonal activities of lower level glands.
3. The model could also explain the finding that in the splitting of flatworm the both new flatworms inherit the memories and that even non-trained flatworms eating trained flatworms get their memories (defined as behavioral patterns involving emotional conditioning).

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