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Biophysical visual virtual reality in retinotopic visual areas

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Abstract

Previously, we have pointed out that biophoton production can be a controlled process that originates from regulated redox/radical reactions. Our biophoton experiments support the notion that various visual related phenomena such as discrete retinal noise, retinal phosphenes as well as negative afterimages are due to biophotons. We have also suggested a new model, stating that the brain is able to create biophysical pictures in retinotopic visual areas via redox regulated biophotons of synchronized neurons. According to our interpretation, visualization (imagery) is a special kind of representation i.e., visual imagery requires peculiar inherent biophysical processes. Our idea of biophysical visual virtual reality in retinotopic areas may be a possible biophysical basis of Kosslyn's reality simulation principle in the case of visual imagery. Long-term visual memories are not stored as biophysical pictures but as epigenetic codes. During visual imagery, top-down processes control the epigenetic encoded long-term visual information. Then, according to retrieved epigenetic information, synchronized retinotopic neurons generate dynamic patterns of biophotons via redox reactions that can produce biophysical pictures. We have also presented an iterative model involving a biophysical picture-representation without *homunculus* during visual imagery.

1. Redox regulated biophotons

A great number of experiments have provided strong evidence that ROS (reactive oxygen species) and RNS (reactive nitrogen species) as well as their derivatives act as regulated secondary messengers in diverse cells and neurons during intracellular signaling and intercellular communication processes[9]. The delicate balance between beneficial and harmful effects of free radicals is essential for redox regulation and redox homeostasis of cells.

Ultraweak photon emission (biophoton) is continuously emitted by all living cells without any excitation. Since the production of ROS and RNS is not a random process, but rather a precise mechanism used in cellular signaling pathways, the biophoton emission can also be a redox regulated process in diverse cells and neurons.

2. Retinal discrete dark noise via biophotons

Recently, we suggested that the discrete dark noise of rods (*spontaneous rhodopsin activation in dark-adapted retinal cells*) can be due to the bioluminescent biophotons generated continuously by retinal lipid peroxidation and oxidative metabolism[5].

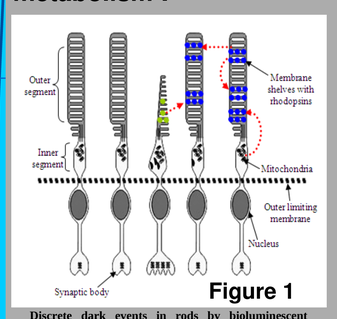

Figure 1

Discrete dark events in rods by bioluminescent photon (red arrows). Rods can absorb bioluminescent photons from the lipid peroxidation of adjacent rods. It is also possible that a given rod emits a bioluminescent photon that changes it direction and a little later it can absorb its own bioluminescent photon. What is more, bioluminescent photons, emitted from the mitochondrial oxidative metabolism in the inner segment, can also be absorbed by rhodopsin.

Later, we presented the first experimental proof of the existence of spontaneous ultraweak biophoton emission and visible light induced delayed ultraweak biophoton emission from *in vitro* freshly isolated rat's whole eye, lens, vitreous humor and retina[2]. Our experimental results support that the retinal dark noise can result from bioluminescent photons (see Fig.1).

3. Retinal phosphenes by biophotons

Bókkon proposed a new biopsychophysical concept of phosphene phenomenon[7]. He raised that various stimuli such as mechanical, electrical, magnetic, ionizing radiation etc., as well as random biophotons firings of cells in the visual pathway can elicit an unregulated overproduction of free radicals and excited species, which generate a transient increase of biophotons in different regions of the visual system. If this excess biophoton emission exceeds a distinct threshold, it can appear as phosphene lights in our mind. However, our experiments about spontaneous and visible light induced delayed biophoton emission from isolated rat's whole eye[2], lens, vitreous humor and retina sustain this new photo-biopsychophysical concept at least in the case in retinal phosphenes. However, if it can be demonstrated that perception of cortical phosphene lights is also due to neurocellular biophotons, intrinsic regulated biophotons of retinotopic visual areas can serve as a natural biophysical (*redox molecular*) substrate of visual perception and imagery.

4-a. Biophysical pictures during visual perception and imagery

Based on the above mentioned functional roles of free radicals and regulated ultraweak biophoton generation in cells and neurons, Bókkon and Bókkon and D'Angiulli put forward a redox molecular hypothesis regarding the natural biophysical substrate of visual perception and visual imagery[6,8]. It states that retinotopic electrical signals (*spike-related electrical signals along classical axonal-dendritic pathways*) can be converted into regulated biophoton signals by redox processes that make it possible to produce biophysical picture representation in retinotopically organized mitochondrial cytochrome oxidase-rich visual areas during visual perception (see Fig.2) and visual imagery (see Fig.3). During visual imagery, top-down processes trigger and regulate the epigenetically encoded long-term visual information. Then, according to retrieved epigenetic information, mitochondrial networks in synchronized neurons generate dynamic patterns of biophotons via redox reactions. Finally, synchronized dynamic patterns of biophotons can produce biophysical pictures (depictive representation) in retinotopic visual neurons of V1 and V2 via iterative processes (see Fig.3 and Fig.4)

4-b. Biophysical pictures during visual perception

During visual perception, visual redox buffer can use bottom-up and top-down processes to display visual perceptions and makes it possible to visualize or identify an object[6,8]. We have stressed that the actual biophoton intensity can be drastically higher inside cells compared to their surrounding environment and according to our rough calculations, the real biophoton intensity within retinotopic visual neurons may be sufficient to produce intrinsic biophysical picture representation[4].

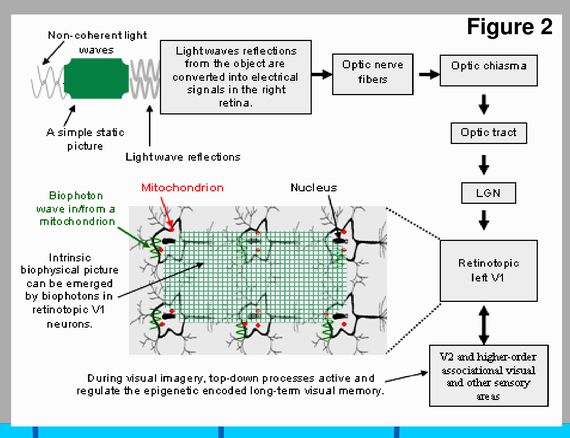

Figure 2

4-c. Biophysical pictures during visual imagery

The long-term visual information can be stored as epigenetically encoded long-term visual information and not as biophysical pictures. During visual imagery, top-down processes trigger and regulate the epigenetically encoded long-term visual information. Then, according to retrieved epigenetic information, mitochondrial networks in synchronized neurons generate dynamic patterns of biophotons via redox reactions that can produce biophysical pictures (depictive representation) in retinotopic visual neurons[6,8].

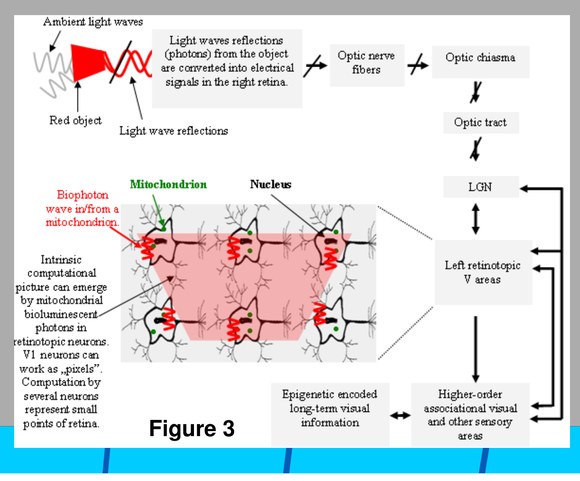

Figure 3

5. Visible light induced ocular delayed bioluminescence as a possible origin of negative afterimage

A generally accepted concept of negative afterimages is based on the photopigment-bleaching hypothesis. However, there are several contradictions about photopigment bleaching idea. In addition, in a dark room, the photopigment bleaching idea cannot explain that where the source is of negative afterimages with closed eyes without any external photon stimulation.

Based on our experiments about visible light induced delayed biophoton emission from isolated rat's whole eye, lens, vitreous humor and retina[2], we suggested that the photobiophysical source of negative afterimage can also occur within the eye by delayed bioluminescent photons[1]. In other words, when we stare at a colored (or white) image for few seconds, external photons can induce excited electronic states within different parts of the eye that is followed by a delayed reemission of absorbed photons for several seconds. Finally, these reemitted photons can be absorbed by non-bleached photoreceptors that produce a negative afterimage interpreted and modulated by cortical neurons.

6. Biophysical picture-representation without *homunculus* during visual imagery

During visual imagery, top-down processes activate and regulate the epigenetic encoded long-term visual memory. Next, according to retrieved long-term information, mitochondrial networks within synchronized neurons produce dynamic patterns of biophotons via redox reactions. These dynamic patterns of biophotons can produce biophysical pictures (depictive representation) in retinotopic and mitochondrial rich visual neurons by iterative processes[3] (see Fig.4). As a result, we could retrieve what we thought we would have seen or done in the analogous perceptual situation during visual imagery.

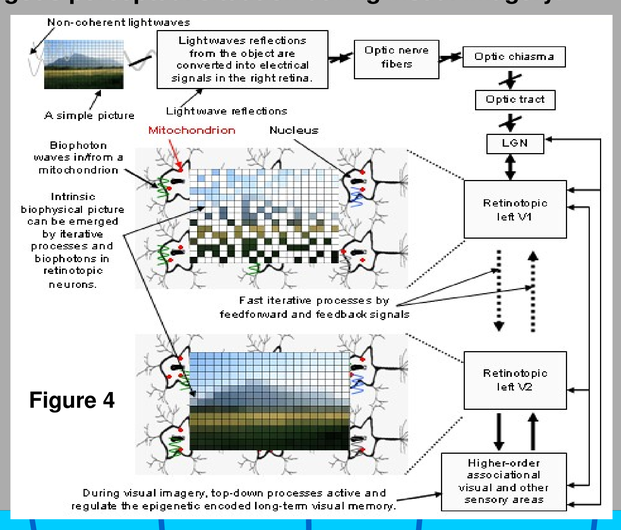

Figure 4

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