A Theoretical Framework for Photosensitivity: Evidence of Systemic Regulation

Ewing G.W

Montague Healthcare, Mulberry House, 6 Vine Farm Close, Cotgrave, Nottinghamshire NG12 3TU, England

Abstract

There is not yet a precise understanding of why flashing lights could be used to induce photosensitive migraine and epilepsy or why flashing lights could be used with therapeutic effect.

Most Proteins and enzymes are activated by light. The chemiluminescence arising from protein-substrate reactions influences visual perception which can be measured. This can be adapted diagnostically. Each protein-substrate reaction releases biophotons of light, commonly known as autofluorescence or chemiluminescence, the colour being unique to each protein-substrate reaction and the intensity being a measure of the rate of reaction. The degree of activation or deactivation of such reactions is dependent upon the prevailing reaction conditions i.e. the influence of systemic parameters (pH, temperature, levels of minerals, etc).

Knowledge of the nature and structure of the physiological systems enables a wider understanding of systemic dysfunction and pathology(s). Specific neural (EEG) frequencies can be associated with visual perception. This can be adapted therapeutically i.e. to photostimulate inhibited protein-substrate reactions thereby regulating the function of each physiological system. By such biofeedback technique(s) it may be possible to treat, in a person-specific manner, the dysfunction associated with specific physiological and psychological disorders.

Keywords: Light; Enzymes; Proteins; Mathematical modelling; Physiological systems; Autonomic nervous system; Visual perception; Virtual scanning

Introduction

Light is an essential requirement for life. It may be supplied by the absorption of sunlight and/or it may be generated by chemiluminescent processes. The precise selection of colour and its intensity are linked to the function of the autonomic nervous system (Kraak, 1941) e.g. it is essential for cellular respiration (Warburg, 1931). Light-based therapies are used in the treatment of neonatal hyperbilirubinemia (Cremer et al., 1958; Sisson, 1976), seasonal affective disorder (Lam et al., 2006; Oren et al., 1991; Wirz-Justice et al., 1996; Wileman et al., 2001), hormonal imbalance (Hollwich and Dieckhues, 1980), etc. Many technologies have been developed which use light although without a precise understanding of the mechanisms involved. Flashing lights at specific frequencies have been shown to induce migraines and/or epileptic fits and, at different frequencies, they have been shown to have a therapeutic benefit. Over 100 medical conditions are known to respond to the therapeutic influence of light. It influences immune function and the morbidity associated with viral infections (Finsen, 1895; Finsen, 1903; Moller-Sorensen and Brade, 1995; Moller et al., 2005). Its influence is context dependent i.e. disease is more prevalent at higher latitudes (multiple sclerosis (Goldacre et al., 2004), cancer(s) (Garland et al., 2006; Kent et al., 2009), depression (Gonzalez and Aston-Jones, 2008), chronic fatigue syndrome, etc) where there is lower levels of natural sunlight. The influence of light upon the body’s physiology: immune response (Roberts, 1995), hormonal system (Hollwich and Dieckhues, 1980) and neurotransmitters (Shealy, 1990), etc is widely reported.

The body absorbs light but it also emits light (Kobayashi et al., 2009). The absorption of light is widely studied however the emission of light is less well understood and is known variously as autofluorescence, chemiluminescence, bioluminescence, biophoton emission, etc (Shimomura et al., 2008). Such emission of light is associated with the activation of enzymes and proteins and their subsequent reaction or interaction with reactive substrates. Under normal circumstances the absorption and emission of light are in an apparent equilibrium however the consequences of stress, and of subsequent oxidative stress reactions, create pathological processes which influence this balance and alter the nature and emission of photon emission (Rattemeyer and Popp, 1981; Grasso et al., 1992). This influences visual perception (Ewing and Parvez, 2008; Ewing and Ewing, 2008) i.e. such changes to visual perception are the consequence of altered biochemistry arising from pathologies and the use of drugs.

Intensity and colour of light

In order to excite the circadian system it is considered that the prevailing light intensity should be approximately 1000 lux. Melanopsin, a key protein in the function of the body clock, is excited by blue light (Avery et al., 2001; Avery et al., 2001; Rea et al., 2004). Morning light brings about a more rapid end to melatonin secretion; exposure to sunlight increases serotonin production; whilst the decline of natural sunlight later in the day stimulates melatonin production, the onset of sleep and

*Corresponding author: Ewing G.W, Montague Healthcare, Mulberry House, 6 Vine Farm Close, Cotgrave, Nottinghamshire NG12 3TU, England. E-mail: graham.ewing@montaguediagnostics.co.uk, graham.ewing@montague-diagnostics.co.uk

Received December 02, 2009; Accepted December 26, 2009; Published December 26, 2009


Copyright: © 2009 Ewing GW. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
production of Human Growth Hormone (HGH). Sleep on its own has not been recognised to perform a function although the quality and quantity of light and sleep influences cognitive function (Tonks, 1999), morbidity and mortality.

**Sleep facilitates the production of HGH**

Nearly fifty percent of HGH secretion occurs during the third and fourth REM sleep stages (Takahashi et al., 1968). This indicates that Sleep provides a regenerative, regulatory or coordinating role facilitating the production of key biochemicals which are necessary for other systems and organs (cardiovascular, endocrine, pancreas, etc) to function properly (Shannahoff-Khalsa et al., 1996; Shannahoff-Khalsa et al., 1997; Shannahoff-Khalsa and Yates, 2000; Shannahoff-Khalsa et al., 2001) and hence that lack of sleep influences the function of other systems.

HGH and its various isomers are considered essential for growth, cell reproduction and regeneration in humans. It is implicated in regulation of body fat, muscle mass, bone density, energy levels, sexual function and immune function. It is produced in a pulsed manner of typically 3-5 hour intervals. The production of HGH is age-related. Teenagers produce HGH at typically 700μg/day whilst adults produce at typically 400μg/day. In general, the rate of HGH production declines with age. Stress in its many and various manifestations influences all aspects of autonomic (ANS) function including sleep. HGH production (Shannahoff-Khalsa et al., 1997), immune function (Kiecolt-Glaser and Glaser, 2002), the speed of recovery following illness, etc.

**Circadian rhythms**

There is evidence of cycles influencing almost every aspect of the body’s function e.g. changes at puberty, pregnancy (9 months), menstruation (28 days), circadian cycle (24 hours), the sleep cycle (90 minutes) and many lesser ultradian cycles; each being evidence of significant biochemical changes (and their rate) in the body at the systemic, organ/cellular and molecular levels e.g. pancreatic cycles which are typical of a feedback control loop which monitors insulin release and blood glucose levels. This is necessary because insulin is highly reactive and internal manufacture of insulin by the pancreas is relatively slow. Circadian rhythms are common to many lifeforms and are a feature of the body’s basic biochemistry (Sweeney and Borgese, 1989; Kondo et al., 1993; Halberg et al., 1965; Katinas et al., 2002). Light influences the autonomic nervous system (Krakov, 1941) and is essential to the regulation and stability of the circadian rhythms (Halberg et al., 1970; Sanchez de la Pena et al., 1989; Hillman et al., 1994), the body’s timing, and its systemic function.

What is not yet known is how the body regulates its function. Is this by light or by biochemistry alone i.e. the autonomic nervous system, or does it involve frequency or a combination of all or some of these factors?

---

**Table 1: Physiological Systems.**

<table>
<thead>
<tr>
<th>Sleep</th>
<th>Temperature</th>
<th>Breathing</th>
<th>Digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td>Blood volume</td>
<td>Blood Glucose</td>
<td>Blood Cell Content</td>
</tr>
<tr>
<td>pH</td>
<td>Sexual function</td>
<td>Osmotic Pressure</td>
<td>Excretion (Uranation)</td>
</tr>
<tr>
<td>Posture &amp; Locomotion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Systemic Function**

**The nature and structure of the physiological systems (revised)**

The Russian researcher I.G. Grakov has mathematically modelled the relationship between cognition, the autonomic nervous system and physiological systems. This includes a revised understanding of the physiological systems (see Table 1) and a revised understanding of the role performed by sleep.

Of these physiological systems only sleep has an apparently unexplained function. Each system performs an essential physiological function and is regulated by a network of organs. Extremes of system function are recognised and referred to as *hyper* function or *hypo* function. Such a viewpoint is not new to the GP who routinely assesses the stability of the physiological systems, albeit in an empirical manner, however Grakov’s revised understanding differs in the following respects: (Krakov, 1941) the inclusion of sleep, temperature, osmotic pressure and pH as physiological systems; (Warburg, 1931) the revised understanding of the cardiovascular system as breathing, blood glucose, blood pressure, blood volume and blood cell content; (Cremer et al., 1958) the exclusion of an immune system i.e. its inherent presence in other systems (e.g. digestion, pH, sleep, blood cell content, etc); (Sisson, 1976) the inclusion of locomotion and posture as a physiological system. Such an explanation is inclusive of all functional systems in the body by comparison with the conventional explanation which excludes consideration of vital aspects of the body’s physiology and function.

**Examples of synchronised function between organs**

That the body’s complex multi-systemic function is regulated is evident by considering the digestive system i.e. that the taste and chewing processes forewarn the digestive system: fermentation by the stomach, preparation of gastric juices and their synchronised and regulated input into the digestive system by the gall bladder, absorption of nutrients by a suitably functioning set of intestines (and hence of appropriate blood quality), neutralisation of excess acids, and ultimately the storage and release of excrement. Poor quality or quantity of pancreatic juices/bile salts, digestive acidity or blood, or their desynchronised function (e.g. premature or delayed addition of pancreatic juices), influences digestive function and the degree of absorption of specific nutrients.

Another example is that of heart function mathematically modelled at the biochemical level (Noble, 2008) however, apart from the practical limitations of such models there is the significant lack of consideration that sensory input/stress could influence the function and stability of the visceral organs (Zagulova et al., 2001) or that there could be a mechanism which regulates the function and stability of physiological systems and inherent organ networks (Ewing and Ewing, 2008).
The Significance of Sensory Input and Sense Perception

There is no evidence to support the contention that the eyes take snap shots or photographs of the world or that the brain has an internal cinema to view the world in a holographic manner. The evidence indicates that the eyes and brain receive information on an almost continuous basis and that this information is stored in neuronal structures. Moreover, the brain does not react to every individual stimulus. It responds to sequences of sensory input which have specific significance (intensity) and/or which compare with stored memories. We note from the phenomena ‘subliminal imaging’ that the brain sees or processes information abt once every cycle and that the rate of visual cycles is typically 40 Hz (i.e. within the gamma frequency range (30-60 Hz) or every 0.25 milliseconds). This indicates that the sensory perception or neural representation of a particular object is encoded by the prevailing biochemistry and by the electrochemical activity associated with differing frequencies (Gray et al., 1989; Eckhorn et al., 1988).

If the brain worked by taking a series of pictures there would be a significant chance that a great deal of visual input would be out of phase therefore the brain must continuously be in phase, or must receive data sufficiently quickly that phasing is not a significant impediment, therefore sensory input and the brain waves, must operate continuously i.e. in a seamlessly overlapping mode. It is also worth noting that our view of a particular object is not one ‘photo’ but instead the summation of a huge amount of visual information comprising shape, colour, visual contrast, and the time to observe the object i.e. we continuously assimilate visual input. Accordingly the presentation of light as a frequency or flashing light will influence the absorption of specific colours of light and of its intensity every cycle. It requires several exposures for a short-term memory to be created i.e. for the first such memory there is no residual memory. There cannot be. It is the first exposure which creates the memory. If the colour alters the effect will be random, however if the same colour is continuously presented this will amplify the absorption of this colour and hence its therapeutic effect upon the body’s biochemistry. It indicates that the rate of receiving and processing sensory information, in particular of visual information, is related to pathologies, age and weight. It explains why response times slow down with increased age and weight. It illustrates that age-related cognitive decline is the physiological consequence of biochemical changes (Ambatipudi et al., 2009) which cease to support the proper function of the neuronal structures and, as a consequence, the creation of memories. The evidence also illustrates that the eyes do not function independently of the other senses but instead function as part of a multi-sensory data processing matrix. Under normal circumstances the eyes are responsible for an estimated 85% of sensory input with verification being provided by the other senses. This is supported by considering how, in the visually impaired, the brain is able to compensate and amplify non-visual input.

There is no evidence that the neuronal structures store complex pieces of information but instead that each stores simple pieces of information and that it is the context in which such information is stored which, when accessed and decoded, is interpreted as a distinct memory i.e. as sensory input is converted into biochemical and electrochemical impulses the brain must store data as complex biochemical and/or electrochemical signatures. Furthermore the ability to store memories is influenced by the prevailing neuronal biochemistries and brain wave frequencies. This illustrates the influence of biochemistry i.e. including the function of the visceral organs, upon memory formation. The process of ‘long-term potentiation’ (Lynch and Baudry, 1984) is considered essential for the formation and storage of new memories and the recall of old memories. This illustrates the potential to use frequency to stimulate the production of specific neurotransmitters e.g. of serotonin, melatonin, catecholamines, etc. It does not however consider the wider implications of the varying EEG frequencies i.e. the multi-level nature of memory and of events of differing physiological significance i.e. of lower (delta/coma) or higher (theta/pain, alpha/thought/shouting, beta/physical activity) EEG frequencies.

We never forget issues which have the greatest significance e.g. the result of harm, injury or disease; and which are indelibly imprinted in the body through the formation of scar tissue(s) or by the memory of pain. The greater the extent and/or significance of our cumulative, multi-sensory, experience(s) the lower will be the prevailing EEG frequency and the greater will be the ability to recall the memory. Similarly the influence of stress e.g. when tired, reduces our ability to store memories.

The brain regulates the release of neurotransmitters by light and frequency. Pathologies or the accumulation of toxins influence the brain wave frequencies which are appropriate for each physiological system i.e. organ and system function are stimulated by frequencies and light e.g. how photosensitive migraine and epilepsy can be initiated by flashing lights. Similarly migraine, dyslexia and other conditions can be treated by the selective use of brain frequencies i.e. there is a positive therapeutic effect which can be employed using knowledge of this relationship between colour and frequency.

The implications of such findings are significant. It indicates that the use of drugs may not be able to create health i.e. drugs may eliminate the progress of pathology and hence reduce the symptoms of disease but their use relies upon the body being able to recover its original stable state. That disease can exist in a stable state i.e. in the case of ‘chronic’ illness and/or of subsequent biochemical change e.g. of demyelination in Multiple Sclerosis, suggests that the assumption that drugs improve health and wellbeing may have significant limitations.

Linking the Function of Proteins and Enzymes to Chemiluminescence and Visual Perception

That protein and enzyme function involves the releases of chemiluminescence (Martinek and Berezin, 1979; Hug et al., 1980; Yousuf-Azeemi et al., 2008; Yousuf-Azeemi et al., 2009) is not a new phenomena however linking this release of light to (i) oxidative stress (Cadenas, 1984; Cadenas and Sies, 1985; Cadenas and Sies, 1984; Kobayashi et al., 1999; Nakano, 1989; Nwose and Ewing, 2009) and pathology and to (ii) visual perception (Ewing and Parvez, 2008) is a significant development. Light raises the enzyme to an activated state (Sytina et al., 2008) in which a more favourable conformation of the
enzyme and its active site facilitates the enzymatic conversion of its substrate i.e. the precise selection of colour (Vojislavijevic et al., 2007), can be used rather than general exposure to sunlight.

Enzymes are catalysts for many biochemical reactions (Bairoch, 2000). They are highly specific and catalyse reactions by providing an alternative reaction pathway with lower activation energy. Their efficiency and specificity is due to the shape of the enzyme molecule. They operate efficiently in a narrow range of environmental conditions i.e. the intra- and intermolecular bonds involved in protein conformation are disrupted by changes to temperature, pH, and the influence of cofactors and inhibitors.

The influence of light upon Bilirubin is notable for several reasons: (i) the isomers of bilirubin (an unresolved mixture of its E, Z and Z, E isomers) produced by exposure to light (and/or UV) are more soluble than the unilluminated isomer. These are excreted by the liver (Sisson, 1981). (ii) Irradiation by visible light catalyses the reaction (Sisson, 1981). (iii) pH influences the rate of reaction and improves albumin’s ability to bind to bilirubin (Kozuki et al., 2008).

Light activates many biochemical reactions. This phenomenon is now being intensively researched for its potential to improve the understanding of neuronal pathways and firing mechanisms (Miller, 2006; Aairan et al., 2007; Banghart et al., 2004), conceivably linked to protein conformation and the degree of coding of DNA, which are considered to be implicated in Alzheimers disease and other neurological conditions. This leads to an improved understanding of: the visual pathways (Bitensky et al., 1978; Arshavsky et al., 1985; Arshavsky and Bownds, 1992; Binder et al., 1990; Nicol GD, Bownds, 1989); specific physiological processes and an improved understanding of the physiological processes of repair (Allain et al., 2008); the neurosensory pathways (Cardin et al., 2009); techniques to activate specific drugs (Xu et al., 1985); techniques to activate or inhibit specific biochemical reactions (Binder et al., 1980; Seeman et al., 1985); and influence behaviour (Lima and Miesenböck, 2005). Current research is focused upon manipulating the function of neurons to be responsive to light in order to alter ion-channels i.e. specific minerals (Sodium, Calcium, Potassium) stimulate firing of neurons (Banghart et al., 2004; Nicol and Bownds, 1989). Others are researching natural phenomena i.e. the natural light-sensitive ion channel channelrhodopsin-2 (Boyden et al., 2005).

It has been illustrated that light activates enzymes and hence influences the rate and completeness of biochemical reactions. This has an influence upon behaviour. It influences memory (Vandewalle et al., 2007), sleep (Duffy et al., 1996; Neumeister et al., 1996), mood (Golden et al., 2005; Kasper et al., 1989), physical strength (Hamid and Newport, 1989), personality (Schaie, 1966), aggressive behaviour (Schauss et al., 1985), and mental illness such as bipolar disorder (Benedetti et al., 2005; Delitto et al., 1991), eating disorders (Goel et al., 2009), seasonal affective disorder and depression (Tuunainen et al., 2004; Martiny et al., 2004), etc. It influences many, if not all, aspects of the body’s function (Daw, 1984; Meer, 1985; Trevor-Roper et al., 1969). Multisensory therapies are used to treat multisensory dysfunction (Wolfarth H, Sam, 1982; Lancia, 2002; Chung and Lai, 2002; Hotz et al., 2006). As drugs help only circa 40% of people with mood disorders and only circa 50% of disease (Spear et al., 2001) we are left to conclude that (i) the understanding and assumptions upon which drugs are based remains significantly deficient, and/or (ii) that light (and/or sensory input) may play a more significant role than hitherto imagined. The role performed by light is associated with the regulation of the body’s function i.e. of the autonomic nervous system and physiological stability, by contrast with that of drugs which seek to eradicate the symptoms of disease. They are two distinctly different mechanisms, each with a different significance and potential benefit depending upon circumstances. They are mutually compatible. These are the different roles performed by the doctor and (a) the nurse, or (b) the health psychologist, and/or (c) which perplex researchers of ‘placebo’ effect.

Is Internal Timing the Key to Physiological Stability?

It is inconceivable that there is not a mechanism to coordinate the function of the organs and systems which regulate the body’s biochemistry. It is the coordinated function of our eyes, limbs and visceral organs which enables our movement. The coordination of sensory function is necessary for the body’s multi-level function i.e. its appreciation of danger.

There are clear precedents that timing of internal events is a significant factor in systemic function e.g. from the first taste and visual input the digestive system is primed to receive food. The processing of this food requires the coordinated function of numerous organs. Whilst the normal flow is that of oesophagus, stomach, duodenum, large intestine, small intestine; in particular it requires coordination with the function of the duodenum in which the digestive juices from pancreas, liver, bile duct and gall bladder mix together and are fed into the digestive stream.

The coordinated function of neurons is regulated by voltage, chemicals, temperature and frequency which influence mental (Bhattacharjee, 2007) and physiological stability. Orthodox medicine (Fell, 1997) considers the body’s biochemistry and fails to recognise the multi-level and multi-systemic nature of the body’s physiology (Noble, 2007; Ewing and Parvez, 2008; Ewing and Ewing, 2008). It overlooks that (i) the body’s function is regulated by the influence of sensory input i.e of light, upon the autonomic nervous system and its subsequent influence upon the physiological systems (Ewing and Ewing, 2008) and (ii) the role of EEG frequency.

Multi-Sensory Functionality

Our senses work in a coordinated manner, as a data processing matrix, each conveying different information to the brain. Information of multi-level significance is linked to the brain by different EEG brain frequencies i.e involving differing biochemistries. Sights enables the vision of events but it requires the coordination of visual input and sound (and other forms of sensory input) to convey meaning, distance, and danger. Sight is used primarily to observe therefore this must be related to memory and to the EEG frequencies in order to give significance and meaning.
Sight is associated with perception; Sound conveys meaning, danger; Touch conveys pain, damage and sensuality; Smell conveys danger, sensuality, maternalism; Taste conveys the pleasure of nutritious food or the danger from rancid or poisonous foods; the movement of hairs on the skin, associated with touch, convey information of temperature changes, etc.

Each acts at different levels of the body’s function (EEG frequencies and the associated biochemistries). There is evidence that sound (Holmes-Atwater, 1997) and smell (Schuett et al., 2000; Schuett et al., 2000) function at delta frequency and are related to consciousness and behaviour. Significant defects associated with sensory dysynchronisation include prosopagnosia, autism, dyslexia and related autistic spectrum disorders, etc (Ewing et al., 2009).

There is evidence that cognitive processes are related to the degree of firing synchronisation of neural networks (Gray et al., 1989; Gray, 1994; Fries et al., 2001; Fries, 2005; Sejnowski and Paulsen, 2006; Schoffelen et al., 2005) and are linked to the coherence or synchronisation of EEG frequency (König et al., 1995). Gamma band synchronisation is related to cognitive function (Bragin et al., 1995) and similarly for other EEG frequencies (Canolty et al., 2006; Tsodyks et al., 2000; Salansky et al., 1998). If exposed to a visual stimulus e.g. at 40 or 50 hz, in the gamma band (30-60 hz) the brain will record the image but will ignore its significance. It is only the repeat exposure to the visual stimulus, its visual recognition and hence its similarity to a stored memory (short-term or long-term) which determines its significance (deCharms and Merzenich, 1996). This may occur by a synchronisation process which enables firing of neurons and hence the fixation of the memory. Similarly the intensity or nature of the exposure will also determine its significance – (Krausk, 1941) through visual comparison with past events and (Warburg, 1931) by aural comparison to past sounds and to the degree of its exposure (loudness). The coordination of sensory input acts to determine its physiological significance, each acting at different EEG bands and recording differing levels of sensory input e.g. by touch, firmness, pain and damage. The body’s function, its receipt of sensory input, is rapid – different species having differing EEG patterns (Bullock et al., 2005) – however the body’s function involves feedback loops to assimilate the data by comparison to past memories e.g. it takes time following physical injury for the pain to develop (up to 30 seconds). The body cannot react instantaneously otherwise physiological stability (regulated by the theta and delta EEG frequencies) would be difficult to achieve. This explains why it takes time for the association with pain to develop following severe injury/trauma. Existing precedents illustrate an association between (i) physiological damage (comatose state) with delta frequency, (ii) pain and the theta frequencies, (iii) thought/neural processing and the alpha frequencies, (iv) physiological responses and the beta, and (v) visual function and the gamma wave frequencies. Accordingly therapies involving lower EEG frequencies can be expected to have greater therapeutic effect than those at higher EEG frequencies (Achmon et al., 1989).

The rate of synchronization or firing must also be related to biochemistry i.e. declining with advancing age (Ambatipudi et al., 2009), the influence of excess weight or of pathology. Through the process of age-related decline the body’s biochemistry ceases to support the production of neurons and their normal neuronal function. This illustrates that the brain is continuously scanning its environment (Womelsdorf et al., 2007) i.e. that neuronal synchronization contributes to cognitive function and that neural desynchronisation is associated with reduced cognitive function i.e. arising from the influence of pathologies.

**The Dynamic Relationship between Cognition and Physiology**

Grakov’s methodology is consistent with a central governor theory (Hill et al., 1924; Bassett, 2002; Noakes et al., 2005 Noakes et al., 2001) i.e. that the brain is continuously assimilating data from its external and internal environments as a set of interacting data processing matrices (via the neural networks and physiological systems (Red’ko et al., 2004; 40 or 50 hz, in the gamma band (30-60 hz) the brain will record the image but will ignore its significance. It is only the repeat exposure to the visual stimulus, its visual recognition and hence its similarity to a stored memory (short-term or long-term) which determines its significance (deCharms and Merzenich, 1996). This may occur by a synchronisation process which enables firing of neurons and hence the fixation of the memory. Similarly the intensity or nature of the exposure will also determine its significance – (Krausk, 1941) through visual comparison with past events and (Warburg, 1931) by aural comparison to past sounds and to the degree of its exposure (loudness). The coordination of sensory input acts to determine its physiological significance, each acting at different EEG bands and recording differing levels of sensory input e.g. by touch, firmness, pain and damage. The body’s function, its receipt of sensory input, is rapid – different species having differing EEG patterns (Bullock et al., 2005) – however the body’s function involves feedback loops to assimilate the data by comparison to past memories e.g. it takes time following physical injury for the pain to develop (up to 30 seconds). The body cannot react instantaneously otherwise physiological stability (regulated by the theta and delta EEG frequencies) would be difficult to achieve. This explains why it takes time for the association with pain to develop following severe injury/trauma. Existing precedents illustrate an association between (i) physiological damage (comatose state) with delta frequency, (ii) pain and the theta frequencies, (iii) thought/neural processing and the alpha frequencies, (iv) physiological responses and the beta, and (v) visual function and the gamma wave frequencies. Accordingly therapies involving lower EEG frequencies can be expected to have greater therapeutic effect than those at higher EEG frequencies (Achmon et al., 1989).

The rate of synchronization or firing must also be related to biochemistry i.e. declining with advancing age (Ambatipudi et al., 2009), the influence of excess weight or of pathology. Through the process of age-related decline the body’s biochemistry ceases to support the production of neurons and their normal neuronal function. This illustrates that the brain is continuously scanning its environment (Womelsdorf et al., 2007) i.e. that neuronal synchronization contributes to cognitive function and that neural desynchronisation is associated with reduced cognitive function i.e. arising from the influence of pathologies.

**Figure 1**

Anokhin, (1975)) which advises the nature of threats and of the body’s condition and preparedness for actions of specific types and intensities.

That the brain’s function involves neural networks to regulate the network of visceral organs is increasingly evident (Rózs, 1987; Massabau and Meyrand, 1996; Suzuki et al., 2005; Silva et al., 2005; Büschges, 2005). In cases of pathology this systemic stability may alter i.e. as a ‘pathological functional system’ in which the most dysfunctional systems work at an EEG frequency which is stable, involves other organs, and hence differs from normal EEG frequency (Kryzhanovskii et al., 1995; Sudakov, 1987; Anokhin, 1975). We recognise this as the *chronic* disease state.

Such observations illustrate that there are neural mechanisms which regulate the function of the visceral organs. By contrast, in cases of severe trauma (stroke, coma) brain function may not, in the short term, be necessary to regulate the body’s function. This illustrates the body’s memory may be able to exert a compensatory influence.

**Flashing Light Therapies**

Flashing lights have been shown to have growth or therapeutic benefit in plants (Sassenrath-Col et al., 1994) and humans (Dewan et al., 1978; Anderson et al., 1997; Anderson, 1989; Noton, 1997; Noton, 2000; Liddle et al., 2005, Nakao et al., 2003). To consider why a migraine or epilepsy could be...
induced by photostimulation it is necessary to have an understanding of what causes a migraineous event or an epileptic fit. The results obtained by Virtual Scanning (Nwose et al., 2009; Ewing and Ewing, 2009; Ewing et al., 2009) illustrate that migraines (and perhaps also epilepsy) are caused by a lack of oxygen being supplied to the brain, arising from the condition of the spine/neck, the quality of the blood (viscosity, iron content, blood glucose and blood cell content i.e. the autonomic nervous system), and the ability of the blood vessels and heart to convey oxygenated blood through the lungs to the brain. This is consistent with known observations and illustrates that systemic dysfunction is a significant factor in migraines. It explains why complex migraine medications are not significantly more effective than simple analgesic combinations. It explains the apparent effectiveness of drugs designed to reduce blood viscosity i.e. that such drugs have a systemic action upon blood cell content and blood glucose.

Frequency is used in flashing light therapies with variable effect, perhaps because of the poor level of understanding of the phenomena. Nevertheless it has been shown to have a beneficial influence upon the Human Menstrual Cycle (Dewan et al., 1978; Anderson et al., 1997), Migraine (Anderson, 1989; Noton, 1997; Noton, 2000), Dyslexia (Liddle et al., 2005), regulation of blood pressure (Nakao et al., 2003) and many other conditions. It is linked to the coherent function of neurons (Fields, 2006) and the regulation of physiological systems. Furthermore the greater the physiological need for synchronised function i.e. at the organ level, the lower will be the frequencies required to support the action of brain waves and of neuronal interaction (Bullock et al., 2005).

Virtual scanning: case studies

Studies of the therapeutic value of such technologies, conducted in Russia and UK and verified by medical professionals, illustrate the powerful nature of such a technology (Vysochin et al., 2000; Nwose et al., 2009; Ewing and Ewing, 2009; Ewing et al., 2009). Case studies reported by doctors and consultants at various Russian hospitals (Vysochin et al., 2000) include the successful treatment of enuresis (involuntary urination), amenorrhrea (absence of menstruation), impaired cardiac rhythm, depression, trigeminal neuralgia, epilepsy, slipped disc, endometriosis, plexitis, infertility, tinnitus, latex allergy, migraine, high blood pressure, excess weight, night phobias, the stabilisation of blood glucose in patients with diabetes mellitus, etc.

Discussion

There are many inconsistencies with the orthodox approach which prevails in current medical research and medicine e.g.

- it assumes that EEG frequencies are the consequence and manifestation of the body’s biochemistry yet fails to consider phenomena which manipulate the EEG frequencies and consequently the body’s biochemistry.

- it overlooks the significance of the different EEG categories which illustrate the multi-level nature of the body’s function i.e. it is not a chance observation but instead a significant phenomenon.

- it recognises that the body’s function is multi-systemic yet fails to consider the significance of phenomena linked to systemic function and dysfunction.

- it assumes that the body’s function is regulated from the bottom up i.e. from its biochemistry, when there are clear indications that stress acts at the neural level and influences the body’s biochemistry—a top down approach. The evidence suggests that the body’s function is dynamic i.e. involving both the top down and bottom up approaches. Both are correct.

- it steadfastly ignores the influence of sensory input upon neural function and organ function when there are clear indications that stress (experienced mainly through visual input) influences the function of many organs including heart, pancreas, duodenum, intestines, lungs, etc.

- it overlooks that the body’s biochemistry alters throughout human development i.e. from birth until death.

- it assumes that the disciplines of psychology and physiology differ i.e. seeking differing neurobiological explanations for what we perceive as psychology and physiology. It overlooks the plausibility, increasingly recognised by neuroscience, that the body’s function and hence its psychology (our health, wellbeing, personality, emotions, consciousness, etc) are manifestations of the body’s multi-level physiology and function.

- it assumes that upon treatment of disease by drugs that the body will re-establish its natural stability i.e. health and wellbeing.

Such issues can be explained by considering that the body’s function is dynamic, hierarchical, multi-systemic, multi-level and context dependent. There is a dynamic relationship which exists between the brain and the body (psychology and physiology), neurons and neural networks, the brain waves and the visceral organs (incl cellular and molecular biochemistry). Such understanding has been developed by I.G. Grakov, (1985) who identified patterns of biological response to the influence of specific frequencies and subsequently mathematically modelled the consequences of visual perception, upon the physiological systems, and upon cellular and molecular biochemistry (Kandel, 2006). In addition he has mathematically modelled the parameters of a flashing light therapy (i.e. of the colour and intensity of light and the appropriate resonant frequencies) which are specific for each patient. This is now the fundamental basis of the commercialized technology – ‘Virtual Scanning’.

Such methodology establishes the systemic consequences of biochemical dysfunction by contrast with what is mislabeled as ‘systems biology’ – which seeks to determine the biology of systemic function and dysfunction. It addresses the limitations of the reductionist approach and takes into account the role of sensory input upon the body’s physiology whereas by comparison biochemical reductionist research often completely ignores such fundamental and significant influences (Kohl and Noble, 2009).

Any explanation for the body’s function must be based upon...
an understanding of the body’s structures, the prevailing biochemistry and of related biochemical phenomena. The photostimulation of specific neurons is linked to specific behavioural traits which involves the body’s cellular and molecular biochemistry. Light (of specific colour and intensity) acts to coordinate the firing of neurons across neural networks. The chemiluminescence (colour and intensity) released by specific protein-substrate reactions is not the same as the light absorbed. The release of light from one reaction activates that of associated reactions. The use of frequency, delivering colour of specific intensity, acts to coordinate the firing of neurons across neural networks and coordinating the function of organ systems, organs, and cells.

The energy from light activates proteins. Specific wavelengths (colours) activates specific proteins. This induces the migration of stem cells (Biener et al., 2009) and translaction of proteins (Levskaya et al., 2009) to the cell membrane. It has also been shown to have a positive therapeutic effect re treatment of diabetes (Ramdawon, 2001). Furthermore, the use of stem cells to treat diabetes mellitus has encountered problems. Initial studies have shown promise however the effectiveness of such therapies has declined with time, conceivably because the stem cells are being exposed to the same biochemical environment which caused their original demise (Ewing and Ewing, 2008). Light has been shown to influence many, if not all, of the body’s key physiological functions. It influences the autonomic nervous system and is associated with all aspects of the body’s function including the migration of stem cells (Horowitz et al., 1999), the production of Nitric Oxide (Nagase et al., 2005), the function of the lymphatic system, regulation of intercellular pH balance, improved wound healing (Horowitz et al., 1999), etc. Light influences the autonomic nervous system and consequently the prevailing phenotype (Speck and Rosenkranz, 1975).

That conditions can be treated by the application of light, colour and frequencies indicates that the brain generates frequencies which are responsible for the synchronised function of networks of organs. Depending upon the parameters selected it may stabilise or destabilise each of the physiological systems. The general exposure to light and colour acts indiscriminately. The wrongful selection of colour, light intensity or frequency will stimulate the sympathetic nervous system or the parasympathetic nervous system. An empirical approach will lead to variable outcomes and hence to controversy over the alleged benefits and claims. In the case of migraines, which has multiple origins, this may lower blood pressure and lead to the occurrence of headaches and migraines. Consequently, and as outlined in this article, phototherapy has more considerable consequences and broader applicability than was originally considered to be possible. A superior understanding of the principles which the body uses to regulate its stability will lead to improved therapeutic outcomes in many areas of medicine.

Acknowledgements

We thank the many researchers who through their work have made this article possible. The findings reported in this article arise primarily from the work of the Russian researcher Dr I.G. Grakov.

Competing Interests

Graham Ewing is a Director of Montague Healthcare, a company dedicated to the future commercialisation of Virtual Scanning.

References

18. Binder BM, Bierbaum MS, Bownds MD (1990) Light activation of one translocation of proteins (Levskaya et al., 2009) to the cell membrane. It has also been shown to have a positive therapeutic effect re treatment of diabetes (Ramdawon, 2001). Furthermore, the use of stem cells to treat diabetes mellitus has encountered problems. Initial studies have shown promise however the effectiveness of such therapies has declined with time, conceivably because the stem cells are being exposed to the same biochemical environment which caused their original demise (Ewing and Ewing, 2008). Light has been shown to influence many, if not all, of the body’s key physiological functions. It influences the autonomic nervous system and is associated with all aspects of the body’s function including the migration of stem cells (Horowitz et al., 1999), the production of Nitric Oxide (Nagase et al., 2005), the function of the lymphatic system, regulation of intercellular pH balance, improved wound healing (Horowitz et al., 1999), etc. Light influences the autonomic nervous system and consequently the prevailing phenotype (Speck and Rosenkranz, 1975).

That conditions can be treated by the application of light, colour and frequencies indicates that the brain generates frequencies which are responsible for the synchronised function of networks of organs. Depending upon the parameters selected it may stabilise or destabilise each of the physiological systems. The general exposure to light and colour acts indiscriminately. The wrongful selection of colour, light intensity or frequency will stimulate the sympathetic nervous system or the parasympathetic nervous system. An empirical approach will lead to variable outcomes and hence to controversy over the alleged benefits and claims. In the case of migraines, which has multiple origins, this may lower blood pressure and lead to the occurrence of headaches and migraines. Consequently, and as outlined in this article, phototherapy has more considerable consequences and broader applicability than was originally considered to be possible. A superior understanding of the principles which the body uses to regulate its stability will lead to improved therapeutic outcomes in many areas of medicine.

Acknowledgements

We thank the many researchers who through their work have made this article possible. The findings reported in this article arise primarily from the work of the Russian researcher Dr I.G. Grakov.
reaction observed in electrophoretically isolated frog rod outer segments exposed to dim illumination. J Biol Chem 265: 15333-15340. » CrossRef » PubMed » Google Scholar


56. Grakov IG (1985) Strannik Diagnostic and Treatment System: a Virtual Scanner for the Health Service. Minutes of Meeting No. 11 of the Praesidium of the Siberian of the Academy of Medical Sciences of the USSR (AMN) held in Novosibirsk. » CrossRef » PubMed » Google Scholar


ISSN:0974-7230  JCSB, an open access journal
