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Can Sunlight Revolutionize the Light Therapy Technique

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Throughout human history, the role of sunlight to sustain life on earth has been recognized. The contribution of sunlight starts with photosynthesis, promoting the growth of plants and crops, which then feed the entire lifecycle, humans being an integral part of the natural process. Interestingly, over 100 years ago as the plastic revolution began and everything natural started to be replaced with their artificial version, sunlight didn't lose its appeal. Only recently, scientists started to think of the sun as a liability. While recognizing, its many benefits, it has also become customary to talk about 'blocking the sun'. With widespread awareness of the danger of global warming, exposure to UV radiation causing skin cancer, and perceptions, people almost became oblivious of the fact that sunlight cannot be replaced and sunlight is beneficial and necessary in its whole. For instance, the exposure to UVB rays causes human skin to produce beta-endorphins, which are hormones that reduce pain. Today, the facts that sunlight is the true source of vitamin D, which is made in the skin when it's exposed to sunlight is almost forgotten. By contrast, "Vitamin D" is a group of fat-soluble secosteroids responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, and many other biological effects. In humans, the most important compounds in this group are vitamin D3 (also known as cholecalciferol) and vitamin D2 (ergocalciferol). These artificial substitutes to vitamin D are no way compatible to natural vitamin D manufacturing in human body [1,2]. Natural vitamin D, which is made by the skin, has the following benefits:

- supporting healthy bones
- managing calcium levels
- reducing inflammation
- supporting the immune system and glucose metabolism

While artificial vitamin D may boost certain aspects of the above benefits, no way it can substitute for the natural vitamin D. For instance, researchers have noted a link between exposure to the sun and lower blood pressure levels, with reduced death rates from cardiovascular issues, lower level of clinical depression, relief from Chronic Fatigue Syndrome (CFS), protection from Type 1 diabetes, multiple sclerosis (MS), several forms of cancer, including colon, breast, and prostate cancer and non-Hodgkin lymphoma, and many others, none of which can be accomplished with artificial vitamin D. Scientists suggest that exposure to sunlight triggers the skin to release stores of nitrogen oxides, which cause arteries to dilate, lowering blood pressure, and may reduce the impact of metabolic syndrome.

Most importantly, sunlight supports better sleep and sets people's circadian rhythms by regulating the levels of serotonin and melatonin. This triggered the notion of light therapy to many illnesses, including, most commonly, the seasonal affective disorder (SAD). It is also noted that 4 out of 5 people with SAD are female [3]. Over a decade ago, Sloane reviewed the role of light therapy in older adults [4]. They cited a large volume of literature that employed a wide range of light sources, quantities, spectra, and delivery schedules, without yielding a consensus as to how to optimally provide this treatment. However, under-use of light as therapy is also due to the fact that light is naturally available and thus un-patentable, making it unappealing as a research or marketing venue for industries. This is a key component that prevented scientists from exploring the possibility of using sunlight, although intuitively it must have been clear to them that sunlight cannot be substituted with artificial light. It is also true that much is yet to be understood about the optimum characteristics of light affecting our health and well-being. Islam et al. attributed this lack of understanding to the absence of a comprehensive light theory that would distinguish between natural light and artificial light [1]. The primary focus of this technical note is to draw attention to the possibility of a light therapy protocol, using sunlight, bolstered with a theory that would describe light propagation in such a way that

- one can distinguish the difference between natural light and artificial light
- one can describe adequately light propagation within a human body.

This will be followed by the development of a system that can use natural light to address specific need of ailments that are currently treated with various forms of light therapy.

Task 1: Development of the comprehensive light theory
The starting point of this task is the Bose-Einstein condensation light theory. Although the original theory did not have a boundary between matter and energy (e.g. light), this distinction has been made by recent scientists [5]. While much progress has been made in developing so-called phase diagram of condensate matter, few considered developing a theory that would allow a smooth transition between matter and energy [6]. This will be done in this task by assuring continuity for all subatomic particles, all the way down to their photonic existence, instead of assigning a zero mass to photons. Mathematically, this continuity removes a number of

spurious conditions, thus making it amenable to practical solutions.

Task 2: Application of the light theory to biological systems
While it is known much of our vital energy is received thought the cornea, the process of light transmission is not amenable to conventional physical theories. The process is complex and involves stimulation of light receptors in the eyes, conversion of the light stimuli or images into signals, and transmission of electrical signals containing the vision information from each eye to the brain through the optic nerves. This information is processed in several stages, ultimately reaching the visual cortices of the cerebrum. In order to reach the retina, light rays focused by the cornea must successively traverse the aqueous fluid, the crystalline lens, the gelatinous vitreous body, and the vascular and neuronal layers of the retina before they reach the photosensitive outer segments of the cone and rod cells. These photosensory cells detect the image and translate it into a series of electrical signals for transmission to the brain. Others have tackled this complex phenomenon with a mix of light theories and electrical theories, even invoking quantum physics in the process. The proposed research will simplify the process and come up with a coherent representation of natural phenomena with a single theory.

Task 3: Application of the light theory to light therapy and bright light therapy (BLT)
Light therapy has become a standard treatment for seasonal affective disorder (SAD) and may also be considered as an option for treating non-seasonal depression [7]. Light therapy is of great interest as an alternative to pharmacological treatment and offers hope for natural remedy [8]. Bright Light Therapy (BLT) is known to ameliorate the symptoms of depression better as compared to placebo condition and equally well as most other available pharmacological and non-pharmacological antidepressant treatments [9]. BLT might be more attractive because it produces antidepressant benefits considerably faster (up to 50–65% of patients experience remission within a week) than most antidepressants [9]. In addition, treatment with BLT is more cost-efficient than several months of modern antidepressant treatment or psychotherapy and has a side-effect profile that is favorable compared to that of pharmacological antidepressants. Many reports of the efficacy of light therapy are not based on rigorous study designs. This analysis of randomized, controlled trials suggests that bright light treatment and dawn simulation for seasonal affective disorder and bright light for nonseasonal depression are efficacious, with effect sizes equivalent to those in most antidepressant pharmacotherapy trials. Adopting standard approaches to light therapy's specific issues (e.g., defining parameters of active versus placebo conditions) and incorporating rigorous designs (e.g., adequate group sizes, randomized assignment) are necessary to evaluate light therapy for mood disorders.

This task will also include Neurodegenerative diseases (NDs). These are a broad, highly heterogeneous group of disorders affecting both the central nervous system (CNS) and the peripheral nervous system and are characterized by irreversible, progressive loss of previously intact neurological function, worsening with age [10]. It includes Alzheimer disease, Parkinson disease, Huntington disease, motor neuron disease, and others. While these studies all focus on the use of artificial light, the role of natural light will be investigated through the newly developed light theory. At present, the mainstay treatments of NDs are pharmaceutics, but the available drugs provide only symptomatic relief and usually carry the risk of adverse reactions, such as diarrhea, nausea, headache, and others. In contrast, physical therapies and chronotherapies, such as transcranial magnetic stimulation (TMS), light therapy (LT), and physical exercise (like Tai Chi), have attracted the attention of researchers due to their high safety, low cost, and feasibility of implementation [11]. Liu et al. opened up the possibility of combining Chinese medicine with the light therapy [11]. This will open up an avenue previously unexplored.

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