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Adv

Article

Photobiomodulation and the brain: A new paradigm

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19(1):013003

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Abstract

Transcranial photobiomodulation (PBM), also known as low level laser therapy (LLLT), relies on the use of red/NIR light to stimulate, preserve and regenerate cells and tissues. The mechanism of action involves photon absorption in the mitochondria (cytochrome c oxidase), and ion channels in cells leading to activation of signaling pathways, up-regulation of transcription factors and increased expression of protective genes. We have studied PBM for treating traumatic brain injury in mice using a NIR laser spot delivered to the head. Mice had improved memory and learning, increased neuroprogenitor cells in the dentate gyrus and subventricular zone, increased BDNF and more synaptogenesis in the cortex. These highly beneficial effects on the brain suggest that the applications of LLLT are much broader than first conceived. Other groups have studied stroke (animal models and clinical trials), Alzheimer's disease, Parkinson's disease, depression and cognitive enhancement in healthy subjects.

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... The infrared light of PBM activates the photosensitive enzyme cytochrome c oxidase (COX, also called Complex IV), which is the terminal enzyme in the mitochondrial electron transport chain and mediates the transfer of electrons from inside the mitochondrion via the electron carriers nicotinamide adenine dinucleotide (NADH) and flavin adenine dinucleotide (FADH₂) to molecular oxygen (Hamblin, 2018; Hennessy & Hamblin, 2017; Salehpour, et al., 2019). It is proposed that when COX absorbs near-infrared light, photodissociation of nitrous oxide (NO) from COX occurs, which increases the availability of electrons for the reduction of oxygen (Hamblin, 2018). ...

... PBM is applied either via LED near-infrared lights to the entire head, or to smaller areas using a direct laser. PBM is considered a safe therapy that is relatively free of adverse side effects (Hennessy & Hamblin, 2017). The most common side effects of PBM are mild headaches and vivid dreams, however, these are rare (Maiello, 2019). ...

... As with other neurostimulation approaches, PBM has typically been used to treat physical and cognitive impairments following brain injury or other neurodegenerative processes, such as Alzheimer's and Parkinson's disease (Hennessy & Hamblin, 2017). However, recent evidence suggests that PBM may also be beneficial for improving cognition in healthy individuals (Salehpour, et al., 2019). ...

Neurostimulation Tools and Approaches

Chapter [Full-text available](#)

Jul 2024

Kristin Jensen Heaton · Caitlin Ridgewell · Jessica Couse · William H. Neumeier

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... 48 Transcranial PBM has demonstrated the capacity to preserve and regenerate cells and tissues. 84 Brain PBM therapy, using red to NIR light, represents an innovative treatment approach for a wide spectrum of neurological and psychological conditions. 85 Its therapeutic potential spans disorders such as dementia, Parkinson's disease, stroke, traumatic brain injury, depression, and even cognitive enhancement in healthy individuals, garnering increasing interest. ...

... 12 The absorption of light by ion channels induces release of Ca²⁺ ions, activating transcription factors and gene expression. 84 This form of PBM administered to individuals struggling with addiction rapidly diminishes both anxiety levels and craving for opioid drugs within mere minutes. 48 To address this more directly, and in relationship to the other facet of our study suggesting that enhanced cognitive executive function can reduce drug cravings, it is worth noting that numerous studies have reported positive outcomes of PBM on cognition and memory retention. ...

... 89 The PBM group exhibited improvements in cerebral microcirculation, resulting in a long-lasting reduction in dementia symptoms and cognitive recovery that persisted for 1-7 years. 84 Considering all aforementioned data, it can be asserted that PBM may be an effective approach for reducing drug cravings in opioid-dependent individuals. ...

Comparative Effects of Cognitive Rehabilitation and Photobiomodulation on Drug Craving in Treatment-Seeking Opioid Addicts

[Article](#)

Jan 2024

Sayena Hadadgar · Javid Peimani ·  Peyman Hasaniabbarian ·  Reza Fekrazad

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... In transcranial phototherapy, pulsed light is significantly superior to continuous light (Hennessy and Hamblin, 2017), possibly because pulsed wave which frequencies closer to brainwave frequencies has an advantage in improving brain injury (Núñez-Seisdedos et al., 2022). The pulses at frequencies of 10, 40, 100 Hz are most commonly utilized, potentially linked to the modulation of cerebral neural oscillations (Montazeri et al., 2021). ...

... The stimulation site is also a consideration in transcranial phototherapy. The skull has varying translucencies in different anatomical regions (0.9% at the temporal region, 2.1% at the frontal region, and 11.7% at the occipital region) (Hennessy and Hamblin, 2017). NIR can penetrate the left/right parietal skull and frontal skull effectively (Jagdeo et al., 2012) and enhance excitability in the human brain cortex (Konstantinović et al., 2013). ...

... However, the developed drugs targeted A β and tau did not achieve the desired therapeutic outcome for AD (Nizamutdinov et al., 2022). Various studies have conducted analyses and comparisons of the selection range of crucial parameters, including wavelength, light intensity, energy density, and treatment duration (Hennessy and Hamblin, 2017). Presently, the utilization of red and near-infrared light for the treatment of AD is widely acknowledged, with the NIR wavelength range of 800-900 nm being the most prevalent (Hamblin, 2019). ...

Phototherapy for age-related brain diseases: Challenges, successes and future

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Jan 2024 · AGEING RES REV

Ling Ding · Ziqi Gu · Haishu Chen ·  Zhiqian Tong

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... While it often uses a laser as a light source, it does not act thermally or ablatively. Specifically, photons stimulate chemical changes within cells, creating beneficial biological responses, such as neuroprotective responses, increase in metabolism, blood flow, and neurogenesis (Hennessy & Hamblin, 2017). ...

... When reactive oxygen species (ROS) production rises, and the body can't counteract its effects by producing enough antioxidants, oxidative stress, which is evident in ASD, ensues. Because of this, ROS can be damaging to the body, especially when they are present at high levels over an extended period (Hennessy & Hamblin, 2017). In addition, mitochondrial dysfunction has been associated with the accumulation of ROS within cells, as they react to oxidative stress when a relatively low ROS environment is present. ...

... One of the methods of PBM is transcranial Photobiomodulation (tPBM), or Transcranial Low-Level Laser Therapy (tLLLT), which involves a transcranial, non-invasive delivery of low-level light. During the progression of the process, photon absorption is realized in the mitochondria and ion channels in the cells, resulting in the activation of signaling processes and the increased expression of protective genes (Hennessy & Hamblin, 2017). ...

Article Full-text available

Jan 2024

Victoria Bamicha · Yolanda Salapata

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... In recent years, photobiomodulation (PBM) has emerged as an extremely promising treatment for improving brain function, especially after damage due to stroke, traumatic brain injury (TBI), neurodegenerative disorders, etc. Also known as low-intensity light therapy, this technique uses light in the red to near-infrared (NIR) range (600-1100 nm) [44, 45]. The first in vivo experiment to demonstrate the cognitive benefits of PBM therapy was conducted in rabbits with small clot embolic strokes. ...

... The first-studied pathway shone a light on CCOs. When the electrons in the metal centers of CCO are excited by photon absorption (Figure 2) [44, 45, [47][48][49][50][51][52], nitrous oxide (NO) from CCO's binuclear center (heme a3/CuB) is photodissociated. Decreasing amounts of NO, a known electron transport inhibitor in the ETC, raise the mitochondrial membrane potential (MMP), consequently increasing the proton gradient and ATP production [52]. ...

... In this second pathway, light appears to be absorbed by temperature-gated calcium channels, causing an increase in cytosolic calcium but a decrease in mitochondrial calcium [48]. . This is a schematic diagram of commonly known near-infrared light targets and the biological effects of transcranial photobiomodulation in the management of AD pathology and associated disease processes [44, 45, [47][48][49][50][51][52]. Abbreviations: ROS, reactive oxygen species; NO, nitric oxide; eNOS, endothelial nitric oxide synthase; SOD, superoxide dismutase; GPx, glutamate peroxidase; CcO, cytochrome C oxidase; TGF-β, transforming growth factor-beta; TNF-α, tumor necrosis factor-alpha; IFN-γ, interferon-gamma. ...

Recent Mechanisms of Neurodegeneration and Photobiomodulation in the Context of Alzheimer's Disease

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May 2023 · INT J MOL SCI

Matthew Su · Damir Nizamutdinov · Hanli Liu · Jason Huang

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... A compelling hypothesis suggests that t-PBM has the potential to enhance brain energy metabolism by promoting optimal mitochondrial function [62]. Adenosine triphosphate (ATP) serves as the primary intracellular source of energy, crucial for sustaining neural activity. ...

... Numerous studies have documented the upregulation of CCO following LED and laser light therapy, particularly in the NIR range. This upregulation of CCO has been associated with an increase in neuronal activity [62]. As previously mentioned, the presence of mitochondrial dysfunction has been observed in various prevalent neuropsychiatric disorders [63], and the utilization of t-PBM could potentially compensate for such dysfunction, thereby restoring cognitive capacity. ...

TransPhoM-DS Study Grant Report: Rationale and Protocol for Investigating the Efficacy of Low-Power Transcranial Photobiomodulation on Language, Executive Function, Attention, and Memory in

Article Full-text available

Jul 2024

David Richer Araujo Coelho · Willians Fernando Vieira · Maia Gersten · Paolo Cassano

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... The effects of PBM therapy described above, significantly damaged tissues restoration and neovascularization, provide edema and inflammatory reaction reactions, a reduction in haemorrhage likelihood [6] and, consequently, pain in the tissue after septoplasty. With the intranasal use of PBM therapy, systemic effects are also achieved through blood cells and components [22], which probably can contribute to a positive neurotherapeutic impact [23]. The tissues adjust to the nasal cavity have an abundant blood supply with relatively slow blood flow. ...

... Studies have shown a relationship between blood rheology, cognitive function [28], and mood improvement [27]. It has been suggested that the systemic effects of PBM therapy after blood irradiation may also ultimately have a neuroprotective effect [23, 33,34]. Intranasal blood irradiation is also known to have the same neurological consequences as intravenous or intravascular PBM therapy [35]. ...

Clinical application of photobiomodulation therapy to reduce the severity of acute pain after septoplasty

Article

Dec 2022

E. Startseva · V. Andreeva · I. Pinigina · E. Sirotkin

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... The effects of PBMT described above, especially the restoration of damaged tissue and neovascularization, provide a reduction in edema and inflammatory reactions, a decrease in the likelihood of hemorrhage [7] and, consequently, pain in the tissue after septoplasty. With the intranasal application of laser therapy, systemic effects are also achieved through cells and blood components [23], which can probably contribute to a positive neurotherapeutic effect [24]. The tissues around the nasal cavity have an abundant blood supply with relatively slow blood flow. ...

... Studies have shown a relationship between blood rheology, cognitive functions [28] and mood improvement [33]. It has been suggested that the systemic effects of PBMT after blood irradiation may also ultimately have a neuroprotective effect [24, 34,35]. It is also known that intranasal blood irradiation has the same neurological consequences as intravenous or intravascular PBMT [36]. ...

Comprehensive rehabilitation of patients after septoplasty

Article

Dec 2022

P. Mikhalskaya · E. Sirotkin · V. I. Popadyuk · N. Zindovic

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... Several potentially beneficial molecular mechanisms of action for tPBMT have been discovered that may be beneficial for AD treatment. These mechanisms include stimulation of neuronal mitochondrial energy production (ATP synthesis), enhancement of brain blood flow, diminution of β -amyloid production and accumulation around neurons and blood vessels, mitigation of dendrite and neuronal loss, reduced inflammatory and oxidative neuronal damage, and enhanced production of neurotrophic factors (Lapchak, 2012;Barrett and Gonzalez-Lima, 2013;Gonzalez-Lima et al., 2014;Hamblin, 2016; Hennessy and Hamblin, 2017; Saltmarche et al., 2017;Hamblin, 2019;Enengl et al., 2020;Dewey et al., 2022;Ailioaie et al., 2023). There is evidence in rodent AD models and human clinical trials that tPBMT improves cognitive function Naeser et al., 2014;Saltmarche et al., 2017;Salehpour et al., 2017;Chan et al., 2018). ...

... Transcranial PBMT has the potential to improve cognition in dogs afflicted by CCD via several mechanisms, including improving neuronal mitochondrial function, reducing toxic brain amyloid load, mitigating inflammatory/oxidative brain damage, and stimulating production of neurotrophic factors (Lapchak, 2012;Barrett and Gonzalez-Lima, 2013;Gonzalez-Lima and Barrett, 2014;Hamblin, 2016;Saltmarche et al., 2017; Hennessy and Hamblin, 2017; Hamblin, 2019;Enengl et al., 2020;Dewey et al., 2022;Ailioaie et al., 2023). Our small, open-label, uncontrolled case series showed an improvement in cognitive scores for dogs with CCD treated with tPBMT. ...

Transcranial photobiomodulation therapy improves cognitive test scores in dogs with presumptive canine cognitive dysfunction (CCD): A case series of five dogs

Article

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May 2024

 Curtis Wells Dewey ·  Mark Rishniw ·  Matthew Warren Brunke ·  Kasie Sakovitch

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... 4,5 Despite routine treatments in clinics, there is no effective treatment approach for DFU patients. [6][7][8][9][10][11] [12] [13] low-level laser therapy (LLLT)which is also known as photobiomodulation using low-power lasers is considered as a new effective method for treating DFU. ...

... 14,15 It is also reported that LLLT could promote fibroblast proliferation, repair in injured neurons, and neurogenesis. [6][7][8][9][10][11] [12] [13][14][15] Several clinical studies have shown the effectiveness of the LLLT in the healing of DFUs with no observed side effects. 16,17 While LLLT effects have been reported with visible lasers in the red spectrum (600-700 nm) or near-infrared (780-980 nm) lasers, there is insufficient information on the combined effect of visible and infrared lasers on the DFU patients. ...

Effect of Visible and Infrared Photobiomodulation on Diabetic Foot Ulcers

Article

Full-text available

May 2024

 Faraj Tabeie ·  Sahar Tabakhha ·  Soheila Sadeghi · Journal of Lasers In Medical Sciences

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... The rationale behind the use of this wavelength is justified by its reduced absorption by the three major tissue chromophores (i.e., haemoglobin, melanin, and water), showing also effective absorption by the mitochondria, which is currently believed to be one of the mechanisms responsible for the effects of PBM on the brain [1] [2][3]77]. ...

... Although light penetration through the head structures plays a dominant role in current studies of PBM for neurological conditions, there are indications in literature that there may be indirect or abscopal effects associated with stimulation with red and NIR light [1, 3]. A 2018 study could even find a relation between PBM applied to the back and thighs, and the improvement of depression symptoms [119]. ...

Devices used for photobiomodulation of the brain—a comprehensive and systematic review

[Article](#) [Full-text available](#)

Apr 2024 · J NEUROENG REHABIL

 Filipa Fernandes ·  Sofia Oliveira ·  Francisca Monteiro ·  Susana O. Catarino

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... Local brain stimulation outcomes include increased mitochondrial activity, control of oxidative stress, vasodilation, restoration and formation of new synapses, neurogenesis and angiogenesis, and neuroprotective and cell-protective properties. Systemic responses are related to anti-inflammatory and immunological effects [13, 32]. The literature describes the effects of tPBM, including increased cerebral blood flow, improved cognitive, behavioral, and emotional function, and tissue restoration and regeneration [10,13,32]. ...

... Systemic responses are related to anti-inflammatory and immunological effects [13,32]. The literature describes the effects of tPBM, including increased cerebral blood flow, improved cognitive, behavioral, and emotional function, and tissue restoration and regeneration [10, 13, 32]. ...

Transcranial photobiomodulation therapy associated with cardiorespiratory rehabilitation in spastic subjects

[Article](#) [Full-text available](#)

Nov 2023 · LASER MED SCI

 Ana Paula Pinto ·  Sérgio Luiz Lemos ·  Alessandra Fagundes ·  Mário Lima

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... For decades, red light has been coupled with different photosensitizers to treat cancer and infectious diseases [45]. Additionally, red light has been used on its own in low-level light therapy (LLLT), which exploits principles in photobiomodulation to promote wound healing [90], treat dementia [91], or even as a method to overcome traumatic brain injury [92]. ...

... When treating infectious diseases, the most applied photosensitizers that are activated by red light are methylene blue [92], new methylene blue [93], porphyrin-based photosensitizers, (such as chlorin e6) [72], and 5-ALA (to stimulate endogenous porphyrin production in cells) [73]. Methylene blue (MB) is perhaps the most well-known and accepted exogenous PS for application in aPDT, given that it is an FDA-approved drug for the treatment of methemoglobinemia [94], and it is used in a variety of medical procedures such as tissue staining [95]. ...

Antimicrobial Resistance: Is There a ‘Light’ at the End of the Tunnel?

[Article](#) [Full-text available](#)

Sep 2023

 Leon G Leanse ·  Sanjay Marasini ·  Carolina dos Anjos ·  Tianhong Dai

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... Experimental work of domestic and foreign researchers (in vitro and in vivo) has shown that the effect of FBM is due to a multi-link chain of consequences from the primary absorption of photons by biological tissues [7][8][9]. The key primary photoacceptors are cytochrome-C oxidase and cytochrome-C oxidase, as well as hemoglobin complexes with nitric oxide (nitrosyl protein complexes), which have absorption bands in the regions of red light and near-infrared radiation [10]. The processes induced by PBM include the photomodification of the activity of enzymes of the antioxidant defense system of living cells, photomodification of the respiratory chain of living cells, photolysis of nitrosyl complexes of proteins, changes in the synthesis of proteins and nucleic acids, and the opening of some light-and heat-dependent ion channels, which eventually lead to the synthesis of more adenosine triphosphate (ATP) by cells [7,8,10,11]. ...

... The key primary photoacceptors are cytochrome-C oxidase and cytochrome-C oxidase, as well as hemoglobin complexes with nitric oxide (nitrosyl protein complexes), which have absorption bands in the regions of red light and near-infrared radiation [10]. The processes induced by PBM include the photomodification of the activity of enzymes of the antioxidant defense system of living cells, photomodification of the respiratory chain of living cells, photolysis of nitrosyl complexes of proteins, changes in the synthesis of proteins and nucleic acids, and the opening of some light-and heat-dependent ion channels, which eventually lead to the synthesis of more adenosine triphosphate (ATP) by cells [7,8, 10, 11]. ...

Photobiomodulation for Correction of Systemic Disorders of Experimental Pain Syndromes

[Article](#) [Full-text available](#)

Aug 2023

Alla G. Polyakova · Anna Gennadiyevna Soloveva · Petr V. Peretyagin · Kseniya L. Belyaeva

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... This therapy consists of the transcranial (the "t" in t-PBM) use of light, especially in the near-infrared (NIR) and red spectra, to deliver energy to cells and tissues; such energy is absorbed by specific cellular chromophores leading to biological and therapeutic effects. 15 If effective for MDD, t-PBM would present notable advantages over ECT and TMS, due to its good safety and tolerability profile and the option of self-administration by patients. ...

... This modality of PBM aims at stimulating subjacent regions of the cerebral cortex potentially related to the illness to be treated. 15 The sources of NIR and red light used for t-PBM include LLL or LED devices. 18 Through both sources of t-PBM light is delivered to the scalp and minimally dissipated as thermal energy. ...

Photobiomodulation for Major Depressive Disorder: Linking Transcranial Infrared Light, Biophotons and Oxidative Stress

[Article](#)

May 2023 · HARVARD REV PSYCHIAT

● Willians Fernando Vieira · Maia Gersten · ● Marco Antonio Caldieraro · ● Paolo Cassano

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... This technique has been used to help individuals with stroke, traumatic brain injury, Alzheimer's, Parkinson's, dementia, depression, and anxiety; several studies have reported significant cognitive improvements. 9 Researchers have demonstrated improvements in executive function and verbal memory when tPBM was applied bilaterally to the frontal, parietal, and temporal lobes in individuals with traumatic brain injury. 10 In addition, Naeser et al. 7 reported, from magnetic resonance imaging (MRI) studies, that nearinfrared photons can stimulate surface brain cortex areas of the brain when LEDs are applied on the scalp. ...

... 12 tPBM research studies with humans, who had sustained traumatic brain injury, have reported that those treated with tPBM starting at days, weeks, months, and even years after traumatic brain injury, still showed some significant improvements. 9, 13 Language and Speech Circuits Language mechanisms depend on neuronal function and learning. For production of language with proper speech sounds, vocabulary, and syntactic rules, the neural 6 circuits/ networks in the brain need to be activated and work together. ...

Increased Improvement in Speech-Language Skills After Transcranial Photobiomodulation Plus Speech-Language Therapy, Compared to Speech-Language Therapy Alone: Case Report with Aphasia

[Article](#)

Mar 2023

Karla Estrada-Rojas · Nidia Patricia Cedeño Ortiz

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... A study by Berman, et al. [50] revealed that tPBM improved cognitive performance and reduced beta-amyloid plaques in an Alzheimer's disease (AD) mouse model. Similarly, a clinical trial by El Khoury, et al. [51] demonstrated that tPBM enhanced motor function and decreased motor symptoms in PD patients. These effects are likely mediated through tPBM's neuroprotective properties and its ability to enhance mitochondrial function and reduce oxidative stress. ...

Enhancing Physiotherapy Outcomes with Photobiomodulation: A Comprehensive Review

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Jul 2024

Parizotto Nivaldo Antonio · Ferraresi Cleber

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... In addition, people are increasingly disappointed with drugs that treat brain function. Based on the above reasons, in recent years, people have become more and more interested in the application of tPBM in TBI Hamblin, 2011, 2015; Hamblin, 2016; Hennessy and Hamblin, 2016) . tPBM has almost no adverse side effects (Hamblin, 2018). ...

Can transcranial photobiomodulation improve cognitive function in TBI patients? A systematic review

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Jun 2024

Jia Zeng · Chen Wang · Yuan Chai · Qiuli Wang

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... The intensity, wavelength, frequency, and duration of light affect the effectiveness of treatment [8][9] [10][11]. PBM has been widely used in neurodegenerative diseases, such as PD, and has achieved good therapeutic effects [12][13][14][15] [16] . Transcranial PBM is currently the most commonly used treatment method, mostly using red-to-near-infrared range light (600-1100 nm). ...

NIR-II light therapy improves cognitive performance in MPTP induced Parkinson's disease rat models: A preliminary experimental study

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Jun 2024

Jiangong Zhang · Qinqin Zhu · Xun Shi · Xisong Zhu

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... According to preclinical studies, PBM can widen blood vessel diameter, elevate NO levels in the brain, and enhance CBF [76][77][78]. Hence, it can be inferred that targeted PBM therapy on specific brain regions may influence regional CBF [8]

Photobiomodulation Therapy on Brain: Pioneering an Innovative Approach to Revolutionize Cognitive Dynamics

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Jun 2024

Tahsin Nairuz · Sangwoo-Cho · Jong-Ha Lee

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... This effect became widely known as Low-Level Laser Therapy (LLLT) or Photobiomodulation (PBM). Recently developed LLLT and PBM, which are performed using red NIR wavelengths, are known to have effects such as wound healing [9,13,14], pain relief [15], inflammation reduction [16,17], animal life extension [18], vision improvement [19], cognitive ability improvement [20], and hair loss improvement [21]. Light-emitting diodes (LEDs) are suitable for laser therapy because they emit low levels of power that do not irritate or burn the skin. ...

Enhancement of skin rejuvenation and hair growth through novel near-infrared light emitting diode (nNIR) lighting: in vitro and in vivo study

Article [Full-text available](#)

Apr 2024 · LASER MED SCI

Keonwoo Choi · Hongbin Kim · Sun-Young Nam · Chan-Yeong Heo

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... Building on promising behavioural outcomes in previous studies, there are approximately 300 registered PBM clinical trials on the effects of PBM on various brain diseases, including Alzheimer's disease (AD), Parkinson's disease (PD), depression, back pain, traumatic brain injury (TBI), plantar fasciitis, chronic obstructive pulmonary disease and many more [23]. However, PBM remains a relatively new stimulation method that has many unknowns regarding how much the light interacts with brain tissue [24] . aimed at identifying an optimal set of parameters that maximize energy accumulation in the brain. ...

Simulation-based dosimetry of transcranial and intranasal photobiomodulation of the human brain: the roles of wavelength, power density and skin colour

Preprint [Full-text available](#)

Apr 2024

Hannah Van Lankveld · Anh Q. Mai · J. Jean Chen · Lew Lim

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... Based on preclinical research, PBM has the capacity to elevate the levels of neuronal NO, enlarge blood vessel diameter, and enhance cerebral blood flow (CBF) [109,110]. Consequently, it is plausible to consider that PBM therapy targeted at specific brain regions may have the potential to influence regional CBF [111] . Transcranial PBM utilizing red and NIR wavelengths resulted in an elevation of cerebral oxygen consumption in both naive rats and AβPP mice [112]. ...

Photobiomodulation for Neurodegenerative Diseases: A Scoping Review

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Jan 2024 · INT J MOL SCI

Qi Shen · Haoyun Guo · Yihua Yan

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... In addition, in contrast with optogenetics, INM can be used directly with neural tissue without gene level modification. Moreover, INM is insensitive to external electromagnetic fields and can be used with magnetic resonance or electrophysiology techniques [25][26] [27]

Advances in the Regulation of Neural Function by Infrared Light

Article [Full-text available](#)

Jan 2024 · INT J MOL SCI

Lequan Song · Hui Wang · Ruiyun Peng

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... Role of PBM in amyloid plaque reduction PBMT was found to reduce the deposition and overload of β-amyloid in the brain, especially in AD [1,[37] [38] [39]. PBMT potential role in the management of AD has been inscribed in Table 1 respectively. ...

Unleashing light's healing power: an overview of photobiomodulation for Alzheimer's treatment

Article [Full-text available](#)

Jan 2024

Aakash Ramanishankar · Ankul Singh S · Rukaiah Fatma Begum · Nirenjen .S

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... "The FBM therapy was introduced as an innovative modality for stimulating neural activity to improve brain function. This therapy is based on a light that involves exposing neural tissue to a low fluence through various light delivery methods capable of absorbing several wavelengths" [9, 10]

Immunohistochemistry Analysis of Animals with Post-Ischemic Stroke Treated with LED

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Dec 2023

● Eliane Gonçalves de Jesus Fonseca · ● Felipe Figueiredo Moreira · ● Ana Carolina Dorigoni Bini · Emerson Carraro

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... 48 Studies showed that LLLT could decrease immune cell infiltration into the injured site. 49 It was shown that neutrophil infiltration significantly decreased after LLLT in animal models. LLLT also inhibited macrophage migration in the inflamed joint. ...

Low-Level Laser Therapy for Rheumatoid Arthritis: A Review of Experimental Approaches

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Dec 2022

● Nikoo hossein-khannazer · ● Mandana Kazem Arki · ● Aliasghar Keramatnia · Journal of Lasers In Medical Sciences

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... NIR Jason Lee Waight and Natalia Arias joint first authorship. light interacts with CCO inside the mitochondria, restoring electron transport chain activity (Hamblin, 2018; Hennessy & Hamblin, 2017) and, therefore, improving energy metabolism. Indeed, there is evidence to suggest that sodium azide, a CCO inhibitor, moderates the impact of PBM (Spittler et al., 2015). ...

UNDERSTANDING FNIRS AS A NEUROMODULATORY TECHNIQUE

[Article](#)

Oct 2023

Natalia Arias Del Castillo · ● Ana M. Jiménez-García · ● Jason Lee Waight · ● Matteo Martini

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... Furthermore, NIR light has demonstrated its impact on cognition by dissociating nitric oxide and enhancing mitochondrial membrane potential, consequently elevating ATP production. Elevated nitric oxide levels can also serve as vasodilators, enhancing nutrient delivery and metabolite clearance [170] [171] [172] [173]. NIR light is employed in photobiomodulation and holds potential as an independent treatment for AD. ...

Optogenetics in Alzheimer's Disease: Focus on Astrocytes

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Oct 2023

E.V. Mitroshina · Elizaveta P. Kalinina · ● M. V. Vedunova

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... In connection with the topic of this review, a multitude of studies involving the application of PBMT to the treatment of patients with neurodegenerative diseases has been reported in recent years (Hamblin, 2016b), demonstrating very encouraging results in both clinical and animal (Purushothuman et al., 2014) trials. This application is typically referred to as brain PBM (Salehpour et al., 2018; Hennessy & Hamblin, 2016) and commonly uses transcranial PBM (tPBM). For example, Cardoso et al. (2022) reported an improved inflammatory response in the brain of aged rats, while Xuan et al. (2014) found that mice experienced enhanced memory and learning after traumatic brain injury following an application of tPBM. ...

Is Alzheimer's disease a manifestation of brain quantum decoherence resulting from mitochondrial and microtubular deterioration?

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Apr 2023

 Trent Nichols ·  Marvin H. Berman

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... Neuronal Activity: In neurons, PBM has been shown to affect neuronal membrane excitability and synaptic transmission. It can alter the firing properties of neurons and modulate neuronal networks, which can have significant implications for cellular bioelectric properties in neural tissues [11]. ...

Photobiomodulation effects on cancer cells through modifications of their bioelectric properties

Article

Aug 2023 · PHYS LIFE REV

 Lew Lim

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... NIR Jason Lee Waight and Natalia Arias joint first authorship. light interacts with CCO inside the mitochondria, restoring electron transport chain activity (Hamblin, 2018; Hennessy & Hamblin, 2017) and, therefore, improving energy metabolism. Indeed, there is evidence to suggest that sodium azide, a CCO inhibitor, moderates the impact of PBM (Spitler et al., 2015). ...

From functional neuroimaging to neurostimulation: fNIRS devices as cognitive enhancers

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Jul 2023 · BEHAV RES METHODS

 Jason Lee Waight ·  Natalia Arias ·  Ana M. Jiménez-García ·  Matteo Martini

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... It is plausible that the delivery of light photons remotely could also provide some beneficial effects to the brain, perhaps by downregulating pro-inflammatory and upregulating anti-inflammatory cytokines [118, 119]. Remote biostimulation (peripheral stimulation) may possess some beneficial effects for the central nervous system. The indirect application of near-infrared light in an MPTP-mouse model of Parkinson's disease had some neuroprotective effects [79]. ...

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... To our knowledge, no previous studies have used transcranial photobiomodulation (tPBM) in the field of creativity. This technique (tPBM) has recently emerged as a promising tool for cognitive enhancement (Lee, Ding, & Chan, 2023;Salehpour et al., 2018) and it involves exposing neural tissue to light wavelengths that usually range from red to near-infrared (NIR) (600 to 1100 nm) (Hennessy & Hamblin, 2017) . The main action mechanism of tPBM seems to be the excitation of mitochondrial cytochrome c oxidase (Karu, 1988), which in turn may enhance the metabolic capacity (Saucedo et al., 2021) and the anti-inflammatory and antioxidant responses of the neurons, among other responses (Salehpour et al., 2018). ...

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... In connection with the topic of this review, a multitude of studies involving the application of PBMT to the treatment of patients with neurodegenerative diseases has been reported in recent years (Hamblin, 2016b), demonstrating very encouraging results in both clinical and animal (Purushothuman et al., 2014) trials. This application is typically referred to as brain PBM (Salehpour et al., 2018; Hennessy & Hamblin, 2016) and commonly uses transcranial PBM (tPBM). For example, Cardoso et al. (2022) reported an improved inflammatory response in the brain of aged rats, while Xuan et al. (2014) found that mice experienced enhanced memory and learning after traumatic brain injury following an application of tPBM. ...

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... Protein kinase D (PKD) is another kinase modulated by PBM. 107 Like PKB and MAPK pathways, PBM-related activation of PKD is mediated through ROS production (Fig. 7). Also, a recent review mentioned that PKC is implicated in PKD activation by phosphorylating its Ser738 and 742 ...

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Weijun Xuan · Liyi Huang · ● Michael Hamblin · [...] · ● Tanupriya Agrawal

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