NEURONIC

LEARN

ABOUT PHOTOBIOMODULATION (PBM)

Maria Da Costa & Nicole Greig

About Your Presenter

Maria Da Costa

Research Coordinator,
Neuronic Devices

Maria graduated from Nova Southeastern University with a bachelor's in Biology and minor in Psychology. She has research experience on epigenetics and cell therapy. She now works promoting and coordinating Neuronic's research efforts.

- What is Photobiomodulation (PBM)
- Mechanisms of Action
- 1064-1072 nm Wavelength
- Research on PBM

About Your Presenter

Nicole Greig

Consultation and Education Specialist, Neuronic Devices

Nicole graduated from the University of British Columbia with a B.Sc. in Behavioural Neuroscience. She has experience working in neurofeedback, research, and working with individuals in the fields of mental health, post-stroke recovery, and cognitive impairment.

- Neuradiant device
- Integration of qEEG and PBM
- Case studies
- Clinical integration

WHAT IS PHOTOBIOMODULATION?

Terminology

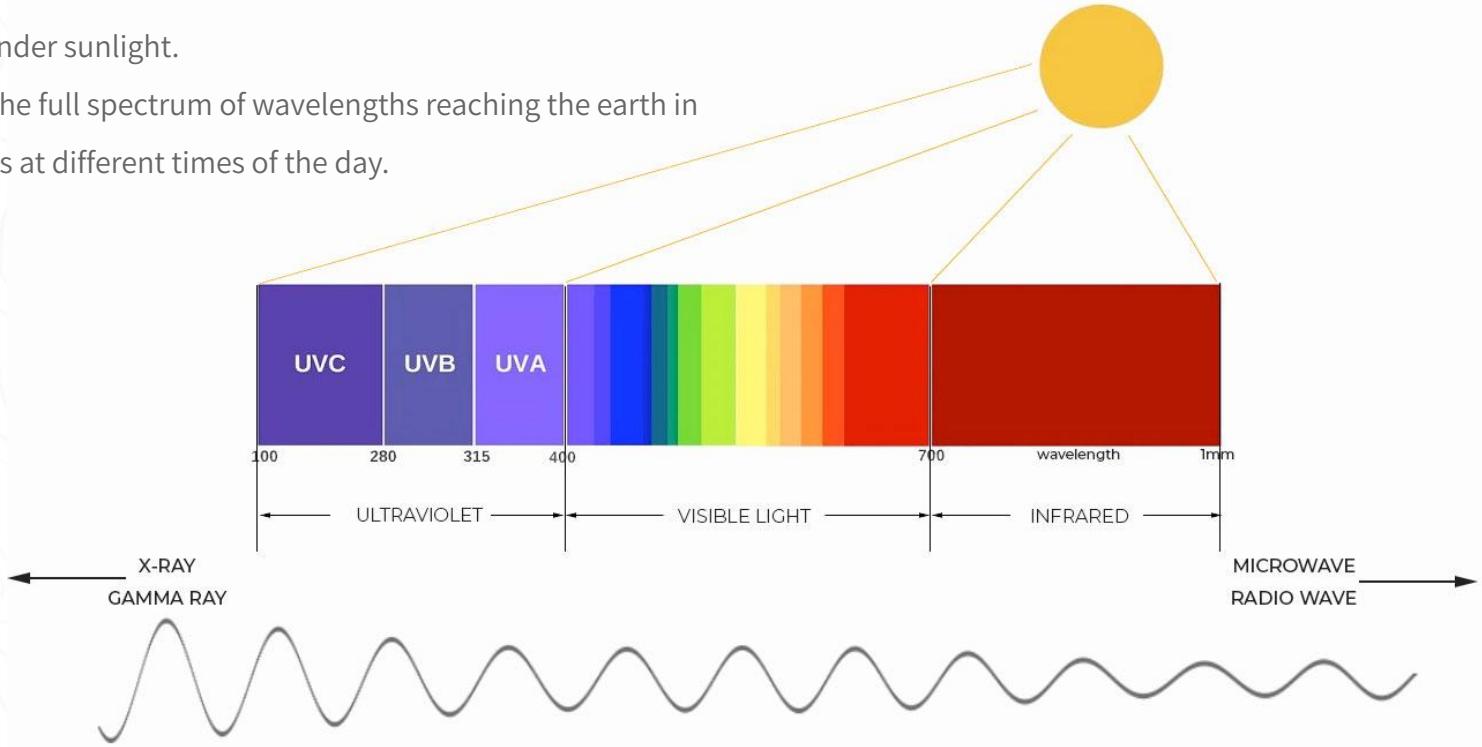
Photo Bio Modulation

1. The umbrella term for light interacting with biology is **PhotoBioModulation – PBM.**
    a. **PBM describes the intervention of cellular processes and biochemical reactions in living cells through photonic energy.**
2. Originally used **LASERS - LLLT** – low level laser therapy / low level light therapy or cold laser therapy
    a. PBM now also uses LEDs
    b. Non-heating & Non-ionizing light
3. **Red light / NIR therapy** is the most commonly used light therapy in biohacking / healthy aging.

*Anders JJ, Arany PR, Baxter GD, Lanzafame RJ. Light-Emitting Diode Therapy and Low-Level Light Therapy Are Photobiomodulation Therapy. Photobiomodul Photomed Laser Surg. 2019 Feb;37(2):63-65. doi: 10.1089/photob.2018.4600. Epub 2019 Jan 24. PMID: 31050924.

Evolutionary Biology - We are solar powered

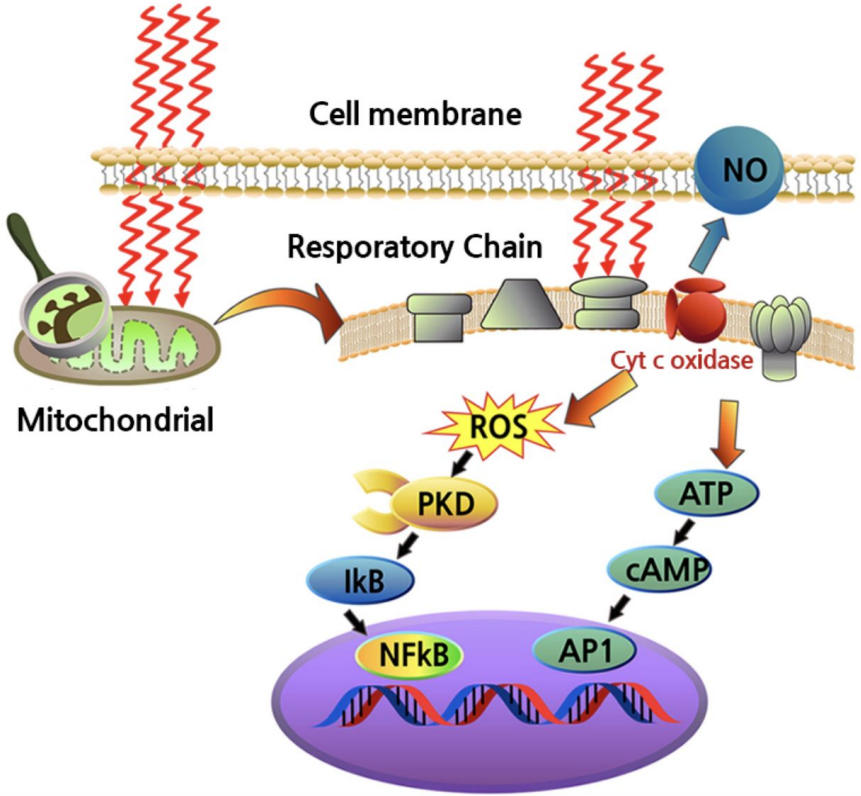
- We have evolved under sunlight.
- Sunlight contains the full spectrum of wavelengths reaching the earth in varying proportions at different times of the day.



PHOTOBIOMODULATION

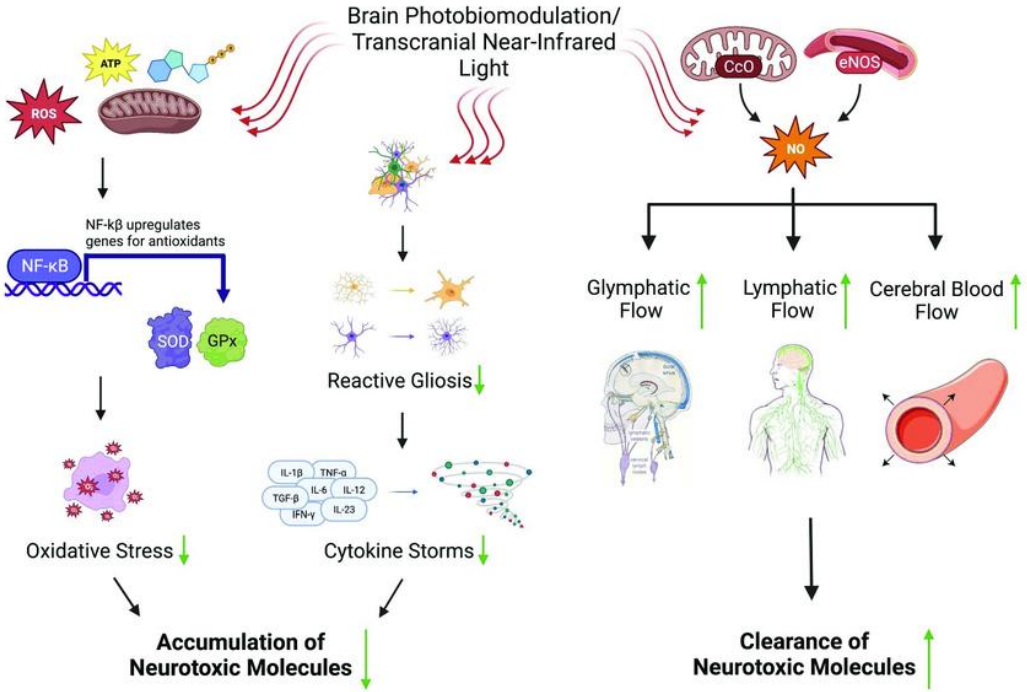
PRINCIPLES AND MECHANISMS OF ACTION

Mechanism of Action



Hamblin MR. Mechanisms and Mitochondrial Redox Signaling in Photobiomodulation. Photochem Photobiol. 2018 Mar;94(2):199-212. doi: 10.1111/php.12864. Epub 2018 Jan 19. PMID: 29164625; PMCID: PMC5844808.

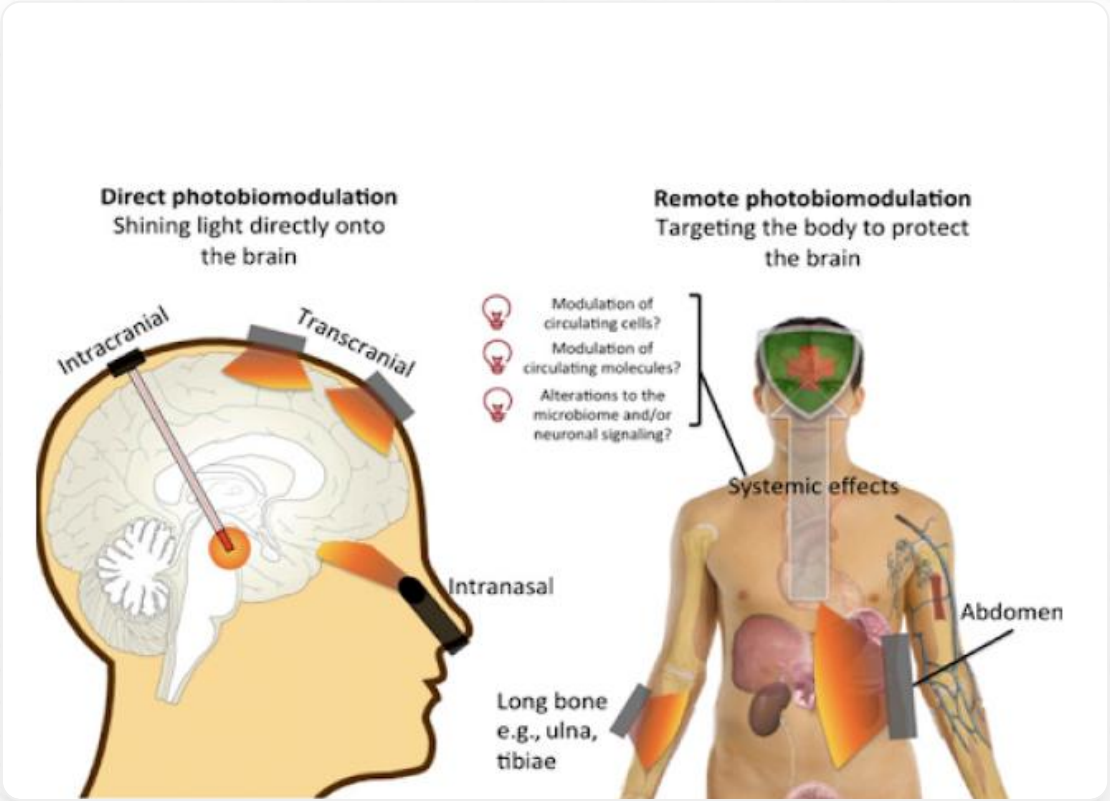
Photobiomodulation Systemic Effects



https://www.researchgate.net/publication/371096560_Recent_Mechanisms_of_Neurodegeneration_and_Photobiomodulation_in_the_Context_of_Alzheimer's_Disease

Delivery Systems

- Transcranial
- Intranasal
- Remote
- Whole body



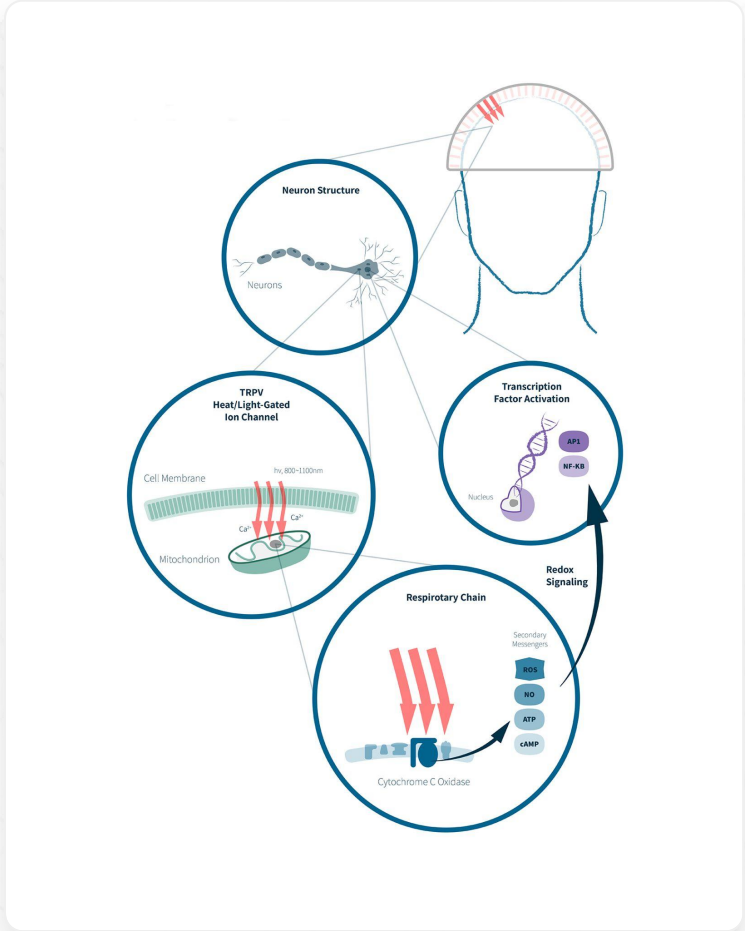
Kim B, Brandli A, Mitrofanis J, Stone J, Purushothuman S, Johnstone DM. Remote tissue conditioning - An emerging approach for inducing body-wide protection against diseases of ageing. Ageing Res Rev. 2017 Aug;37:69-78. doi: 10.1016/j.arr.2017.05.005. Epub 2017 May 24. PMID: 28552720.

PHOTOBIOMODULATION ON THE BRAIN

What is tPBM?

Transcranial photobiomodulation (tPBM) is a form of light intervention that involves the application of near-infrared or red light to the head with the intention of stimulating mitochondrial activity in brain cells.

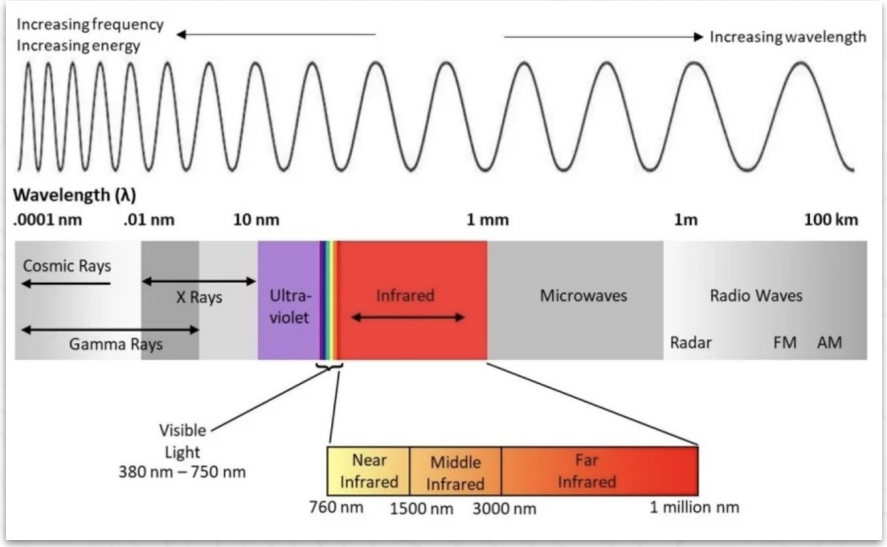
The mechanism relies on the ability of certain wavelengths of light to penetrate the skin and skull, reaching the brain, where it can exert its effects on neurons and other brain cells.

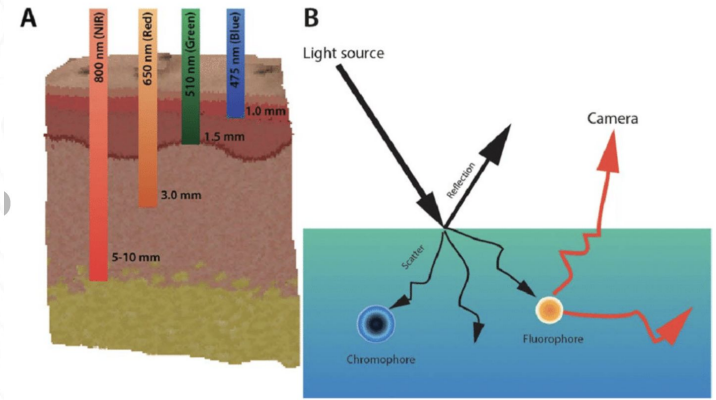


tPBM Light Penetration

Red Light (630-670 nm): Close to the peak absorption of photoreceptors like **cytochrome c oxidase**. Red light can penetrate our skin and underlying tissues.

Near-Infrared Light (800-1070 nm): The NIR spectrum is known for its deeper tissue penetration capabilities.

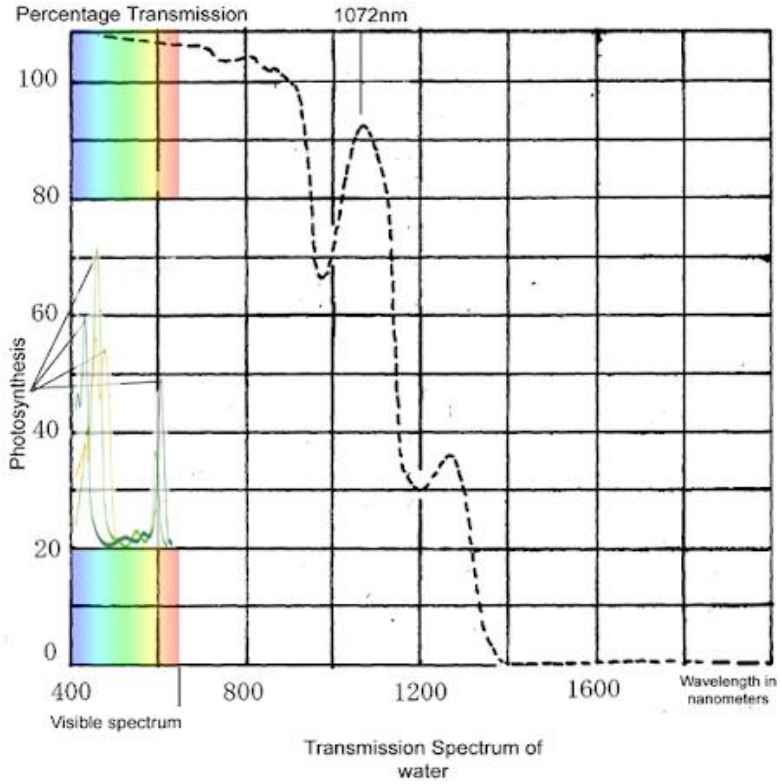




https://www.azooptics.com/Article.aspx?ArticleID=1666

Why 1060-80 nm?

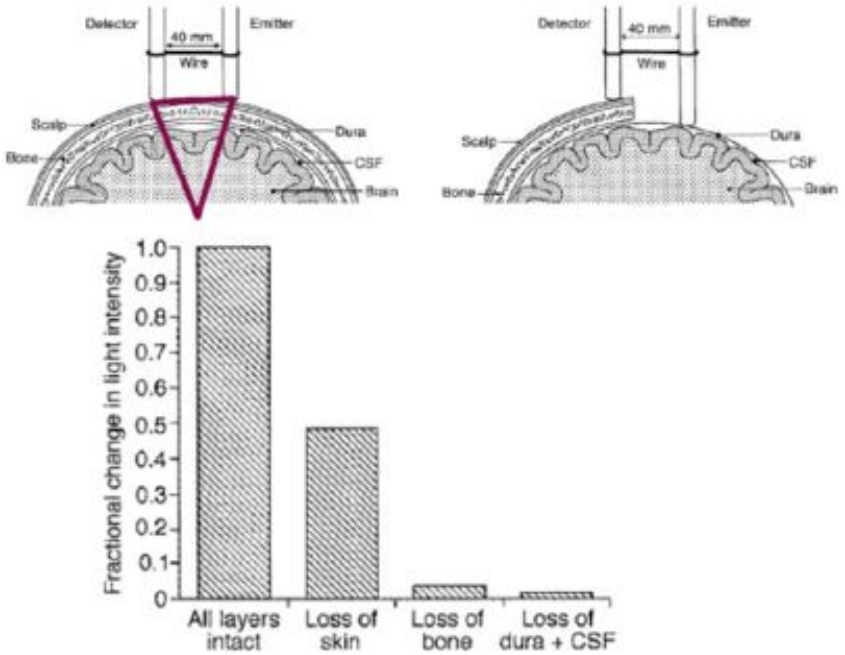
- Peak H2O Transmission
- Interfacial water layers (IWL)



https://www.sciencedirect.com/science/article/pii/S1011134405001077#fig1
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6462613/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6462613/

tPBM Light Penetration

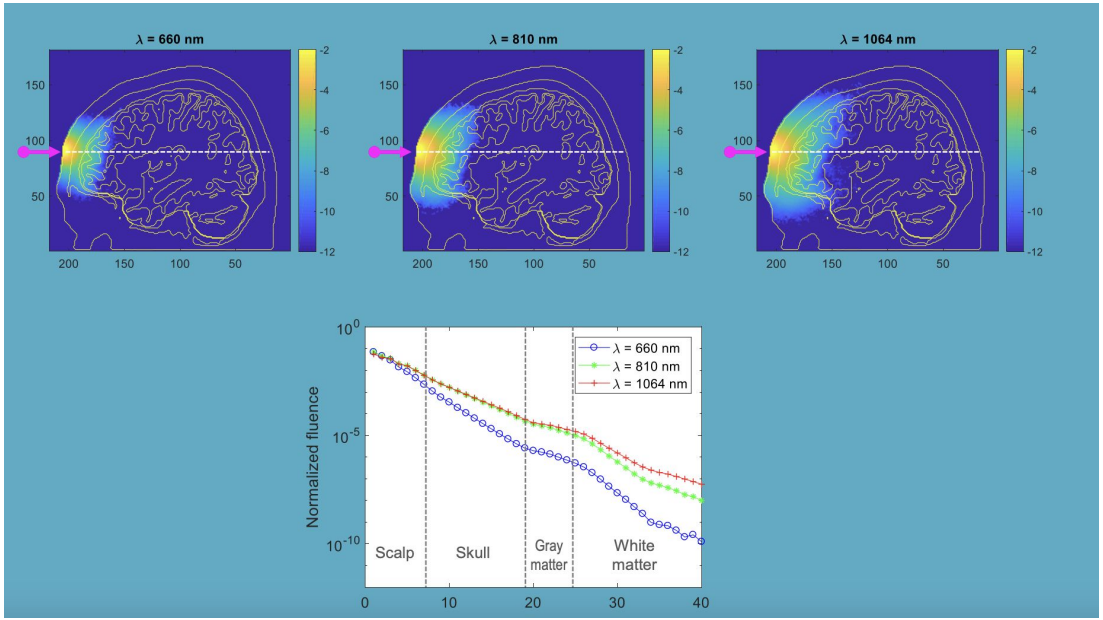
3-5 cm into cortex



https://www.bjanaesthesia.org/article/S0007-0912(17)38229-6/pdf

tPBM Light Penetration

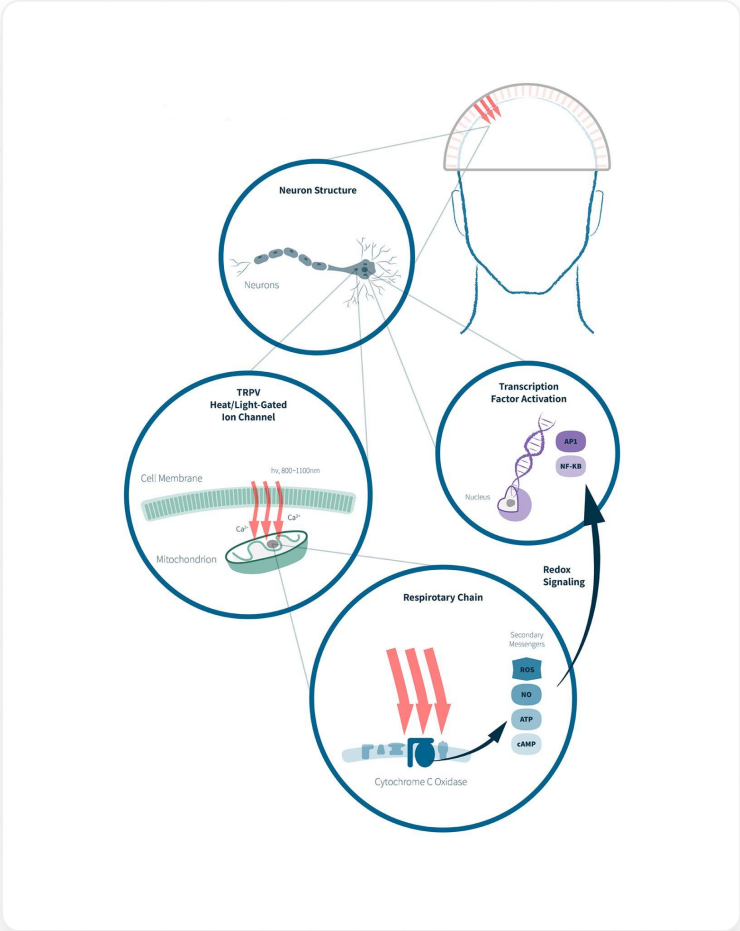
Effect of Wavelength (Point source)



https://www.spiedigitallibrary.org/conference-proceedings-of-spie/11221/112210B/Effects-of-wavelength-on-transcranial-laser-stimulation--a-Monte/10.1117/12.2545286.short#_=_

tPBM Mechanism of Action

1. Activation of TRP heat-gated ion channels
2. Mitochondrial Activation
3. Reduction of Oxidative Stress
4. **Anti-inflammatory Effects**
5. **Neuroprotection and Neurogenesis**
6. **Increased Blood Flow**
7. **Upregulation of Brain-Derived Neurotrophic Factor (BDNF)**
8. Reduction of Apoptosis



tPBM Mechanism of Action

Activation of TRP Open Ion Channels:

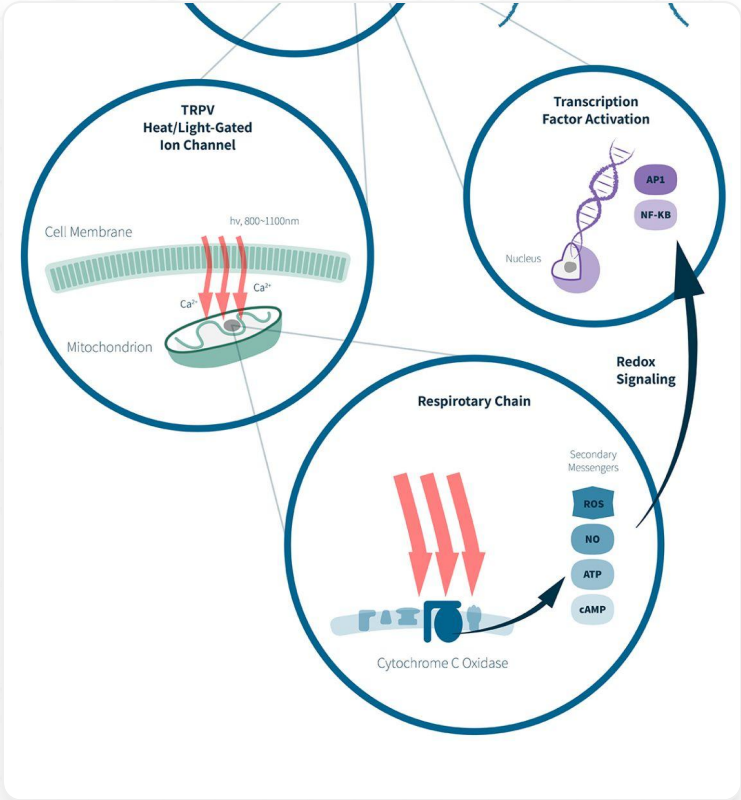
- Transient receptor potential (TRP) channels
- TRPV1, can be activated by heat
- Upon activation, these channels can allow calcium and sodium ions to enter the cell

Mitochondrial Activation:

- Cytochrome c oxidase, absorbs photons in the red and NIR range.
- Increase in the production of ATP, the primary cellular energy molecule.

Reduction of Oxidative Stress:

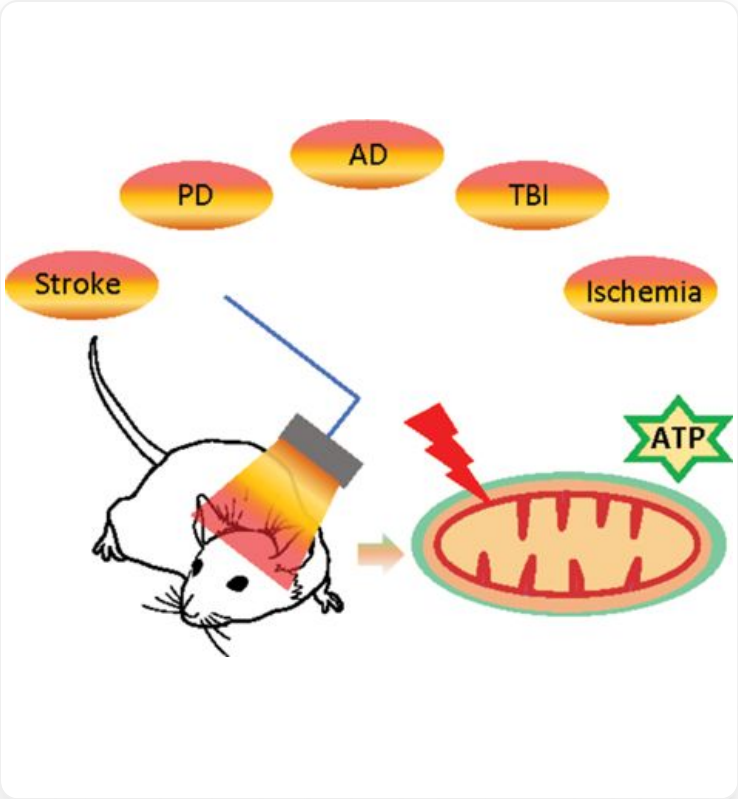
- Initial elevation in the cellular levels of reactive oxygen species (ROS), that culminate in reduced oxidative stress.
- This is because mild elevations in ROS can upregulate antioxidant enzymes, helping cells handle and neutralize ROS more efficiently.



tPBM Mechanism of Action

Anti-Inflammatory Effects

- Cells in the central nervous system (CNS) like microglia react to harmful triggers by releasing substances that can cause inflammation, such as cytokines.
- When this inflammation persists, it can cause harmful effects like tissue damage, cell death, and even facilitate diseases.
- A study by Martins et al. (2016) administered 950 nm laser PBM therapy in an animal model of inflammatory pain and found that the animals exhibited a reduced pain and an improvement of antioxidant enzymes and high levels of the anti-inflammatory cytokine IL-10.
- A study by O'Brien and Austin (2019) provided the first evidence that PBM may be neuroprotective against low-level neurodegeneration in a mouse model of Parkinson's disease, reducing microglia-induced neuroinflammation.



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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6723099/

https://onlinelibrary.wiley.com/doi/full/10.1002/tbio.202000024

tPBM Mechanism of Action

Neuroprotection and Neurogenesis:

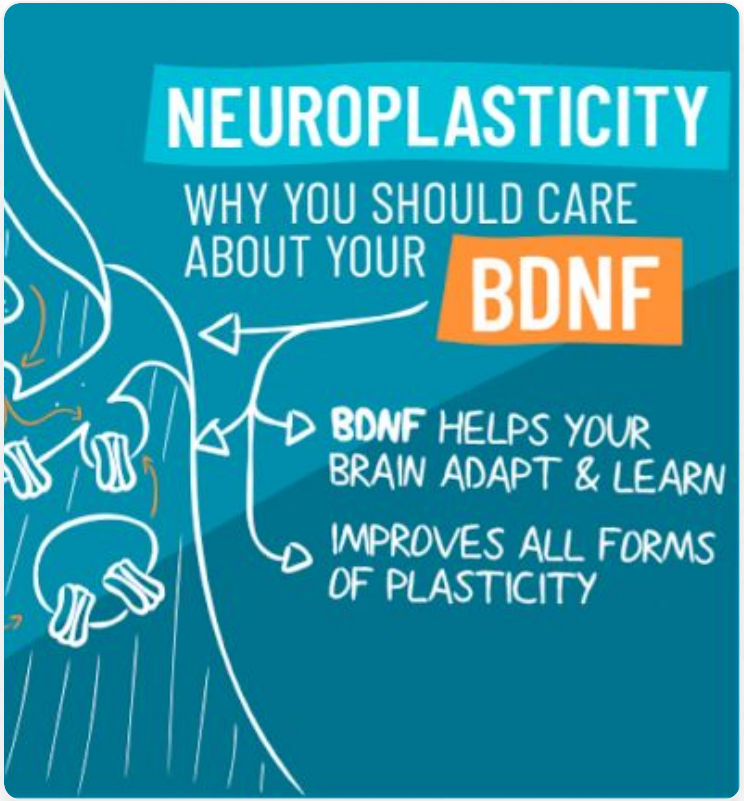
- Increasing Nitric Oxide (NO) levels in the prefrontal cortex and hippocampus

Upregulation of Brain-Derived Neurotrophic Factor (BDNF):

- BDNF is a crucial protein that supports the survival of existing neurons and encourages the growth and differentiation of new neurons and synapses.

Increased Blood Flow:

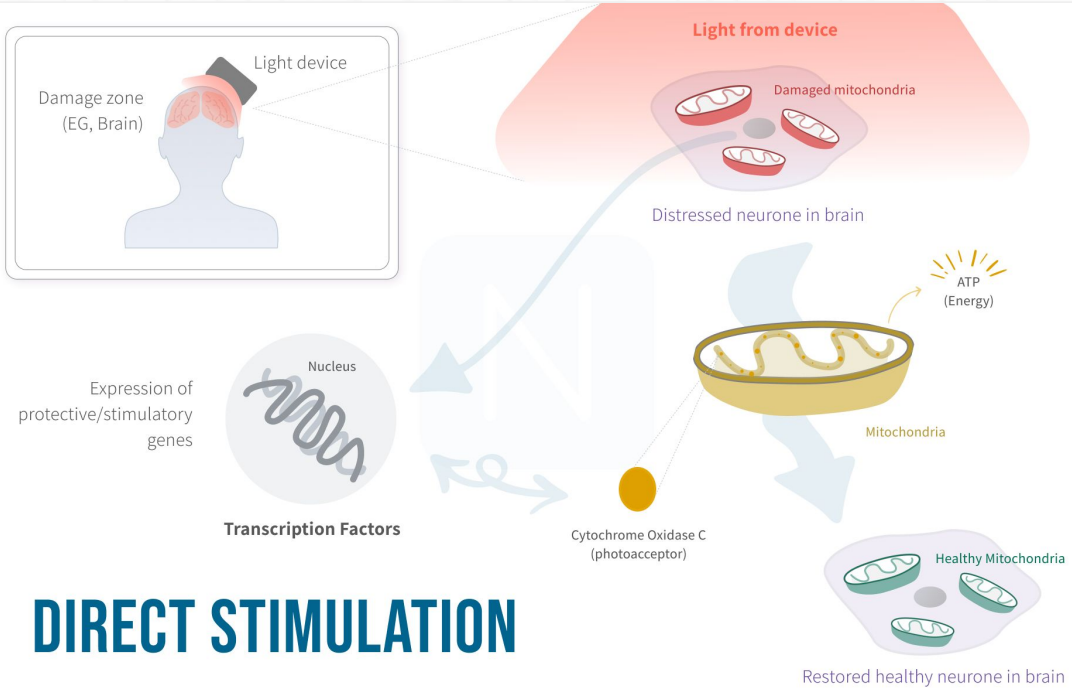
- PBM can influence vasodilation, leading to improved blood flow in treated areas. This can ensure better oxygen and nutrient delivery to brain cells.



https://www.jneurosci.org/content/33/33/13505.short

tPBM Mechanism of Action

Reduction in Apoptosis:



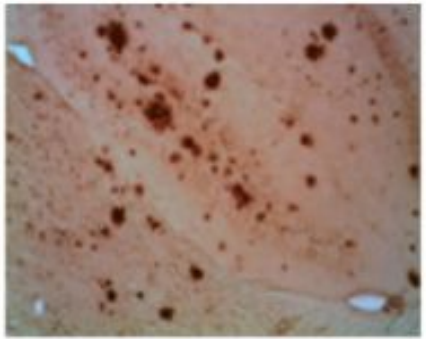
DIRECT STIMULATION

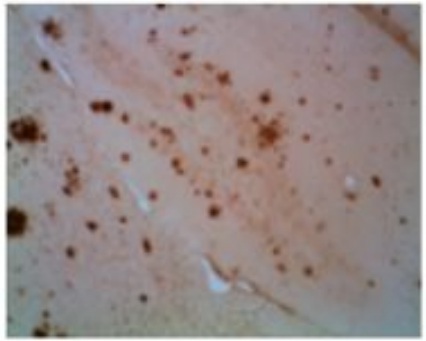
RESEARCH IN TPBM

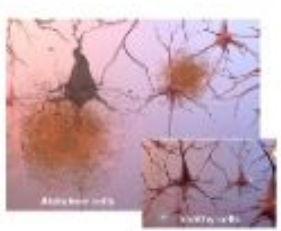
Common biomarkers linked to Alzheimer's disease pathology.

Biomarker		Importance
Amyloid biomarkers	APP	APP cleavage by γ- and β-secretases results in Aβ formation
	Aβ42/Aβ40	Reduced Aβ42/Aβ40 ratio is observed in AD
Tau biomarkers	T-tau	Elevated in prodromal and dementia AD
	P-tau	Hyperphosphorylation of tau leads to NFT formation Elevated in prodromal and dementia AD High P-tau in CSF is only observed in AD
Neural damage biomarkers	NfL	Marker for acute brain damage and neurodegeneration, but not specific for AD
	S100β	High levels correlate with greater brain atrophy
Neuroinflammation biomarkers	GFAP	Marker of astrocyte activation Observed to be higher in preclinical AD cases
	TNF-α	Pro-inflammatory cytokine frequently reported to be elevated in blood plasma and CSF of AD patients
	IL-β	Promotes Aβ plaque and NFT formation
Synaptic biomarkers	α-synuclein	Elevated in CSF of MCI and AD patients
	Neurogranin	High neurogranin is observed in AD and reflects synaptic (dendritic) degeneration
Metabolic biomarkers	ApoE	Major lipid transporter in the brain May lead to synaptic defects and cognitive impairments
	GDNF	Promotes dopamine uptake in dopaminergic neurons Significant decrease reported in AD patients

Reduction of Beta-amyloid with 1070nm IR







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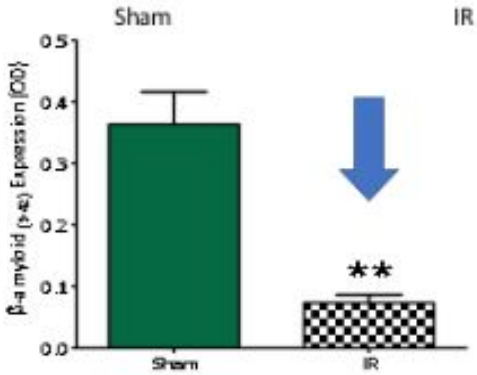
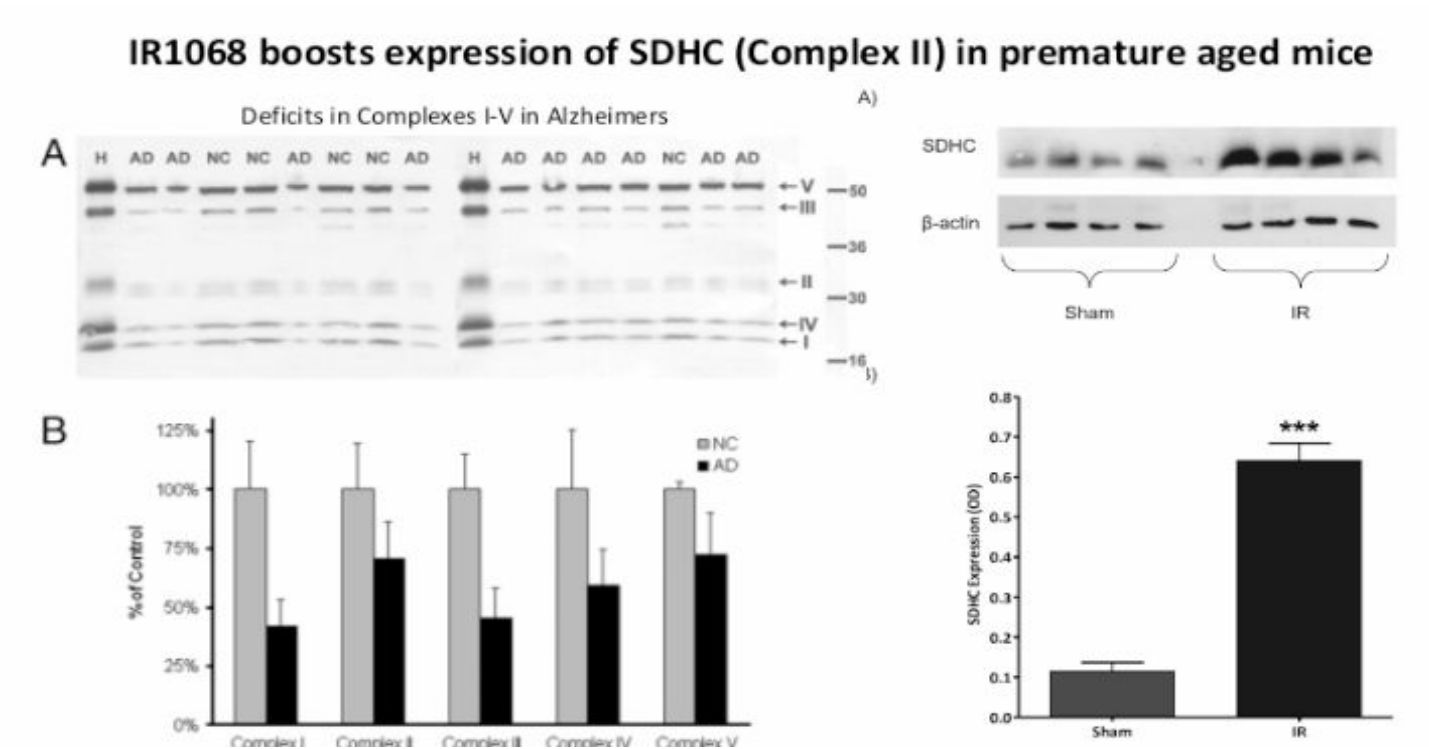
Journal of Photochemistry and Photobiology B: Biology

Volume 123, 5 June 2013, Pages 13-22



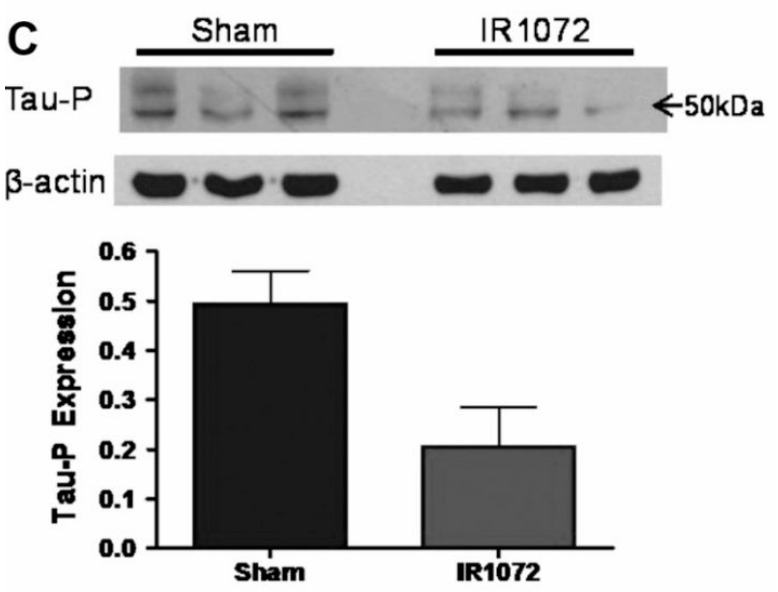
Non-invasive infra-red therapy (1072 nm) reduces β-amyloid protein levels in the brain of an Alzheimer's disease mouse model, TASTPM. J Photochem Photobiol B. 2013 Jun 5;123:13-22.

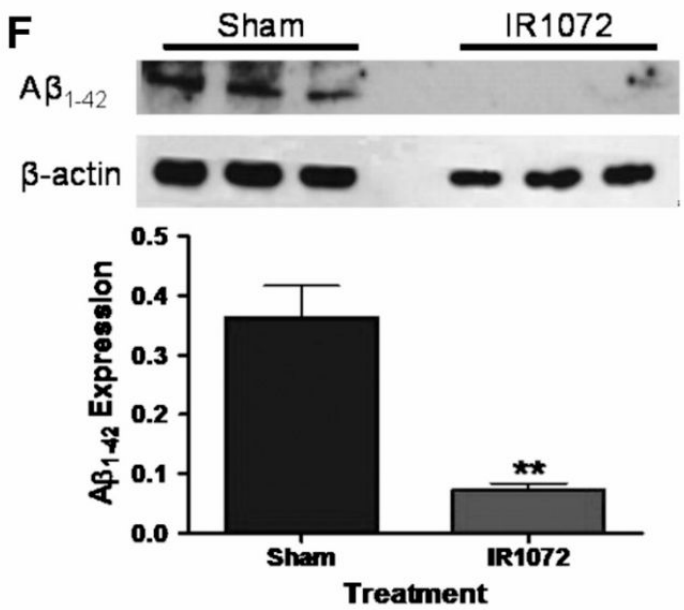
SDHC (Complex II) Decreases Mitochondrial Structural Damage, Oxidative Stress, Cellular Apoptosis and Tumorigenesis



Ishii T, Yasuda K, Akatsuka A, Hino O, Hartman PS, Ishii N. A mutation in the SDHC gene of complex II increases oxidative stress, resulting in apoptosis and tumorigenesis. Cancer Res. 2005 Jan 1;65(1):203-9. PMID: 15665296.

1072nm PBM reduces Tau-P & β-amyloid protein levels in AD mouse model

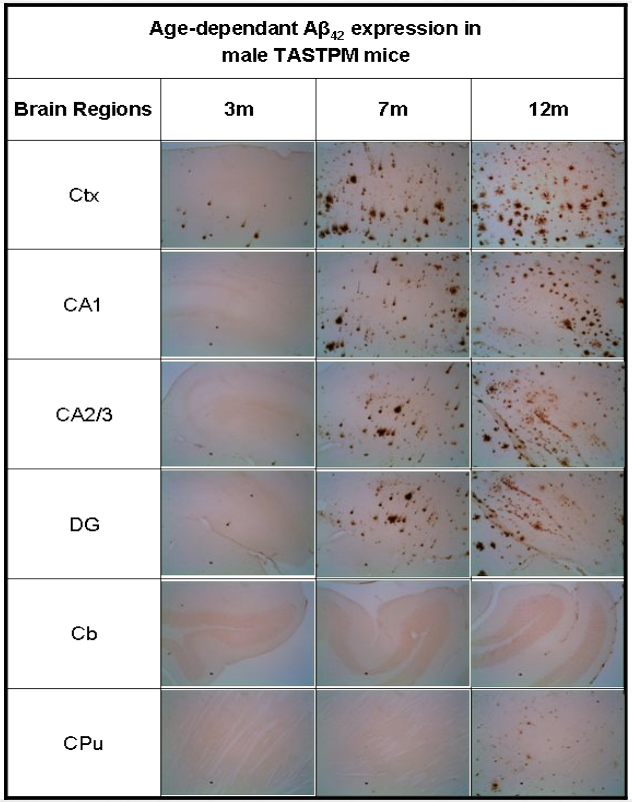




Preventing Toxic Protein Accumulation

Amyloid plaque formation

in TASTPM mice



Grillo SL, Duggett NA, Ennaceur A, Chazot PL (2013). Non-invasive infra-red therapy (1072nm) reduces β-amyloid protein levels in the brain of an Alzheimer's disease mouse model, TASTPM. J Photochem Photobiology B Biology, 123:13–22.

Human studies - tPBM

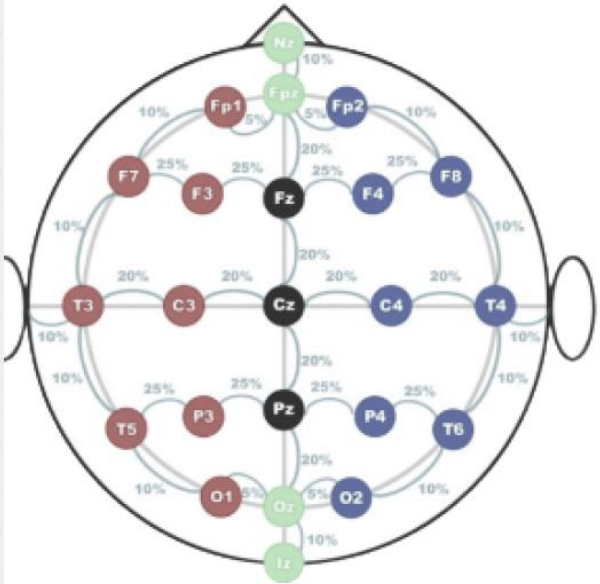
Study/Year	Subjects (n)	Light Source	Wavelengths	Irradiation Parameters	Irradiation Approach/Sites	Findings
Barrett Gonzalez-Lima 2013	Healthy volunteers (40)	Laser	1064 nm	250 mW/cm2, 60 J/cm2, 4 min CW	Transcranially; 2 sites, unilateral (right frontal pole on 4 cm medial and lateral)	Improved reaction time Psychomotor Vigilance Task and performance in a delayed match-to-sample memory task. Positive emotional states 2 weeks post-irradiation
Naeser et al. 2014	Chronic TBI (2 with depression) (11)	LED	633 and 870 nm	500 mW, 22.48 mW/cm2, 13 J/cm2, 10 min per site, 3×/week for 6 weeks, CW	Transcranially; 11 sites, midline and bilateral forehead	Improved sleep quality; decreased PTSD improved performance social, interpersonal, and occupational functions
Berman et al. 2017 and 2021	Dementia (11)	LED	1060–1080 nm	6 min/day for 28 consecutive days, PW at 10-Hz with DC of 50%	Transcranially; whole brain irradiation with LED helmet	Improved executive functioning including clock drawing, immediate recall, praxis memory, visual attention and task switching; improved EEG amplitude and connectivity measures
Dougal et al 2021	Healthy Volunteers	LED	1068NM	6 min twice daily 3.8w	Transcranially, Helmet with 14 LED arrays	Significant improvement in motor function, memory performance, and processing speed was observed in healthy individuals with PBM-T compared to the placebo group. No adverse effects were reported

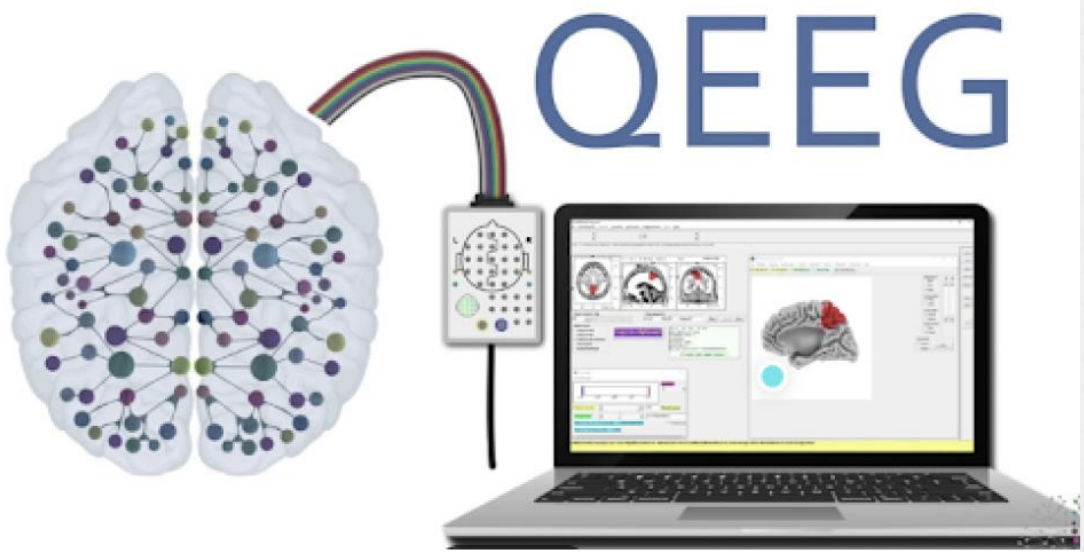
Salehpour F, Mahmoudi J, Kamari F, Sadigh-Eteghad S, Rasta SH, Hamblin MR. Brain Photobiomodulation Therapy: a Narrative Review. Mol Neurobiol. 2018 Aug;55(8):6601-6636. doi: 10.1007/s12035-017-0852-4. Epub 2018 Jan 11. PMID: 29327206; PMCID: PMC6041198.

Study/Year	Subjects (n)	Light Source	Wavelengths	Irradiation Parameters	Irradiation Approach/Sites	Findings
Saltmarche et al. 2017 [71]	Dementia (5)	LED	810 nm	14.2 or 41+23 mW/cm2 per LED, 10.65 or 24.6+13.8 J/cm2, 25 or 20 min, PW at 10-Hz,	Transcranially + Intranasally; Multiple areas, bilateral mesial prefrontal cortex, precuneus/posterior cingulate cortex, angular gyrus, and hippocampus	Improved function and sleep quality; decreased angry outbursts, anxiety, and wandering
Cassano et al. 2015 [203]	Major depressive disorder (4)	Laser	808 nm	5 W, 700 mW/cm2, 84 J/cm2, 2 min per site, 2×/week for 3 weeks, CW	Transcranially; 4 sites, bilateral (right and left forehead center at 20 and 40 mm from sagittal line)	Decreased depression rate at 6 to 7 weeks post-irradiation assessed by Hamilton Depression Rating Scale-17 items
Liebert et al 2022	Parkinson's disease	Laser	810 nm	3 x per week for weeks 1 to 4, 2 x week for weeks 5 to 8, 1 x week 9 to 12	Transcranially with 4 LEDs, 240 joules, intranasally 1 LED, 15 joules, abdomen 4 laser diodes, 39.6 joules	Improvements in outcome measures after PBM therapy for up to 52 weeks. Significant improvements over the clinic-treatment period included TUG motor, TUG cognitive, 10MWT walking speed and stride length, tests of balance (step test, TS test with affected leg behind), cognition (MoCA) and fine motor skill (spiral test).

Salehpour F, Mahmoudi J, Kamari F, Sadigh-Eteghad S, Rasta SH, Hamblin MR. Brain Photobiomodulation Therapy: a Narrative Review. Mol Neurobiol. 2018 Aug;55(8):6601-6636. doi: 10.1007/s12035-017-0852-4. Epub 2018 Jan 11. PMID: 29327206; PMCID: PMC6041198.

Quantitative EEG (QEEG)





tPBM with 1064-nm laser modulates brain EEG rhythms

Wang et al. (2019)

Sample

20 healthy subjects (average age = 26.8)

64-channel EEG

2-min baseline period (Bl)
11-min laser stimulation period (T1–T11)
3-min recovery period (R1-R3)

1064 nm CW laser

Power density of 0.162 W/cm2,
Energy density ≈ 107 J/cm2
Total energy 1452 J over 11-min tPBM

Each subject received both active and sham stimulations on the same day (sham first, followed by active stimulation)

All subjects were unaware that one of the sessions consisted of sham stimulation.

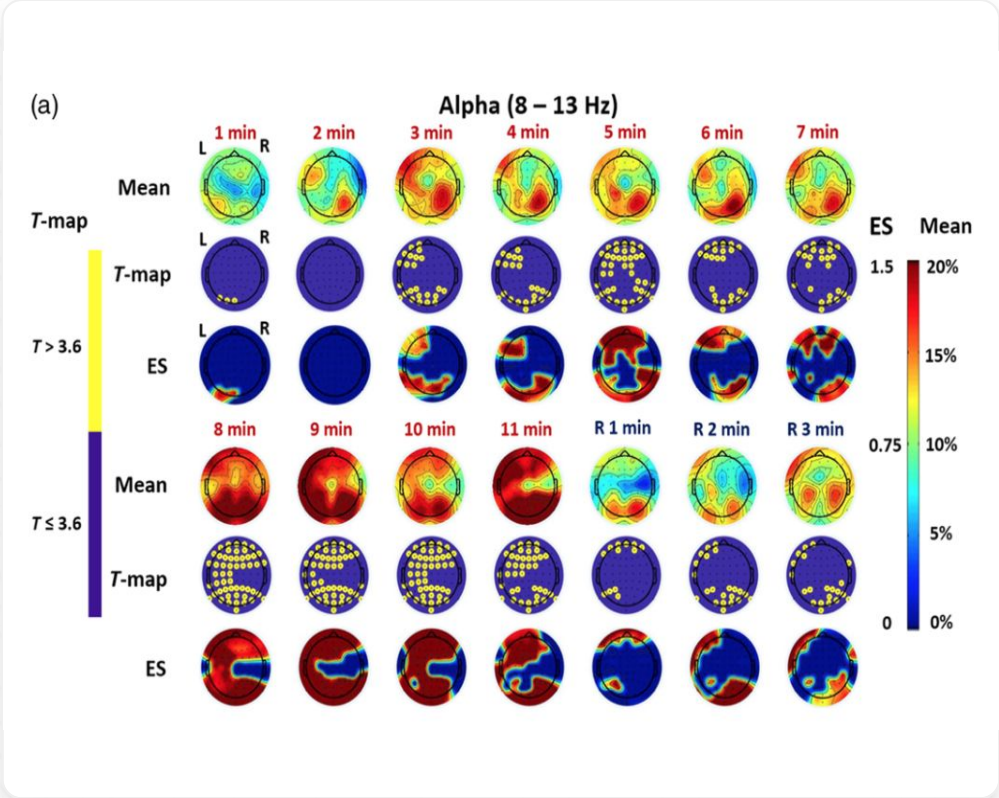
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6563945/

tPBM with 1064-nm laser modulates brain EEG rhythms

Spatial topographies of group-level mean differences EEG power density at the alpha (8 to 13 Hz) between tPBM and sham

Alpha power increases after tPBM onset and remains elevated over bilateral anterior and posterior regions even post stimulation.

tPBM caused very large effects in alpha power as compared to the sham control



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6563945/

Figure 4 A

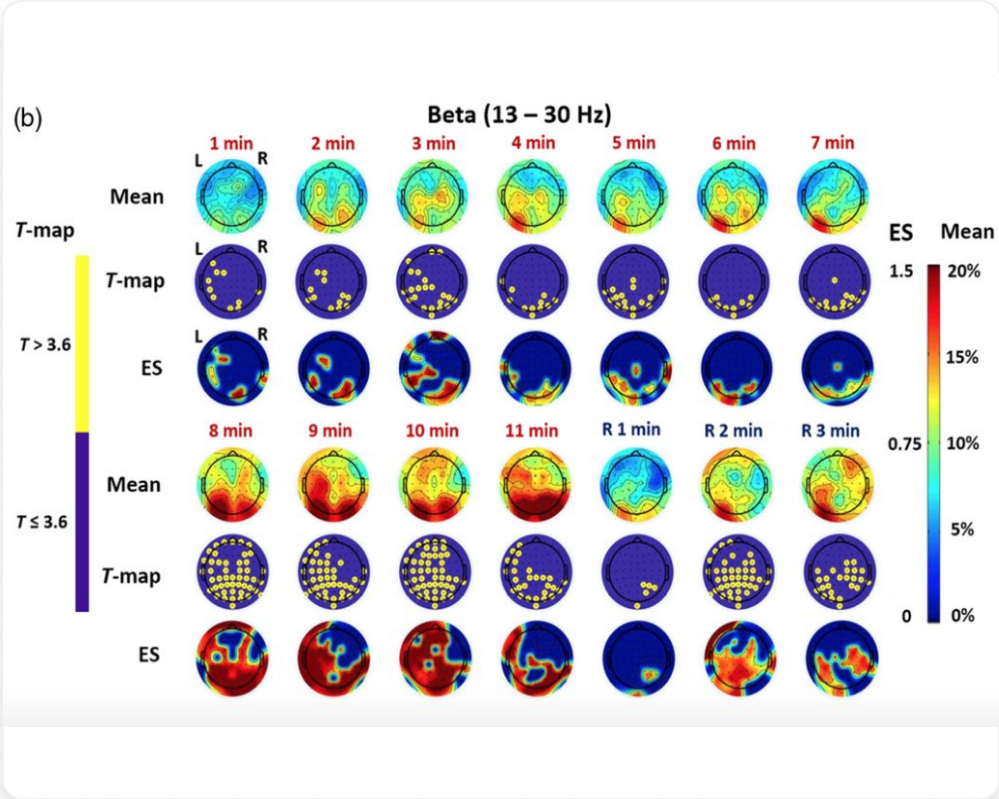
tPBM with 1064-nm laser modulates brain EEG rhythms

Beta (13-30 Hz) power density

Increased beta power over the posterior electrodes 4-7 min after stimulation onset.

Beta power, like Alpha, increased significantly across most of the scalp 8- 11 min after tPBM onset.

T-maps reveal statistically significant differences in beta power density between active and sham tPBMs during the recovery period.

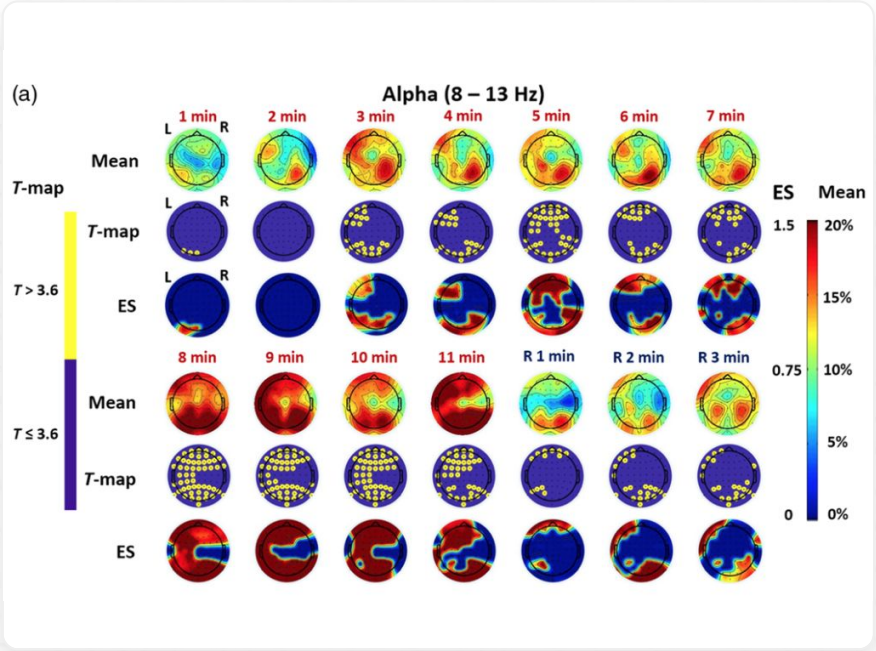


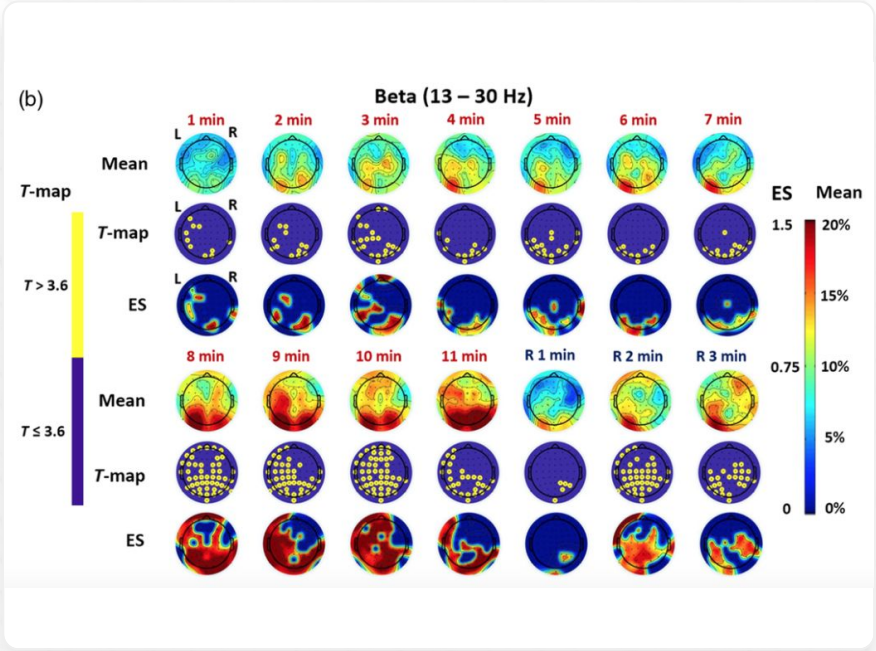
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6563945/

Figure 4 B

tPBM with 1064-nm laser modulates brain EEG rhythms

The results show time-dependent, significant increases of EEG powers at the alpha (8 to 13 Hz) and beta (13 to 30 Hz) bands at broad scalp regions, exhibiting a front-to-back pattern.





https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6563945/

Transcranial PBM vs thermal stimulation in EEG of healthy humans

Wang et al. (2021)

Prefrontal tPBM 1064 nm laser	Compared the effects of tPBM and heat in EEG rhythms changes
Hypothesis	tPBM- and heat-induced alterations in EEG power topography were significantly distinct
Healthy humans (2 groups)	tPBM vs Thermal stimulation groups Each group participated in the study **twice under active & sham stimulation** with concurrent recordings of 64-channel EEG before, during, and after 8-min tPBM or thermo stimulation of 33–41 °C

https://www.nature.com/articles/s41598-021-97987-w

tPBM vs thermal stimulation in EEG of healthy humans

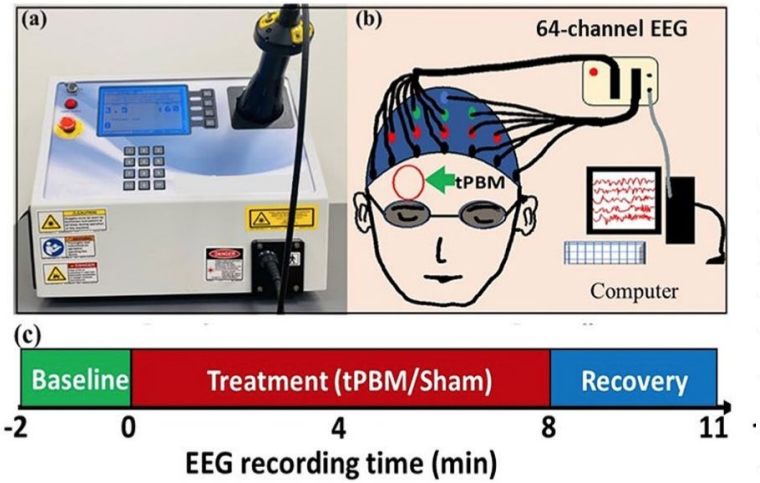
tPBM Group (n=46)

Active tPBM:

- Continuous Wave (CW) 1064-nm laser
- 8 min stimulation on the right forehead
- Power density of ~ 0.25 W/cm2 & total energy dose of 1680 J over 8 min of tPBM

Sham device:

- The laser device was on but set to 0.1 W during the 8-min stimulation time.
- Single-blind, cross-over study
- Sham or tPBM condition order was randomly assigned.



EEG Recording (64-channel)

- 2 min baseline
- 8 min treatment
- 3 min post-treatment

https://www.nature.com/articles/s41598-021-97987-w

tPBM vs thermal stimulation in EEG of healthy humans

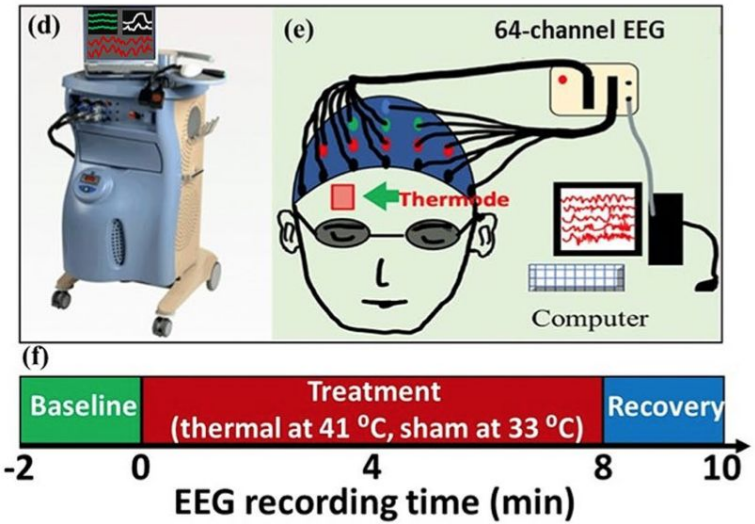
Thermal Stimulation Group (n=11)

True heating:

- Thermode probe replicates tPBM heating
- Probe placed on the right forehead
- Baseline: 2 min 33 °C
- Active stimulation: 8 min – 33 to 41 °C
- Recovery: 2 min – probe removed

Sham device:

- Order of sham or heating condition was randomly assigned
- Baseline: 2 min at 33 °C
- Active stimulation: 8 min at 33 °C
- Recovery: 2 min – remove the thermode probe



https://www.nature.com/articles/s41598-021-97987-w

tPBM vs thermal stimulation in EEG of healthy humans

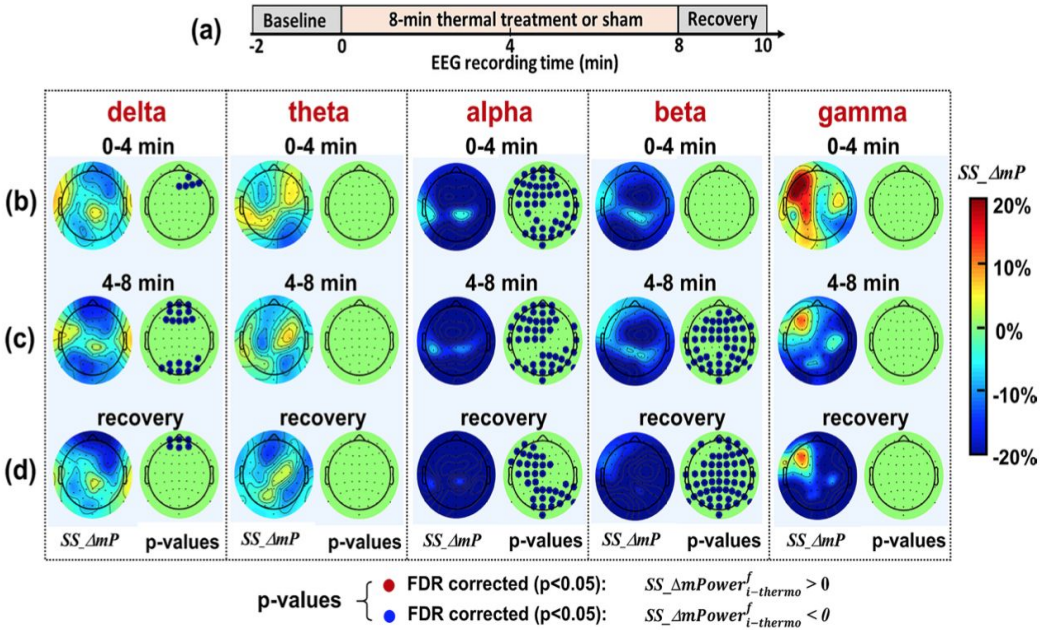
Wang et al. (2021)

Thermo stimulation (n=11)

a) Outlines of protocol timing

b-d) ΔmPower % by thermal stim at all five frequency bands

No significant changes evidenced



https://www.nature.com/articles/s41598-021-97987-w

tPBM vs thermal stimulation in EEG of healthy humans

Wang et al. (2021)

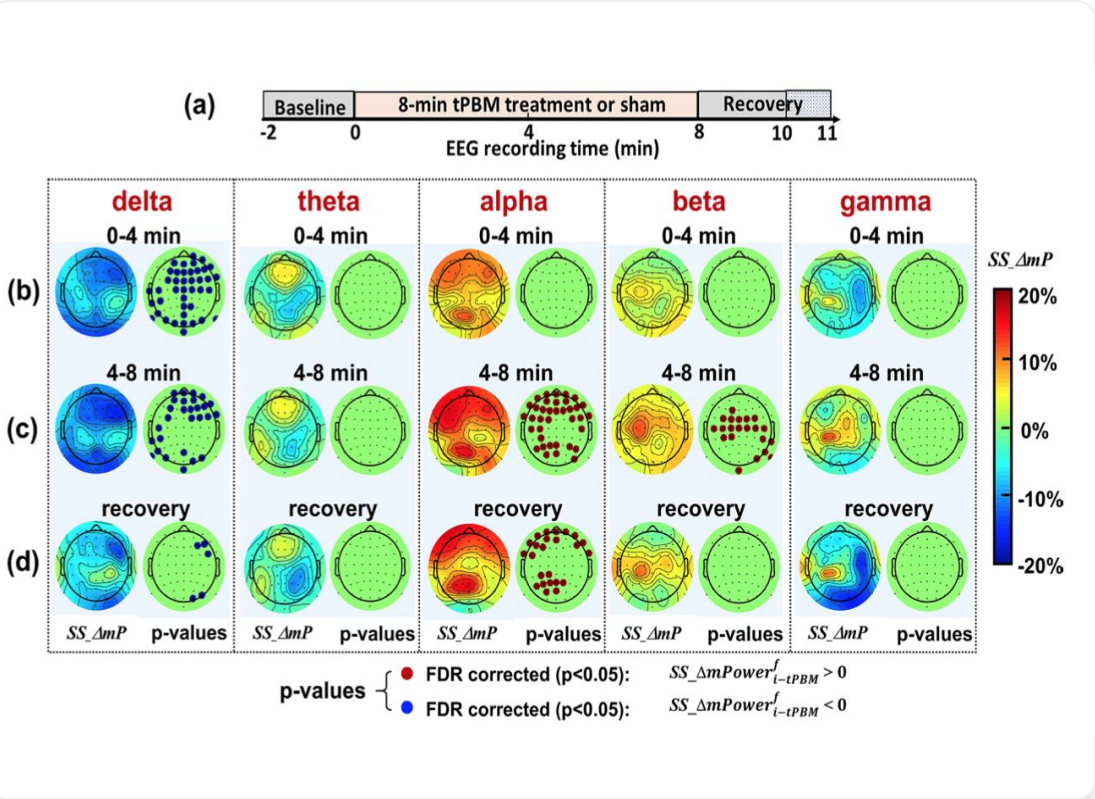
tPBM (n=46)

a) Outlines of protocol timing

b) 0–4 min tPBM/sham

c) 4–8 min tPBM/sham,

d) 8–10 min recovery

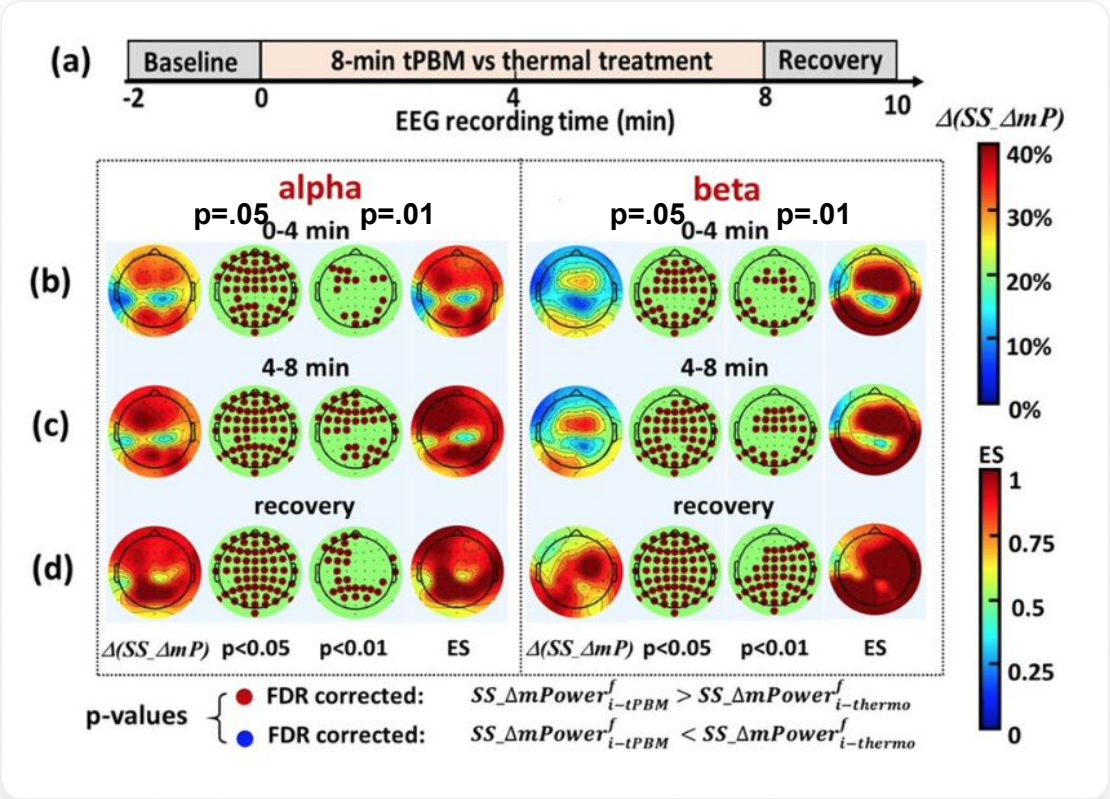


https://www.nature.com/articles/s41598-021-97987-w

tPBM vs thermal stimulation in EEG of healthy humans

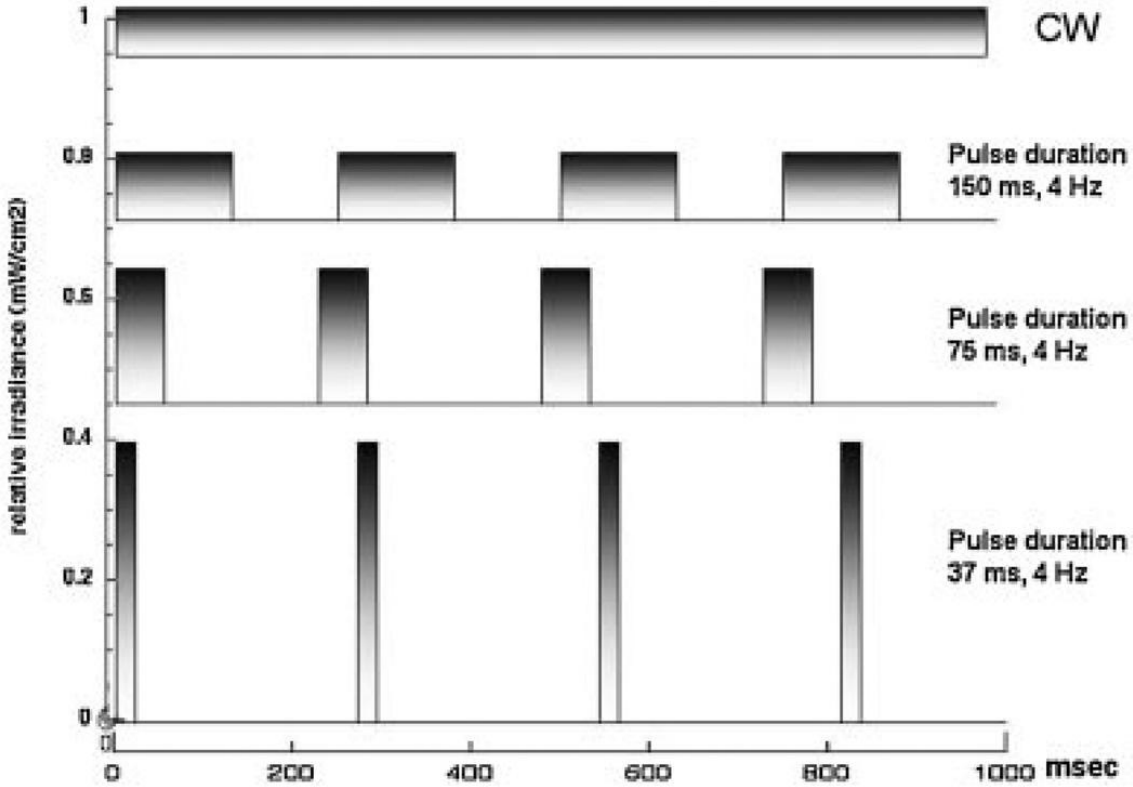
Wang et al. (2021)

Difference of EEG alpha and beta power changes between tPBM and thermal stimulations



https://www.nature.com/articles/s41598-021-97987-w

Continuous Wave (CW) vs Pulsed Wave (PW)



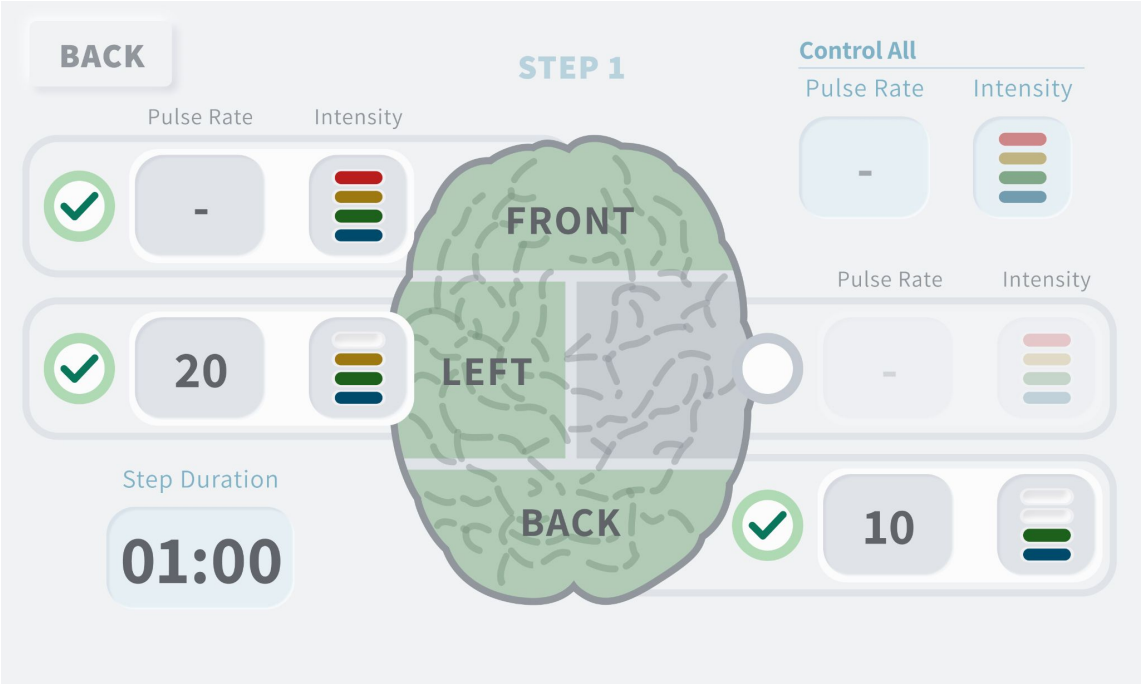
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2933784/

tPBM and Pulse Rate

Refs.	Subject	Condition	λ (nm)	*f* (Hz)	Other reported parameters	Results?
Kymplova et al. [24]	Humans	Wound healing	670	10, 25, and 50	Power: 20 mW; energy density: 2 J/cm^2	PW > CW
Brondon et al. [36]	In vitro (human HEP-2 cells)	Increasing the penetration depth of light through melanin filters	670	6, 18, 36, 100, and 600	Power: 10 mW; energy density: 5 J/cm^2	PW > CW
Lapchak et al. [26]	Rabbits	Ischemic stroke	808	100 and 1,000	Power density: 7.5 mW/cm^2; ON time: 0.3 milliseconds (1,000 Hz), 2 milliseconds (100 Hz); average energy delivered to the brain: 0.9–1.2 J; duty cycle: 30% and 20%	PW > CW
Lapchak and De Taboada [27]	Rabbits	Ischemic stroke	808	100	Cortical irradiance: 7.5 mW/cm^2 (CW), 37.5 mW/cm^2 (PW); cortical fluence: 0.9 J/cm^2 (CW), 4.5 J/cm^2 (PW)	PW > CW
Gigo-Benato et al. [23]	Rats	Nerve regeneration	808 (CW), 905 (PW), 808 + 905 (CW + PW)	10,000	Power: 416 mW (CW), 28 W (PW); energy density: 29 J/cm^2 (CW), 40 J/cm^2 (PW); pulse duration: 454 seconds (CW), 200 nanoseconds (PW)	Combined (CW + PW) > CW > PW
Braverman et al. [61]	Rabbits	Wound healing	632.8 (CW), 904 (PW)	4,672	Power: 10 mW (CW), 50 mW (PW); energy density: 1.65 J/cm^2 (CW), 8.25 J/cm^2 (PW); pulse duration: 200 nanoseconds	CW = PW
Al-Watban and Zhang [28]	Rats	Wound healing	635	100, 200, 300, 400, and 500	Power density: 0.89 mW/cm^2; energy density: 1.0 J/cm^2	CW > PW
Ueda and Shimizu [37]	In vitro (osteoblast-like cells from fetal rat calvariae)	Bone stimulation	830	1, 2, and 8	N/A	PW > CW
Sushko et al. [25]	Mice	Pain	610–670, 850–910	10, 600, and 8,000	N/A	PW > CW

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8355782/

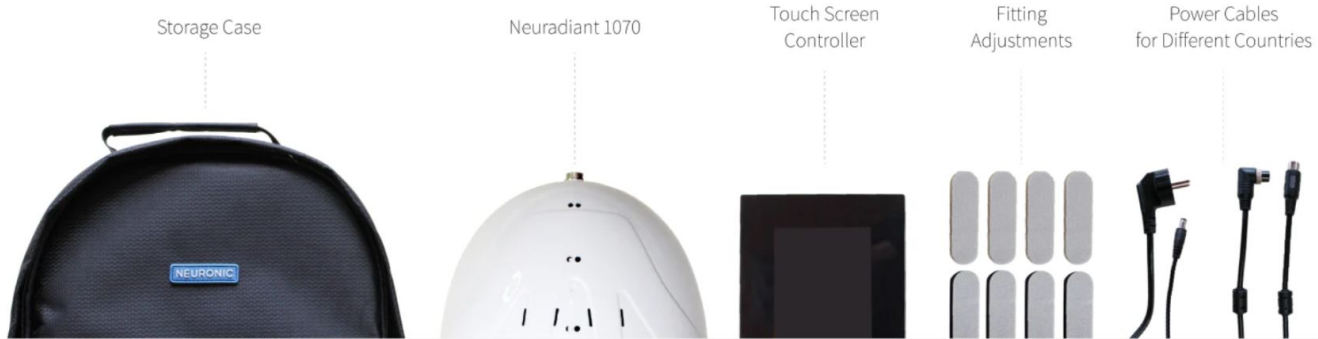
Neuradiant 1070 PBM-NFB Therapy



The Neuradiant 1070

- 256 LEDs delivering 1070 nm light
- Near infrared light (i.e. you cannot see it in the helmet!)
- Pre-set protocols vs 4 quadrant access for more intricate protocol creation

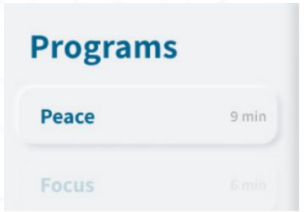
NEURADIANT 1070



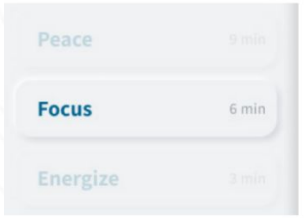
https://neuronic.online/products/1070nm-helmet

Pre-Set Protocols

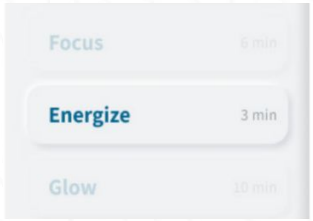
- Set protocols in the alpha (10 Hz), beta (20 Hz) and gamma range (40 Hz)
- Glow - continuous wave protocol with no pulse rate
- More personalization offered through the 4 quadrant feature



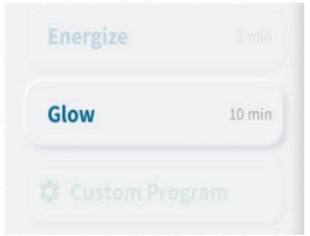
Time	9 min
Pulse Rate	10 Hz
Intensity	25%



Time	6 min
Pulse Rate	40 Hz
Intensity	50%



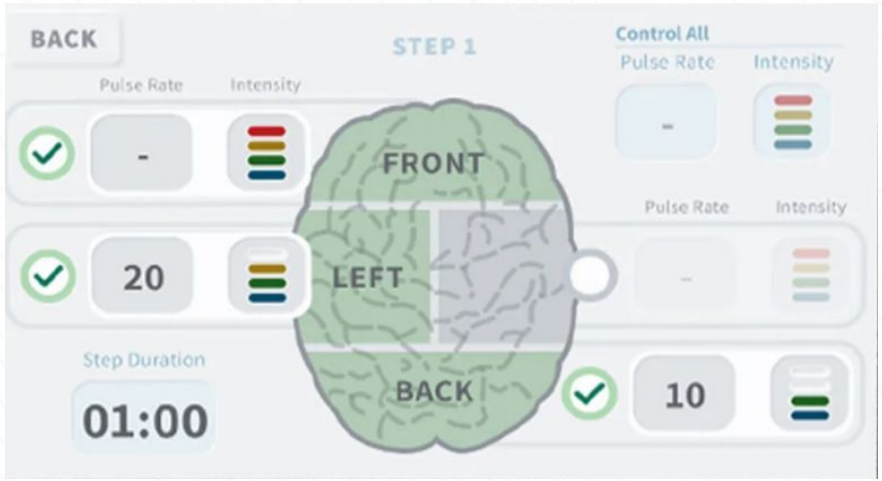
Time	3 min
Pulse Rate	20 Hz
Intensity	75%



Time	10 min
Pulse Rate	- Hz
Intensity	100%

4 Quadrant Feature

- Include a protocol with up to 4 steps
- Quadrant control - decide which sides to stimulate
    - Ex. stroke = only stimulating injured side with pulsed light
    - Ex. if qEEG shows deficit on only right side, direct stimulation there
- Ability to change:
    - Pulse rate
    - Intensity
    - Protocol duration



*green = on (stimulation is delivered here)
*gray = off (stimulation is not delivered here)

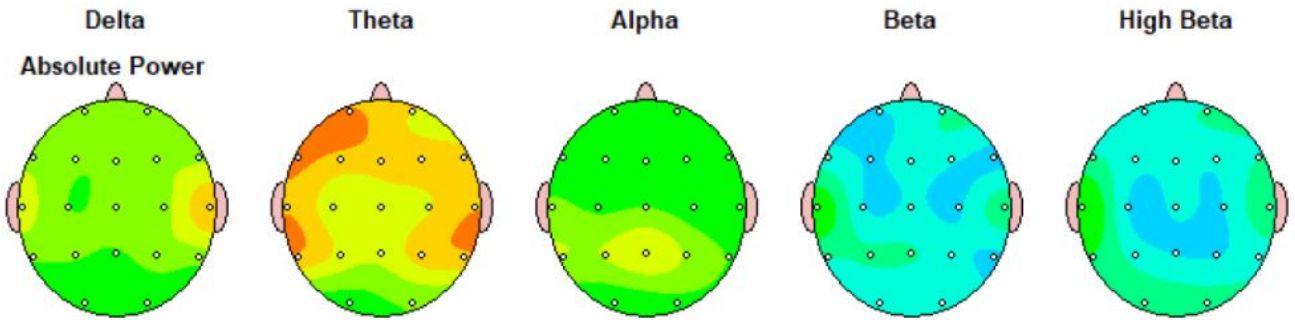
https://www.liebertpub.com/doi/abs/10.1089/photob.2019.4630

Entrainment with PBM

- Our device is bimodal = light therapy (delivery of 1070 nm light) + entrainment (pulsation of the light)
- **Entrainment** - external stimulation at a certain frequency leads to the brain's electrocortical activity oscillating at the same frequency.
    - Common entrainment modalities: binaural beats, transcranial magnetic stimulation (TMS).
- Research suggests using light pulsed at a certain frequency can modify certain oscillations in the brain (see previous slides).
- Using this knowledge, we read a qEEG and can create a protocol based off excessive or deficient activity of certain brain waves.

Protocol Development

- Two ways to create protocols:
    - Based on **symptoms** (guided by research)
        - Ex. Benefits of 40 Hz pulsation for Alzheimer's disease (AD)
    - Based on **qEEG**
        - Ex. Someone with AD showing the protocol below - you may want to entrain beta based on this deficiency



https://pubmed.ncbi.nlm.nih.gov/30072722/

Who is tPBM for?

Better question…who is tPBM ***NOT*** for?

4 Main Categories for Clinical Applications of tPBM:

- Neurodegenerative diseases
  - -Alzheimer's disease
  - -Parkinson's disease
  - -Dementia
  - -ALS (Amyotrophic lateral sclerosis)
  - -CTE (chronic traumatic encephalopathy)
  - -Huntington's disease
- Traumatic brain disorders
  - Stroke
  - Traumatic brain injury
- Neurodevelopmental disorders
  - Autism
  - ADHD
  - Down syndrome
- Psychiatric Diseases
  - Depression
  - Anxiety
  - PTSD
  - Addiction
  - Insomnia

Contraindications + Overstimulation (Side Effects)

- **Contraindications**:
  - Metal plates, implanted stimulation devices or other metal objects in the brain, cancer/malignant tissue/active carcinoma, brain tumors, medications causing light sensitivity, open wounds on the head, pregnancy, or certain hyperthyroid conditions.
- **Overstimulation**:
  - Light therapy behaves using a biphasic dose response (Hamblin et al., 2009)
  - Too little stimulation = suboptimal results, too much stimulation = overstimulation reactions (mild and transient)
  - Signs of overstimulation: Anxiousness, congestion, headache, dizziness, irritability, and sleepiness.

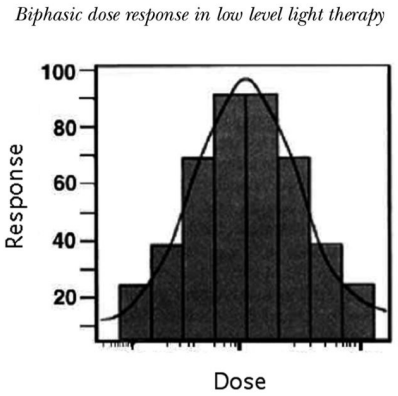


FIGURE 8. Idealized biphasic dose response curve (often termed Arndt-Schulz curve) typically reported in LLLT studies.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3315174/

Case Studies (qEEG)

Case Study #1 Autism Spectrum Disorder

- C.C.K. was diagnosed with autism.
    - Limited verbal ability
    - Little understanding of daily conversations
    - Low verbal and cognitive performance
    - Would often mix up the names of teachers and would often pause before speaking

Interventions

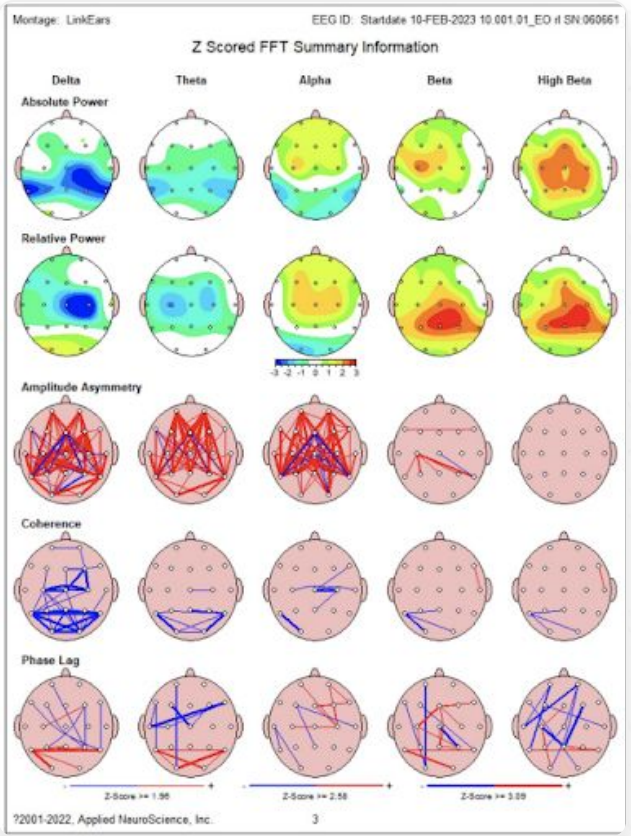
- Started with swLORETA neurofeedback
    - Improvements:
        - Social abilities and language
        - Could name his teachers correctly with two to three seconds delay.
- Then, started using the Neuradiant 1070 Plus, given autism has been associated with mitochondrial dysfunctions.

Source, Roger Lee 6/22/23, Neuronic Discussion Rounds https://youtu.be/1jW-AATJscs?si=WGMmiiDq3MER7Y3O

Initial Protocol

- Addressing under-activated Alpha (i.e., Absolute power and relative power) in the rear part scalp
- Starting at the “minimal” dose in the tPBM helmet (i.e., Neuradiant 1070nm 4Q) before every neurofeedback session (i.e., swLORETA)
- “Minimal” dose = 10Hz, 1 minute, with 25 % intensity
- Session administered once per week
- Gradually increase the dose at 1 minute intervals or +25% intensity (maximum at 75%)
- Receiving parents’ positive feedback after a few sessions of incorporating the tPBM and NF

Pre Stimulation (Feb 2023)



Source, Roger Lee 6/22/23, Neuronic Discussion Rounds

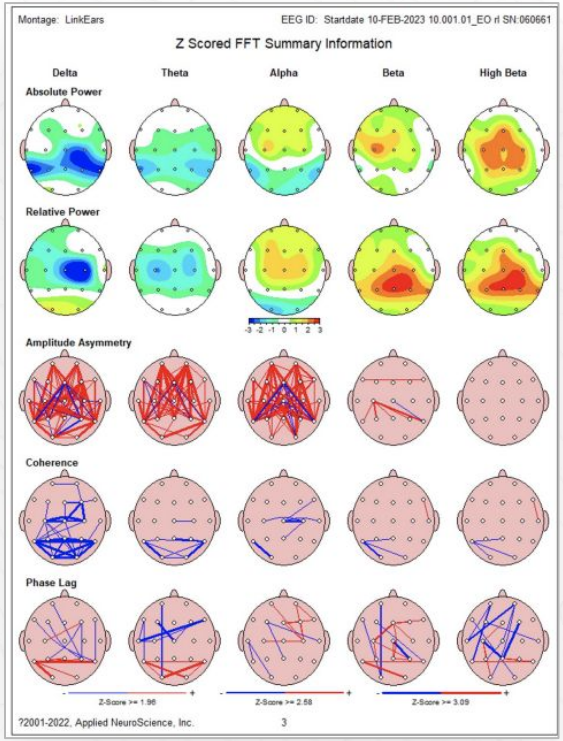
Source, Roger Lee 6/22/23, Neuronic Discussion Rounds https://youtu.be/1jW-AATJscs?si=WGMmiiDq3MER7Y3O

Results

- Incorporating the tPBM magnified improvements from NFB
    - He can say hello or bye to his teachers correctly without delay. He could talk about his emotions and express what he wanted the first time.
- He completed a drawing of a dinosaur under the verbal guidance of the teacher, which showing significant improvement

Source, Roger Lee 6/22/23, Neuronic Discussion Rounds https://youtu.be/1jW-AATJscs?si=WGMmiiDq3MER7Y3O

Pre-stimulation
Feb 2023



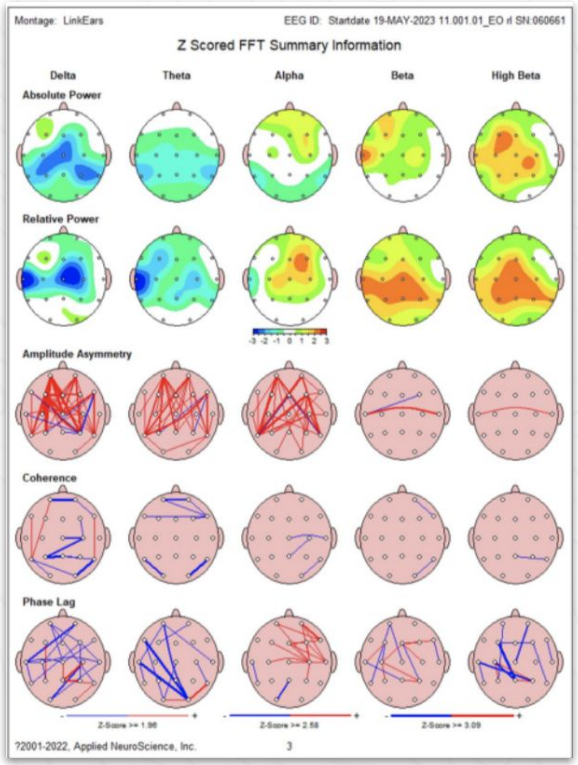
tPBM Protocol

- Duration = 2 minutes
- Pulse Rate = 10Hz
- 4Q = REAR Q only
- Intensity = 25%

Initial Outcome

- Under-activated power in lower frequency bands reduced.
- Over-activated power in Beta and High-Beta reduced
- Hypo-coherence improved across various frequency bands.

Post-stimulation
May 2023



Source, Roger Lee 6/22/23, Neuronic Discussion Rounds https://youtu.be/1jW-AATJscs?si=WGMmiiDq3MER7Y3O

Source, Roger Lee 6/22/23, Neuronic Discussion Rounds

Case Studies (Anecdotal)

- Female, 69 years old named MP with Alzheimer's disease
- First consult Nov 23, 2023. Protocol, 2x daily (based off symptoms):
    - 6 mins, 100%
    - 6 mins, 40 Hz, 75%
- Dec 21 (from caretaker)
    - Message: "I'm pleased to say that my wife is in good shape. She is much brighter in the evenings now, whereas, before, she was completely wiped out by 4pm. She has been cooking for the first time in several years and her memory is noticeably better. So far so good!"
- Dec 27 (from chart notes)
    - Family and friends have noticed she is brighter and more conversational, started cooking for the first time in years. Handwriting is much better. No more hallucinations in the afternoon/evening time. Daughter in law has said to keep going with the device because she is getting better. Friends over Christmas have said MP is more like her normal self.

Clinical Integration

Professionals that use light therapy in their practice:

- Psychiatrists, Psychologists, Psychotherapists;
- Neurofeedback and Biofeedback Practitioners
- Chiropractors
- Acupuncturists
- Neurologists
- Functional and Integrative Medicine Professionals;
- Neurotherapists;
- Naturopaths;
- Occupational and Physical Therapists;
- TBI Specialists;
- TMS Clinicians;
- Addiction and Recovery Specialists;
- Mental Health Professionals.

- Used as a “primer” before neurofeedback or other modalities that may tire the brain.
- Can be integrated with other modalities OR used as a standalone modality.
- Many of our partners become affiliates to provide their clients with a discount to buy a device to use at home.
- Some providers will rent out units to clients.
- New providers - one consultation call to get started (free) OR Masterclass + 2 hours of supervision (paid).

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THANK YOU FOR YOUR INTEREST

If you have any questions, please reach out to us anytime!

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Participating in Research: Please contact research@neuronic.online.