ADVANCES IN MULTISENSORY NEUROSTIMULATION

CSO Conference
May 17th 2025, Tucson

PART 1:
Anadi Martel

SENSORY NEUROSTIMULATION

What are the possible modalities?

- Light
- Sound
- Touch & Kinesthetic
- Vestibular motion
- Taste & Smell
- Electric / Magnetic stimulation (tACS, CES, PEMF…)
- …

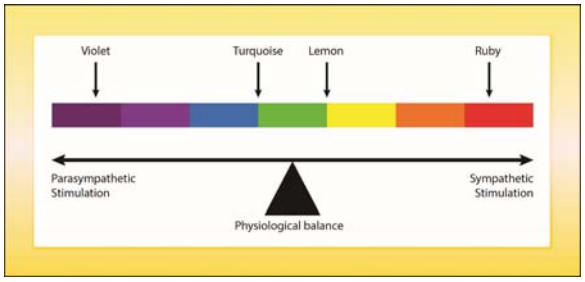
LIGHT STIMULATION: SYNTONICS

The Syntonizer

H.R. Spitler, 1935: ***Syntonic Optometry***
based on ANS balancing
with colours through the visual field

*In 2025 the **College of Syntonic Optometry***
will hold its
92nd International Conference on Light and Vision

LIGHT STIMULATION: SYNTONICS



Sympathetic ANS Stimulants:
Red, Orange, Yellow

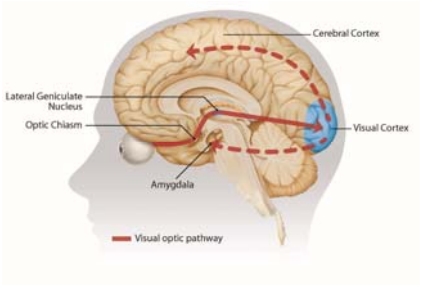
Parasympathetic ANS Stimulants:
Blue, Green, Turquoise

LIGHT AND THE BRAIN

Light reaches into
most of our brain centres.

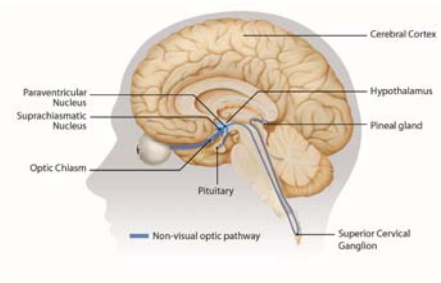
Light and Colours influence every level of our cerebral processes:
physiological, emotional and cognitive,
both conscious and unconscious.

VISUAL OPTIC PATHWAY



- Visual Cortex (cognition)
- Limbic system and Amygdala
  (instinctive emotional reactions)

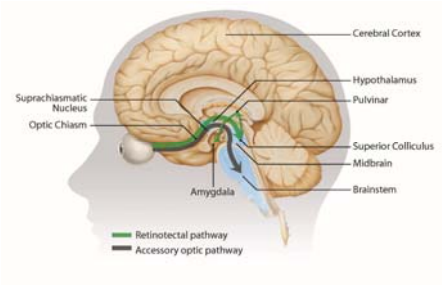
NON-VISUAL OPTIC PATHWAY



Retino-hypothalamic tract:
Direct connexion between the retina and
- Hypothalamus
- SCN (Suprachiasmatic Nucleus)
- Pineal gland
- Pituitary Gland
- …

➔ circadian, neuroendocrine, and neurobehavioral regulation

RETINOTECTAL & ACCESSORY OPTIC PATHWAYS



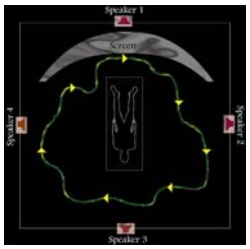
- Superior Colliculus
  (unconsciously perceived emotional stimuli)
- Brainstem
  (heart rate, sleep regulation, alertness)

SOUND STIMULATION

Possibly the most ancient neurostimulation modality…

SPATIAL SOUND

SP-1
Spatial Sound Processor
(Anadi Martel 1985)



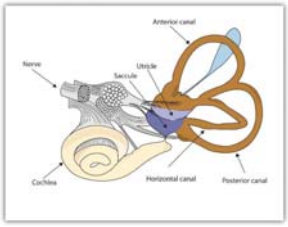
Sound Space

VIBROACOUSTICS

Kinesthetic vibrations
(usually extracted from low-frequency sound)
release accumulation of cortisol
in muscular tissues

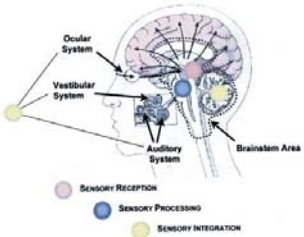
Usable frequency range:
35Hz - 150Hz

VESTIBULAR MOTION



"Lying on a moving table, the person receives gentle, precise patterns of circular movement. This vestibular stimulation circulates fluid in the semi-circular canals of the inner ear.

The motion puts the nervous system in a profoundly relaxed state and supports sensory integration."



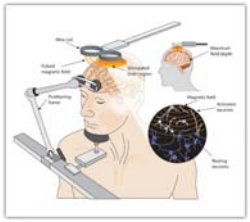
Sensory systems and their general location within the brain
(Bolles 2001)

OLFACTIVE STIMULATION

Early experiments with olfactive stimulation in the PYRADOME (Montréal, 1986)

ELECTROMAGNETIC NEUROSTIMULATION

- tACS (transcranial Alternating Current Stimulation)
- tDCS(transcranial Direct Current Stimulation)
- CES (Cranial Electrotherapy Stimulation)
- PEMF (Pulsed Electromagnetic Fields)
- …



tACS

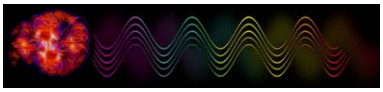
tDCS

RHYTHMIC SENSORY NEUROSTIMULATION

Introducing rhythmic pulsations
at specific frequencies
within the sensory stimulation

➔ Enables stimulation, interaction and entrainment of various biorhythms through resonance

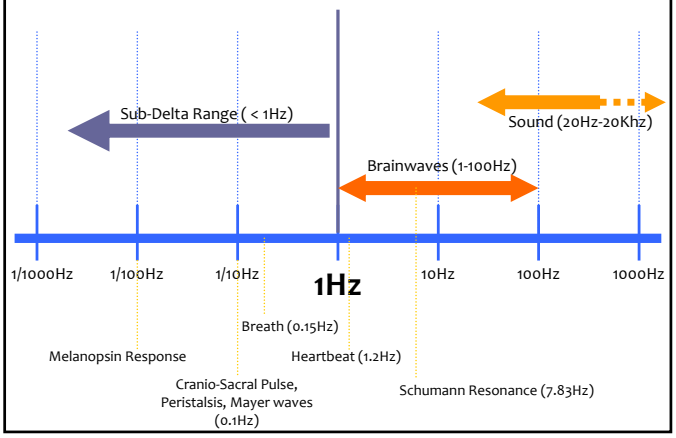
BRAINWAVE ENTRAINMENT



EEG Phase	Frequency Range	Associated Properties
Gamma	30 to 100 Hz	May be organized to sweep across the whole brain, perhaps providing "temporal binding into a single cognitive experience."
Beta	14 to 30 Hz	Brain waves in this range indicate the normal waking state. This is a state of mental activity and attention turned out towards the world. Most of us spend the majority of our waking hours in this state.
Alpha	8 to 13 Hz	Alpha waves accompany relaxation. This state indicates attention turned inward, as in meditation and deep unwinding, let-go.
Theta	4 to 7 Hz	The hypnagogic state just before falling asleep. This state plays an important role in visualization, creativity and learning.
Delta	1 to 4 Hz	Delta waves appear during the deepest portions of sleep. They are also associated with states such as trance mediumship.

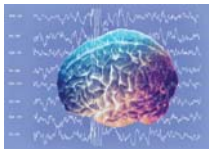
EEG Phases and their associated mental states

RHYTHMIC SENSORY NEUROSTIMULATION



PHOTIC DRIVING

Discovery of "Photic Driving", Adrian & Mathews (1934):
Brainwaves can be entrained by pulsing light



Gysin's DreamMachine
(here with William Burroughs, 1959)

AUDITORY DRIVING

Numerous techniques enable introducing brainwaves frequency pulsations (normally inaudible when below 20Hz) within sound and music

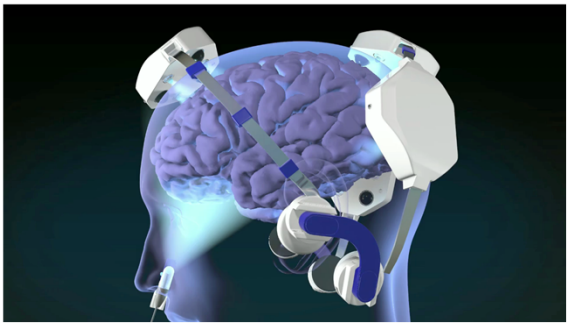
- Binaural beats
- Isochronic tones
- Heterodyned ELF
- …

Pioneered by Robert Monroe (1960s)

NEAR INFRARED TRANSCRANIAL THERAPY (NILT)

Significant Improvement in Cognition in Mild to Moderately Severe Dementia Cases Treated with Transcranial Plus Intranasal Photobiomodulation

A. Saltmarche, M. Naeser, K.F. Ho, M.R. Hamblin, L. Lim Biological Psychiatry, March 2017



12 weeks trial: cognitive improvements were so significant that subjects were given the equipment

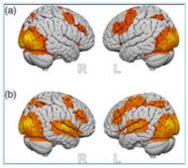
MULTIMODAL SENSORY STIMULATION

Simultaneous stimulation from multiple sensorial gateways

➔ supralinear dynamics of brain activation, such that the resulting activation may be greater than the sum of its parts

Increased neural activation of multisensory integration

(a) Activation clusters during olfactory–visual integration
(b) Activation clusters during audio–visual integration



Stickel S, Weismann P, et al. ***Audio-visual and olfactory-visual integration in healthy participants and subjects with autism spectrum disorder.*** *Hum Brain Mapp.* 2019 Oct 15;40(15):4470-4486

AVS
(AUDIO-VISUAL STIMULATION)

Combining photic and audio entrainment

➔ Many instruments have been designed since the 1970s

Dave Seiver
www.mindalive.com

D.A.V.I.D.

(Digital Audio Visual Integration Device)

SENSORY LEARNING PROGRAM

30-day multimodal intervention developed in the 1990s by Mary Bolles of Boulder, Colorado

"The goal of SLP is to create interaction effects among the **visual, auditory, and vestibular** systems, resulting in overall improvement in sensory integration.

SLP utilizes a trochoidal motion table, computerized light instrument, and acoustic training suite.

Syntonics (Liberman, 1986; Spitler, 1941) provides the rationale for using colored light.
Tomatis (1991) and Bérard (1993) conducted research that forms the basis for the acoustic stimulation portion of SLP.
The work of Ayres (1998) forms the basis for the vestibular portion."

Kaiser, Erika & Gillette, Craig & Spinazzola, Joseph. (2010). A Controlled Pilot-Outcome Study of Sensory Integration (SI) in the Treatment of Complex Adaptation to Traumatic Stress. Journal of Aggression, Maltreatment & Trauma. 19. 699-720. 10.1080/10926771.2010.515162.

BOTTOM-UP VS TOP-DOWN APPROACH

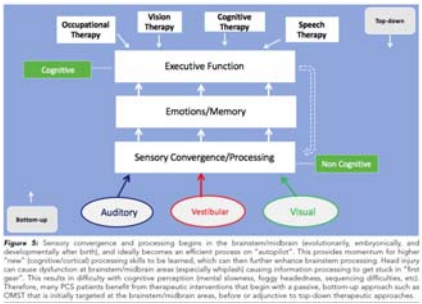


Figure 5: Sensory convergence and processing begins in the brainstem/midbrain (evolutionarily, embryonically, and developmentally after birth), and ideally becomes an efficient process on "autopilot". This provides momentum for higher "new" (cognitive/cortical) processing skills to be learned, which can then further enhance brainstem processing. Head injury can cause dysfunction at brainstem/midbrain areas (especially whiplash) causing information processing to get stuck in "first gear". This results in difficulty with cognitive perception (mental slowness, foggy headedness, sequencing difficulties, etc). Therefore, many PCS patients benefit from therapeutic interventions that begin with a passive, bottom-up approach such as CMRT that is initially targeted at the brainstem/midbrain areas, before or adjunctive to top-down therapeutic approaches.

Curtis SJ: Neuro-Optometric Rehabilitation using a multisensory-based bottom-up to top-down paradigm for postconcussion syndrome – A retrospective case series study. Vision Dev & Rehab 2019;5(4):235-48.

GAMMA BRAIN WAVES

30Hz to 100Hz

- Like the conductor of the brain, they keep the rest of the brain in sync.
- When one is actively engaged in some sort of cognitive task, trying to focus, gamma at 40 hertz is present.

GAMMA AND ALZHEIMER'S

Dr Li-Huei Tsai

The Picower Institute for Learning and Memory at MIT

➔ Research into Gamma brain waves since 2016

"In brain disorders like Alzheimer's, schizophrenia and concussions, gamma waves are disrupted.

…

Gamma impairment actually appears very, very early, before the symptoms are manifested and even before overt pathology can be detected"

MULTIMODAL GAMMA STUDIES

The recent surge of studies on Gamma stimulation has renewed the interest in multimodal approaches within mainstream research:

2016: Light

Gamma frequency entrainment attenuates amyloid load and modifies microglia
Iccarino et al, Nature, Dec 2016

2019: Light and Sound

Multisensory Gamma Stimulation Ameliorates Alzheimer's-Associated Pathology and Improves Cognition
A.J. Martorell, A.L. Paulson, H.J. Suk, E.S. Boyden, A.C. Singer, Li-Huei Tsai Cell 177, 1–16, April 4, 2019

2023: Vibrotactile

Vibrotactile stimulation at gamma frequency mitigates pathology related to neurodegeneration and improves motor function
Suk HJ, Buie N, Xu G, Banerjee A, Boyden ES, Tsai LH Frontiers in Aging Neuroscience, Volume 15 - 2023

2023: Audiovisual

Audiovisual gamma stimulation for the treatment of neurodegeneration
Blanco-Duque C, Chan D, Kahn MC, Murdock MH, Tsai LH. J Intern Med. 2024 Feb;295(2):146-170. doi: 10.1111/joim.13755. Epub 2023 Dec 19. PMID: 38115692; PMCID: PMC10842797.

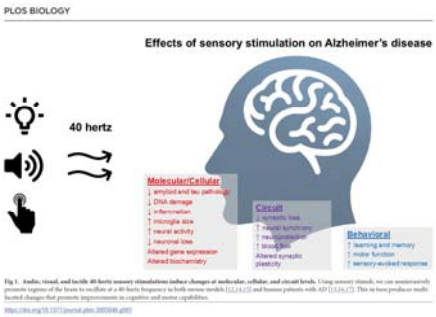
2024: Multisensory

Multisensory gamma stimulation promotes glymphatic clearance of amyloid
Murdock, M.H., Yang, CY., Sun, N. et al. Nature **627**, 149–156 (2024). https://doi.org/10.1038/s41586-024-07132-6

MULTIMODAL GAMMA STUDIES

2025: Innovations in noninvasive sensory stimulation treatments to combat Alzheimer's disease

Park JM, Tsai LH PLOS Biology February 28, 2025



MULTIMODAL GAMMA STIMULATION

"Gamma stimulation paradigms have expanded from visual stimulation to include auditory, audiovisual, tactile stimulation, and transcranial noninvasive stimulation.

A key advantage of multimodal stimulation is that there is more widespread engagement of the brain."

Blanco-Duque C, Chan D, Kahn MC, Murdock MH, Tsai LH.
Audiovisual gamma stimulation for the treatment of neurodegeneration.
J Intern Med. 2024 Feb;295(2):146-170. doi: 10.1111/joim.13755.
Epub 2023 Dec 19. PMID: 38115692; PMCID: PMC10842797.

MULTIMODAL NEUROSTIMULATION

- Widespread activation of brain regions, beyond specific sensory processing centers
- Enables embedding of brainwaves stimulation frequencies within more "organic" / less artificial sensory stimulation
- Bottom-Up approach, from non-cognitive levels (sensory convergence & processing) towards cognitive ones
- Going beyond single-frequency interventions, towards more complex and integrated approaches

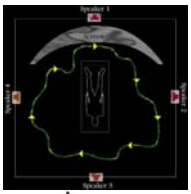
THE SENSORA ROOM

SENSORA

A Multi-Sensorial Environment combining:

Light Modulation

LPA-2 Light Projection Array

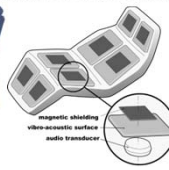


Sound Space

SSP-100, SSP-200 & OPS-1
Sound Spatialization Processors

Kinesthetic Vibrations

TC-2 Transducer Chair



TD-1 & TD-2 TransDrivers

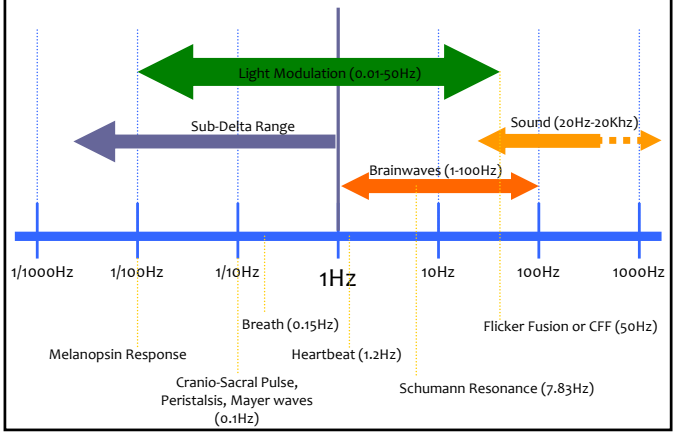
LIGHT MODULATION

Light Modulation combines the light spectrum

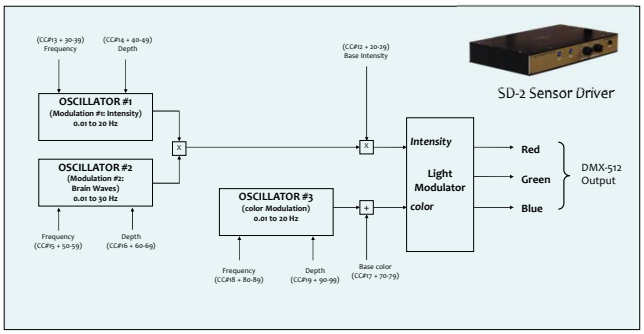
with a much lower frequency spanning our perceptual domains transition (around 1Hz)

➔ Interaction with biorhythms through resonance

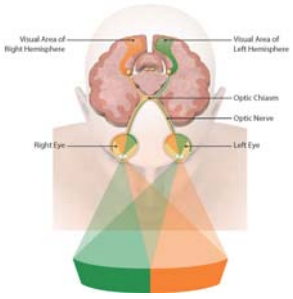
FREQUENCY RANGE OF LIGHT MODULATION



MODULATION STRUCTURE

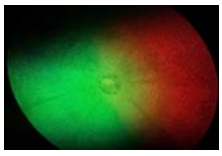


BRAIN LATERALITY



Each side of the visual field is connected to one brain hemisphere *(Optic nerve fibers crossover at the Optic Chiasma)*

➔ Light can differentially influence brain hemisphere dominance, and functions specific to each hemisphere



LATERAL LIGHT THERAPY

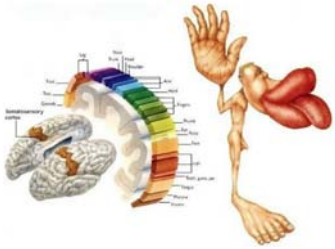
Developed from 1990s by Dr. A.P. Chuprikov (Russia)

DYNAMIC SOUND TRANSDUCTION

Kinesthetic vibrations in the Sensora chair create moving patterns of vibrotactile sensation across the surface of the body

DYNAMIC SOUND TRANSDUCTION

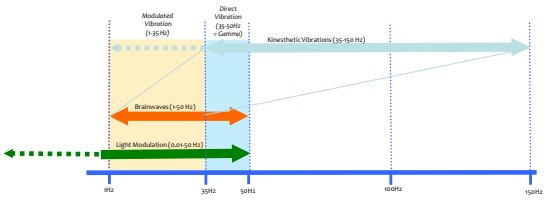
Vibrotactile sensation moving across the surface of the body generate dynamic stimulation in the mapped areas of the somatosensory cortex



The sensory homunculus, a representation of the primary sensory cortex mapping

KINESTHETIC BRAINWAVE ENTRAINMENT

Novel modulation techniques are required to map brainwaves frequencies (1-50Hz) unto the usable range of vibroacoustic frequencies (35-150Hz)



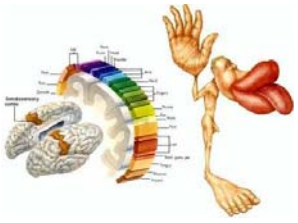
TH-1 TRANSDUCER PODS for KINESTHETIC HAND STIMULATION

WHY HAND STIMULATION?

Hands are one of the most innervated and sensitive parts of the body,

their influence on the primary sensory cortex is major.

➔ Hands are therefore an ideal sensorial conduit for vibrotactile stimulation

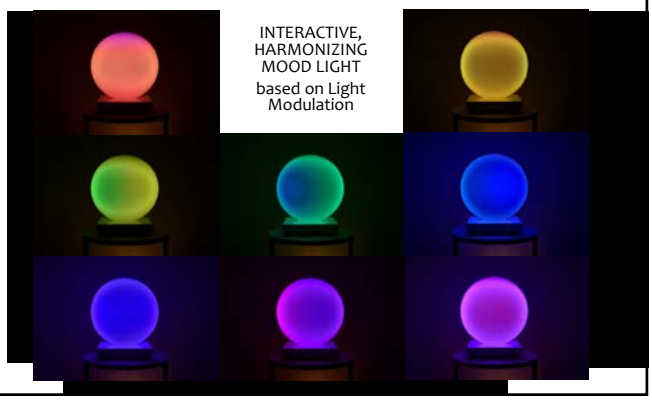


The sensory homunculus,
a representation of the primary sensory cortex mapping

SENSORA
CLINICAL APPLICATIONS AREAS

- Neurological Rehab
- Post-Traumatic Stress Disorder (PTSD)
- Depression and burnout, chronic fatigue
- Insomnia
- Addiction
- Recovery, re-education, ergo therapy
- Attention Deficit Hyperactivity Disorder (ADHD)
- Anxiety, distress, mental tension
- Chronic pain, Fibromyalgia
- Palliative care
- Labyrinthitis, Tinnitus
- …

SENSOSPHERE



INTERACTIVE, HARMONIZING MOOD LIGHT

based on Light Modulation

SENSOLIGHT

A portable, interactive Light Modulation lamp

- 12cm Diameter
- Bright RGB LED source
- Light Modulation with a 12 oscillators array (LFO)
- Accelerometer detecting movements for interactivity

THANK YOU!

Anadi Martel

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