Why Music Moves Us:

With application to dementia

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Music Care Conference, November 2025

Some key points about myself

- Past 30 years I have increasingly focused on music medicine
- For 10 years I designed brain-wave entrainment music (25 albums)
- past 10 years – pain research under the umbrella of CIHR's SPOR program – patient oriented research – patient reps on studies – listened to patients.
- I want to positively address problems
- I am a researcher and theorist – I want to understand and explain.
- My focus: **how** and **why** does it work (mechanism).
- Music Medicine (audioceuticals – doseable and prescribable) – what can sound and music achieve without human mediation.

My key goal then is:

If you want to positively address problems with music, you need to understand how and why music and sound moves specific individuals and then what strategies are available to you to move what needs to be moved.

Causes of dementia

- Accumulation of certain proteins – e.g., amyloid beta, tau, alpha-synuclein
- Reduced blood flow
- Inflammation
- Dysfunction of the blood brain barrier
- Reduced glymphatic and lymphatic waste removal
- Malfunction of microglia
- Reduced gamma brain wave activity

Experiential Effects of Dementia

Changes in:

- memory function
- mood and arousal levels
- stress and anxiety
- experience of pleasure
- social affiliation

Music, Sound, **Mind**, and Dementia

Music can stimulate memory -- Familiar, long-known music uses more brain regions than recent music

Thaut MH, Fischer CE, Leggieri M, Vuong V, Churchill NW, Fornazzari LR, Schweizer TA. Neural Basis of Long-term Musical Memory in Cognitively Impaired Older Persons. Alzheimer Dis Assoc Disord. 2020 Jul-Sep;34(3):267-271

Iballa Burunat, Anastasios Mavrolampados, Deniz Duman, Friederike Koehler, Suvi Helina Saarikallio, Geoff Luck & Petri Toiviainen (15 Sep 2025): Memory bumps across the lifespan in personally meaningful music, Memory,

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Brain anatomy involved with music

Rhythm

- **Cerebellum:** processing and regulating rhythm, timing; coordinating the physical response to a musical beat
- **Motor Cortex/Pre-motor Cortex:** Involves the physical response to rhythm, such as tapping feet or playing an instrument. Cerebellum to basal ganglia to motor cortex
- **Belt and Parabelt areas (**right side auditory cortex): responsible for recognizing a song's rhythmic pattern.

Melody

- **Auditory Cortex:** processes pitch, tone, melody, and harmony.
- **Superior Temporal Gyrus:** This part of the auditory cortex processes melody and harmony.

Words of Songs (Lyrics)

- **Temporal Lobe (left hemisphere):** Focuses on interpreting words, language, and lyrics within songs.
- **Wernicke's Area:** Involved in understanding the meaning of lyrics.
- **Pitches Working Memory and Lyrics Working Memory:** store and categorize the sequence of pitches (melody) and words.

Timbre

- **Auditory Cortex:** Processes the quality of a musical sound that distinguishes different instruments or voices, known as timbre.

Form

- **Prefrontal Cortex:** Involved in higher-level processing, including forming expectations about a song's structure and analyzing if the music makes sense in terms of its overall form.

Music, Sound, **Mind**, and Dementia

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Music has an effect on mood and arousal	Schellenberg EG, Music and Cognitive Abilities. Current Directions in Psychological Science, Vol. 14, No. 6 (Dec., 2005), pp. 317-320 Lam HL, Li WTV, Laher I, Wong RY. Effects of Music Therapy on Patients with Dementia-A Systematic Review. Geriatrics (Basel). 2020 Sep 25;5(4):62. doi: 10.3390/geriatrics5040062.
Music can reduce stress	Thoma MV, La Marca R, Brönnimann R, Finkel L, Ehlert U, Nater UM. The effect of music on the human stress response. PLoS One. 2013 Aug 5;8(8):e70156. doi: 10.1371/journal.pone.0070156.
Music can provide pleasure (Dopamine)	Chanda, Mona Lisa et al. The Neurochemistry of Music. *Trends in Cognitive Sciences*, Volume 17, Issue 4, 179 - 193
Music can facilitate social affiliation (Oxytocin) (synchronized groove)	Chanda, Mona Lisa et al. The Neurochemistry of Music. *Trends in Cognitive Sciences*, Volume 17, Issue 4, 179 - 193

Music, Sound, BRAIN, and Dementia

Can these causes of dementia be affected with music or sound??

- Accumulation of certain proteins – e.g., amyloid beta, tau, alpha-synuclein
- Reduced blood flow
- Inflammation
- Dysfunction of the blood brain barrier
- Reduced glymphatic and lymphatic waste removal
- Malfunction of microglia
- Reduced gamma brain wave activity

Baycrest Alzheimer's sound stimulation study

RESEARCH TEAM

- Amy Clements Cortes, Heidi Ahonen, Michael Evans, Dr. Morris Freedman, Lee Bartel

STUDY DESIGN

- 18 patients – 6 mild, 6 medium, 6 severe
- Randomized cross-over - Sound stimulation or watching video

PRESCRIPTION:

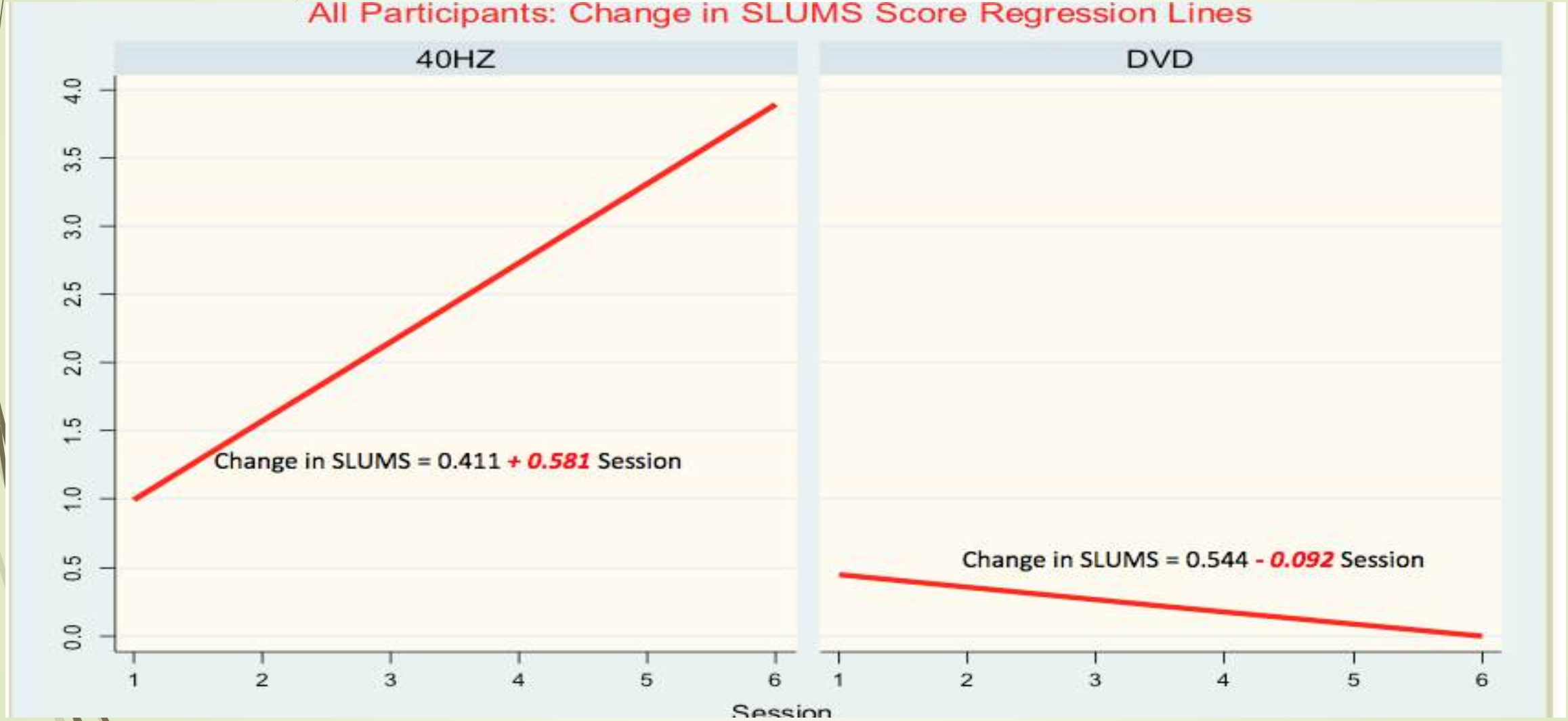
30 minutes of 40Hz stimulation,

2 times a week for 3 weeks

Reference: Clements-Cortes, A., Ahonen, H., Evan, M., Freedman, M. & Bartel, L. (2016). Short term effects of rhythmic sensory stimulation in Alzheimer's disease: An exploratory pilot study. *Journal of Alzheimer's Disease, 52*(2), DOI 10.3233/JAD-160081 Electronic Pre-published – March 25, 2016

- Permission of CTV Toronto

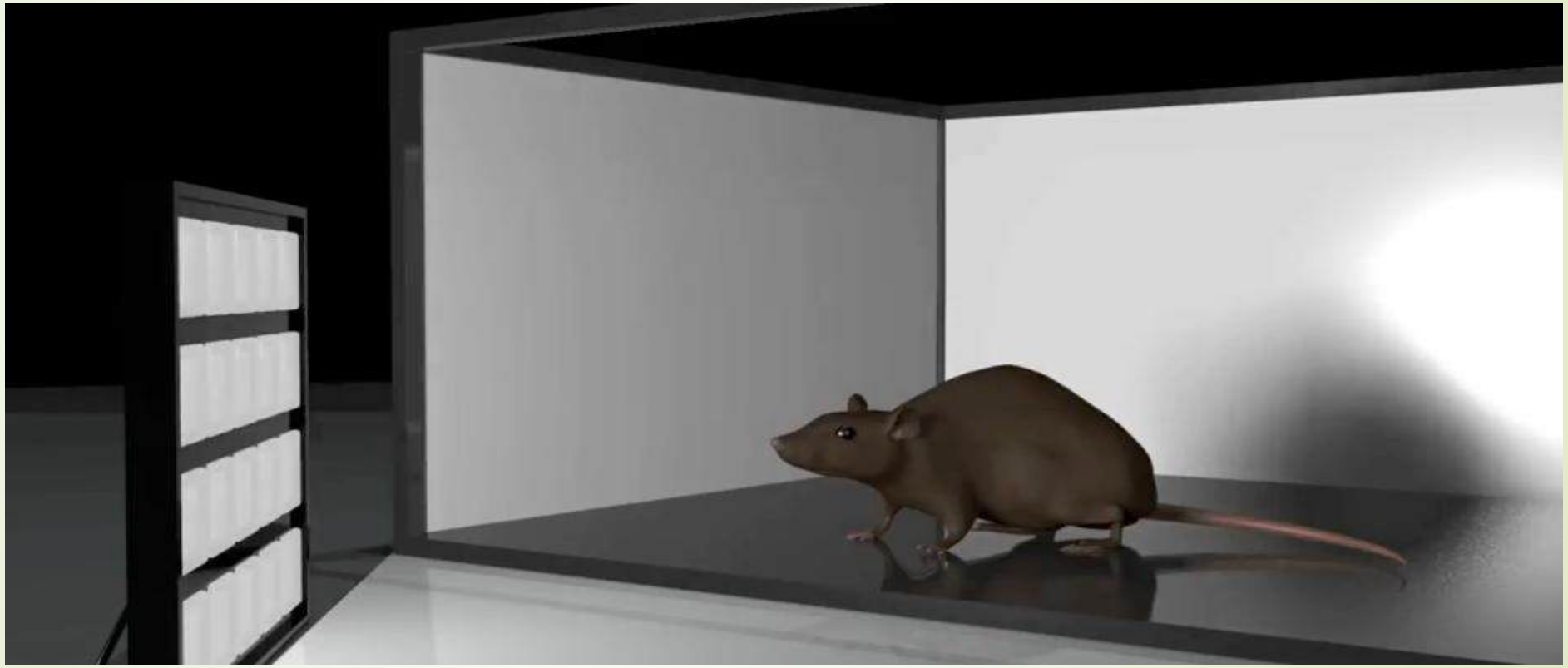
Alzheimer's Gamma Study Results



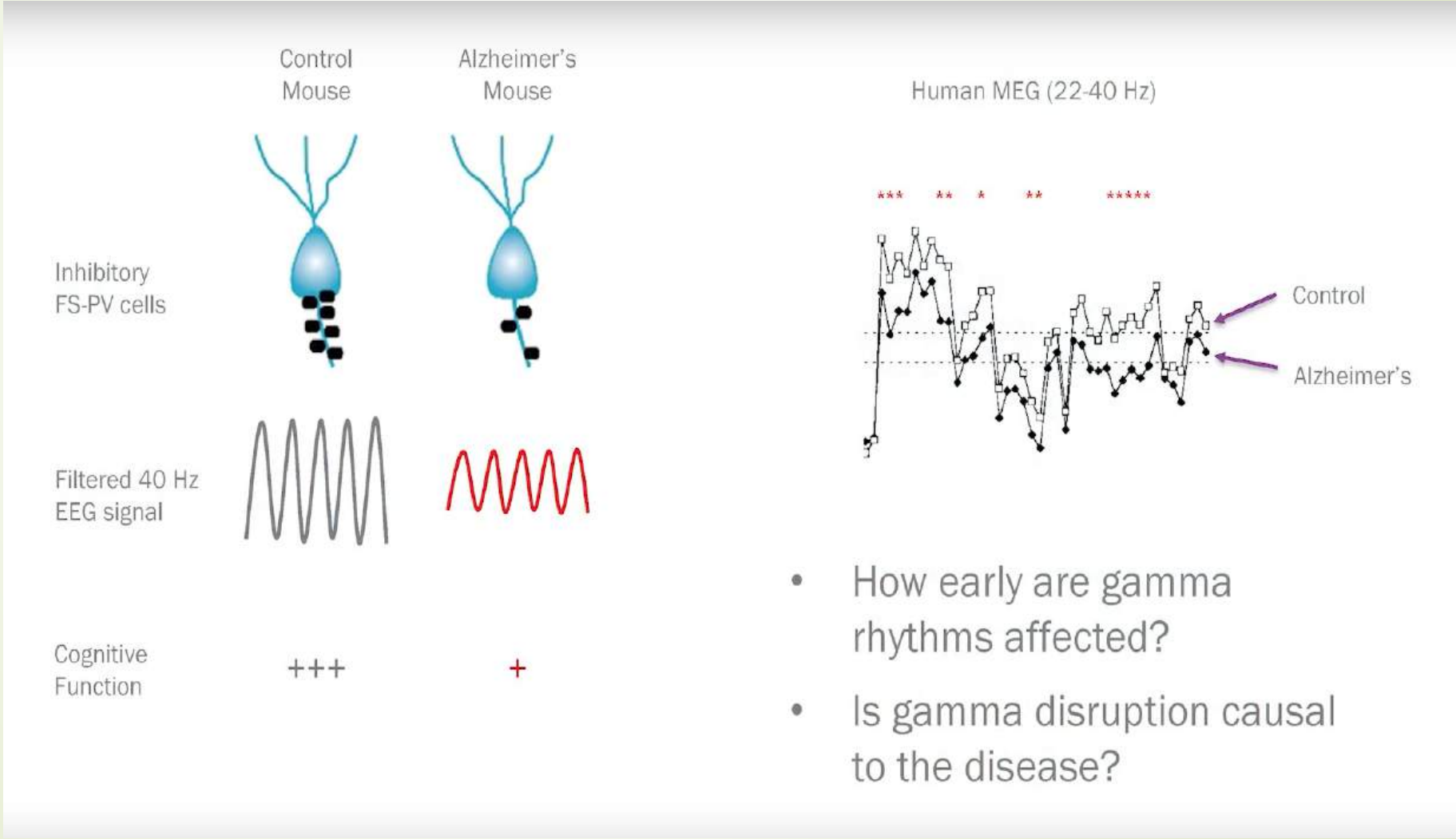
What made this effect happen?

Li-Huei Tsai, MIT

5XFAD Mice – AD mice

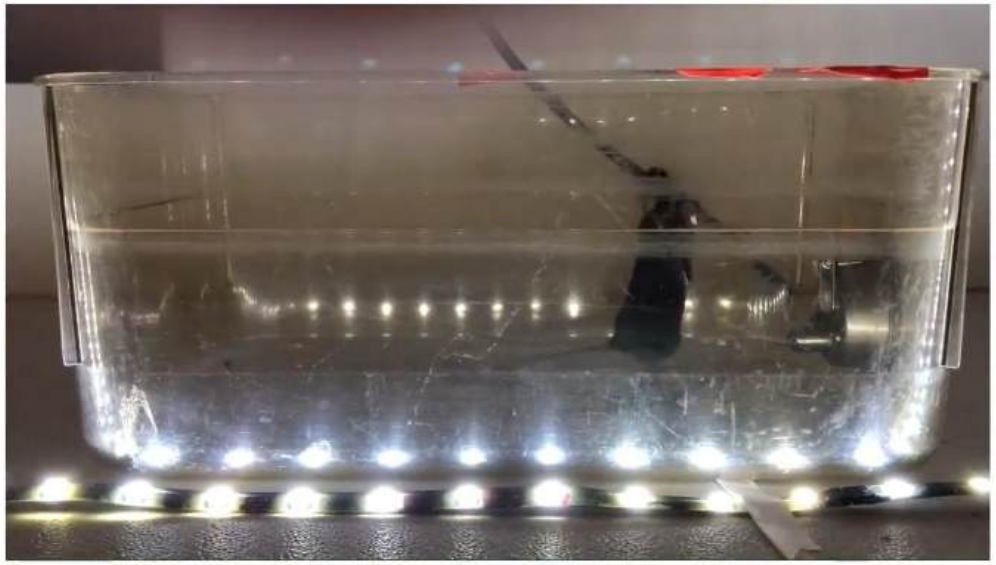


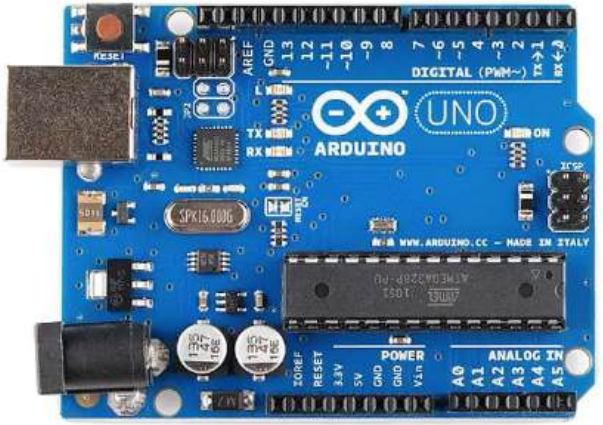
Gamma - Not just in AD mice

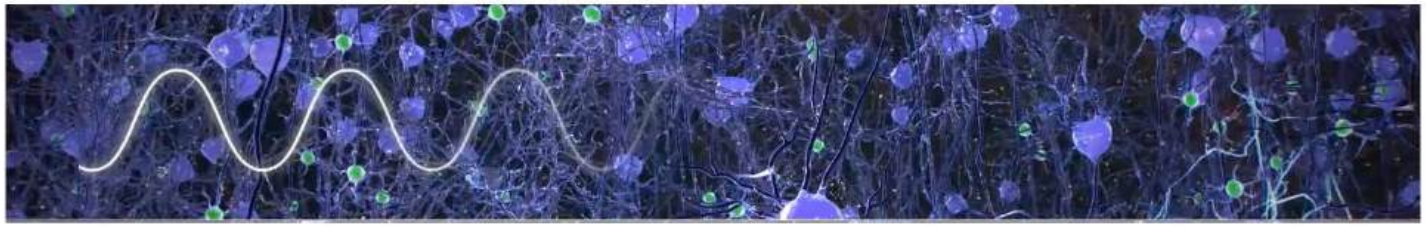


Mice treated with light flicker at 40Hz

Light Flicker at 40 Hz Can Drive Gamma Oscillations in Mice

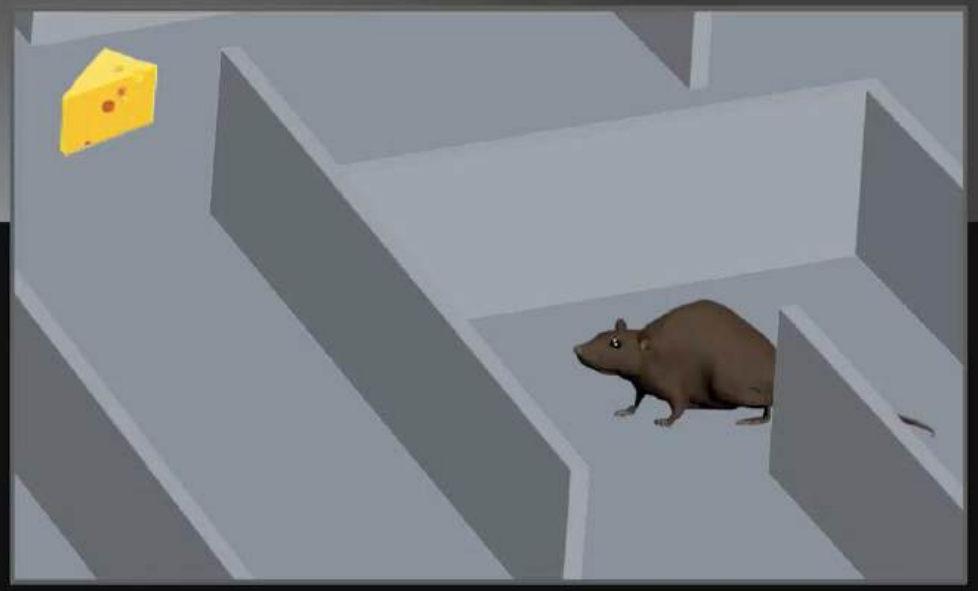






Cognitive results

Gamma Visual Training Improves Learning and Memory



COGNITIVE BEHAVIOR

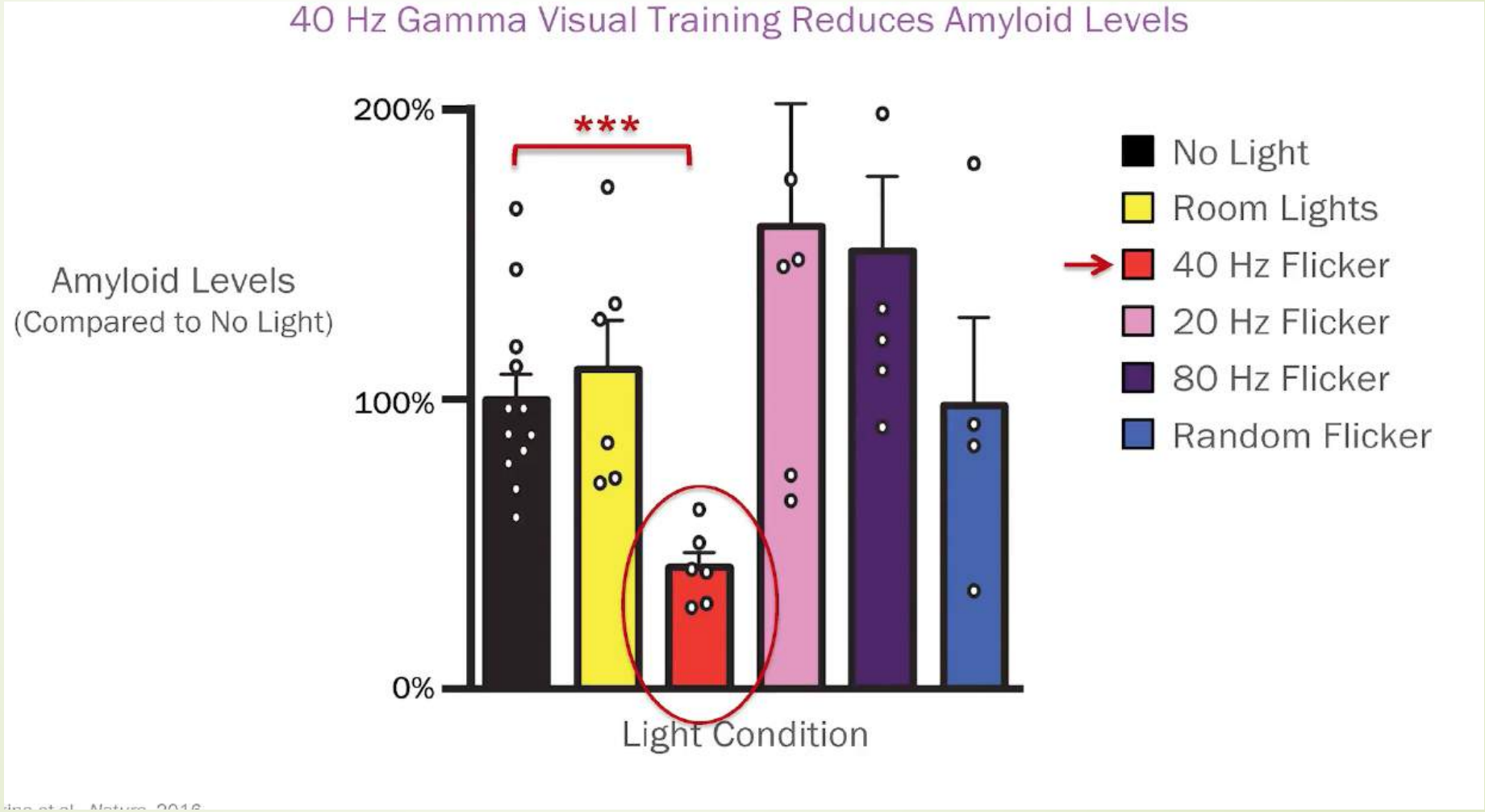
- ↓ Anxiety levels
- ↑ Memory for Places
- ↑ Recognizing Objects
- ↑ Locating Objects

NO CHANGE IN:

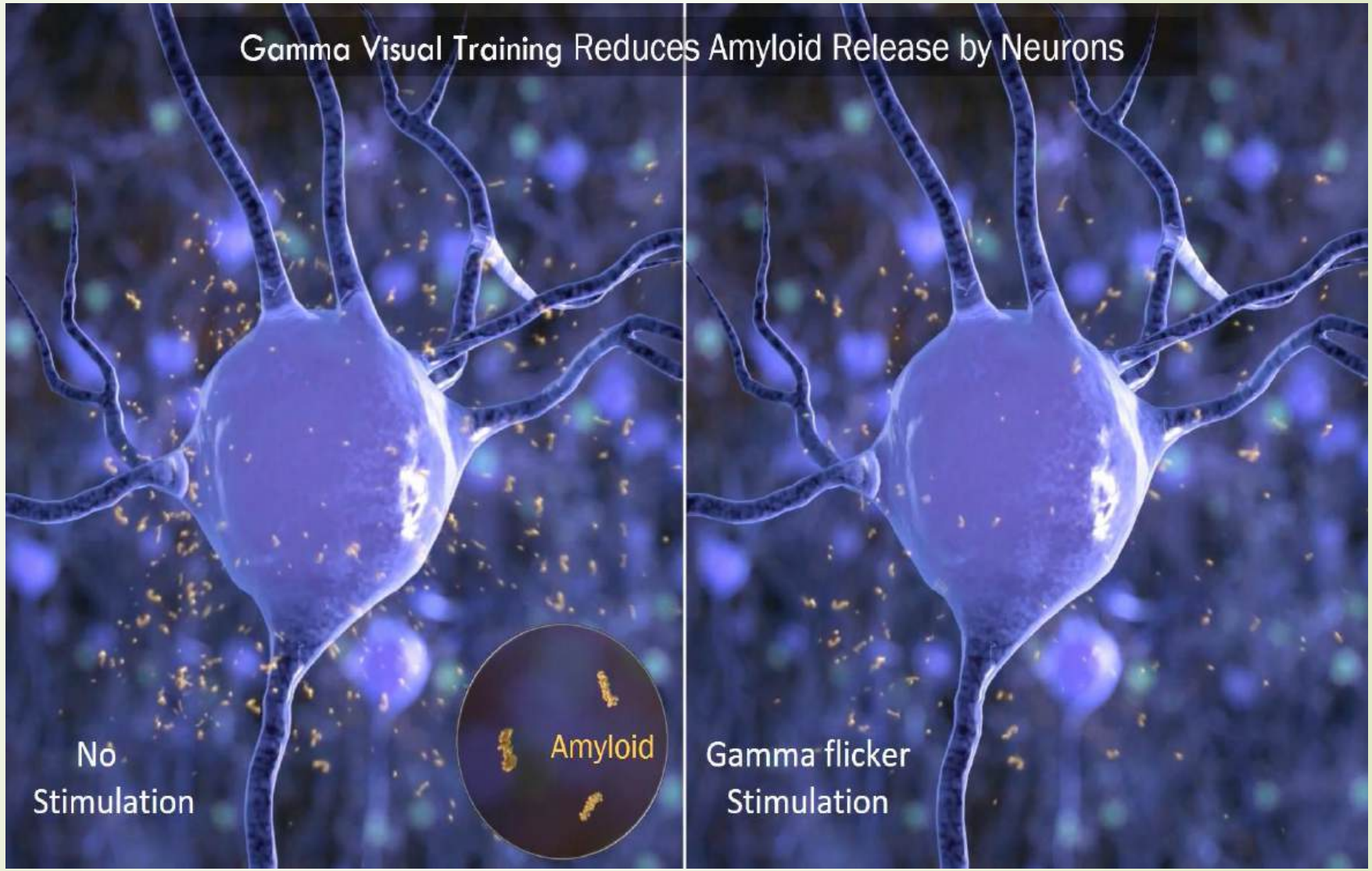
- Body weight
- Home cage behavior
- Multi-sensory behavior

No adverse effects even after several weeks

The big surprise – RSS reduced amyloid levels

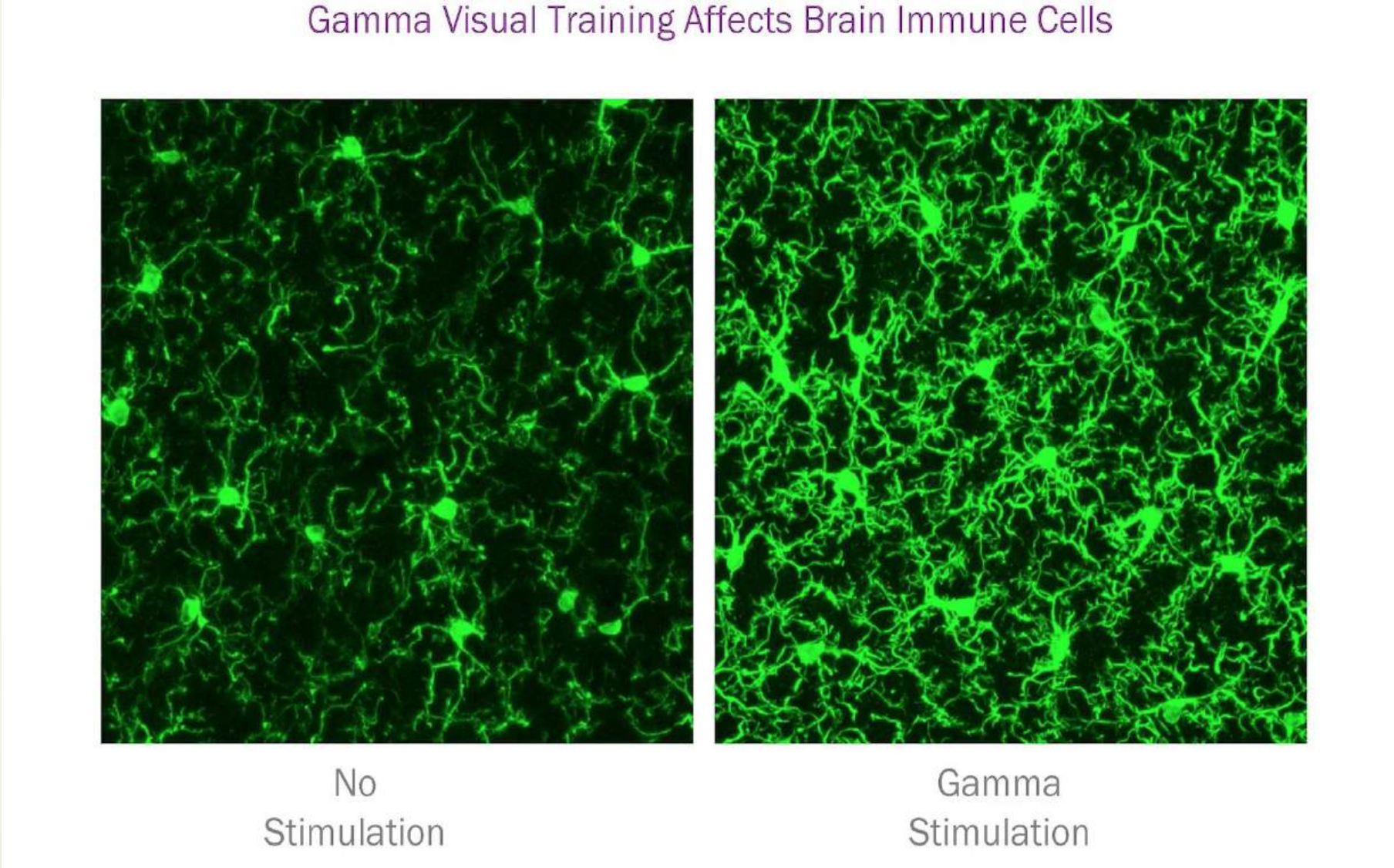


Why are Amyloid levels lower?

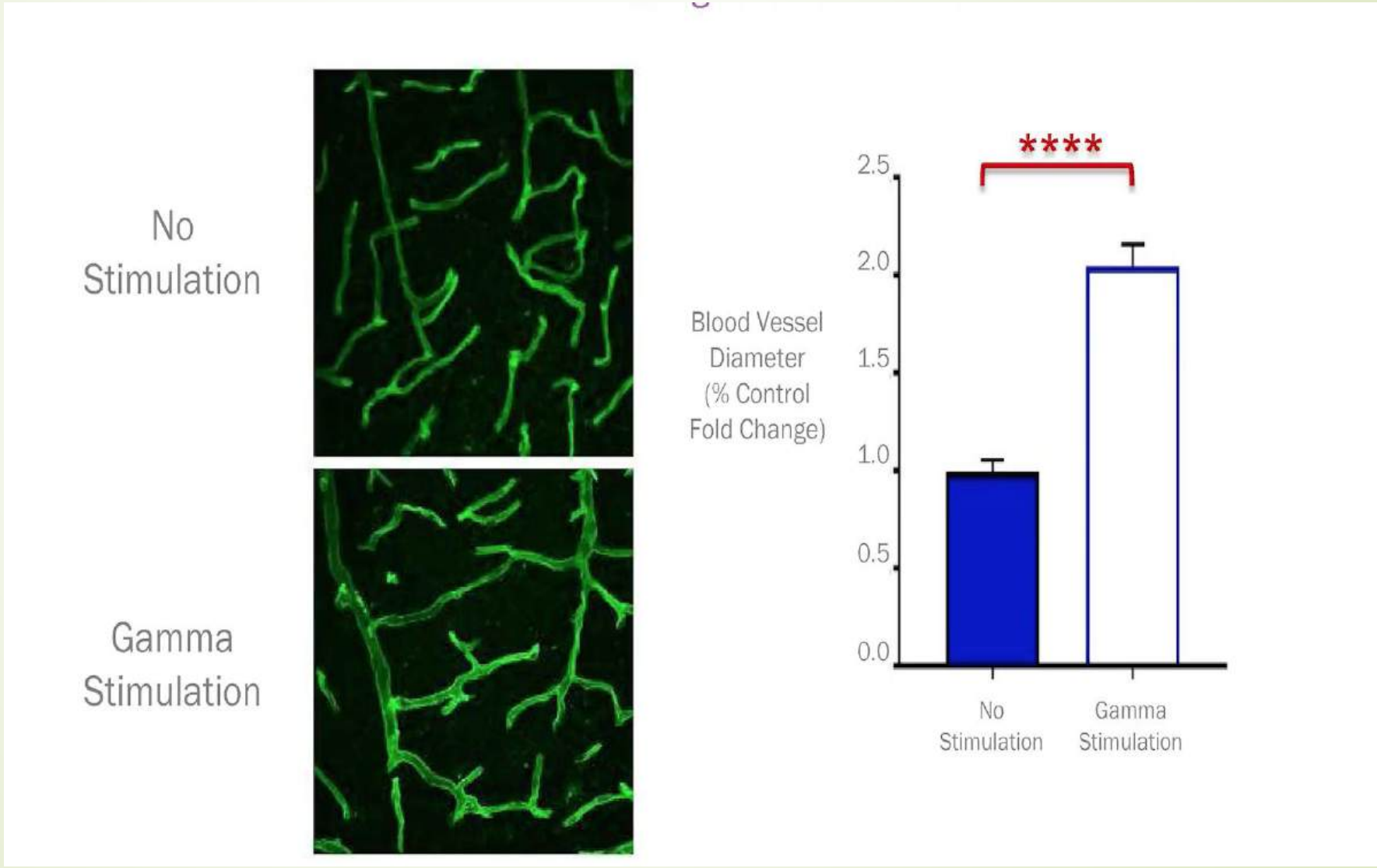


Microglia activated

Increased microglia activity



Blood vessel response



MIT results

- Improved cognition and memory
- Increased microglia activity
- Reduced amyloid beta and tau levels
- Increased blood vessel size
- Decreased inflammation

Reference: Iaccarino, H.F.; Singer, A.C.; Martorell, et al.

Gamma frequency entrainment attenuates amyloid load and modifies microglia.

Nature 2016, 540, 230–235.

Can these causes of dementia be affected with music or sound?

YES?

- Accumulation of certain proteins – e.g., amyloid beta, tau, alpha-synuclein
- Reduced blood flow
- Inflammation
- Dysfunction of the blood brain barrier
- Reduced glymphatic and lymphatic waste removal
- Malfunction of microglia
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To create or select music/sound for individuals to affect (move) their experience or brain mechanism what might you consider and how would you do it?

Seeing the individual

Context Considerations

Individual Differences Affecting Response

Individual context and inherent characteristics

Culture

Experience
Learning

Inherent (genetic) mind

Musical Aptitude (talent),
Timbre preference,
Synesthesia

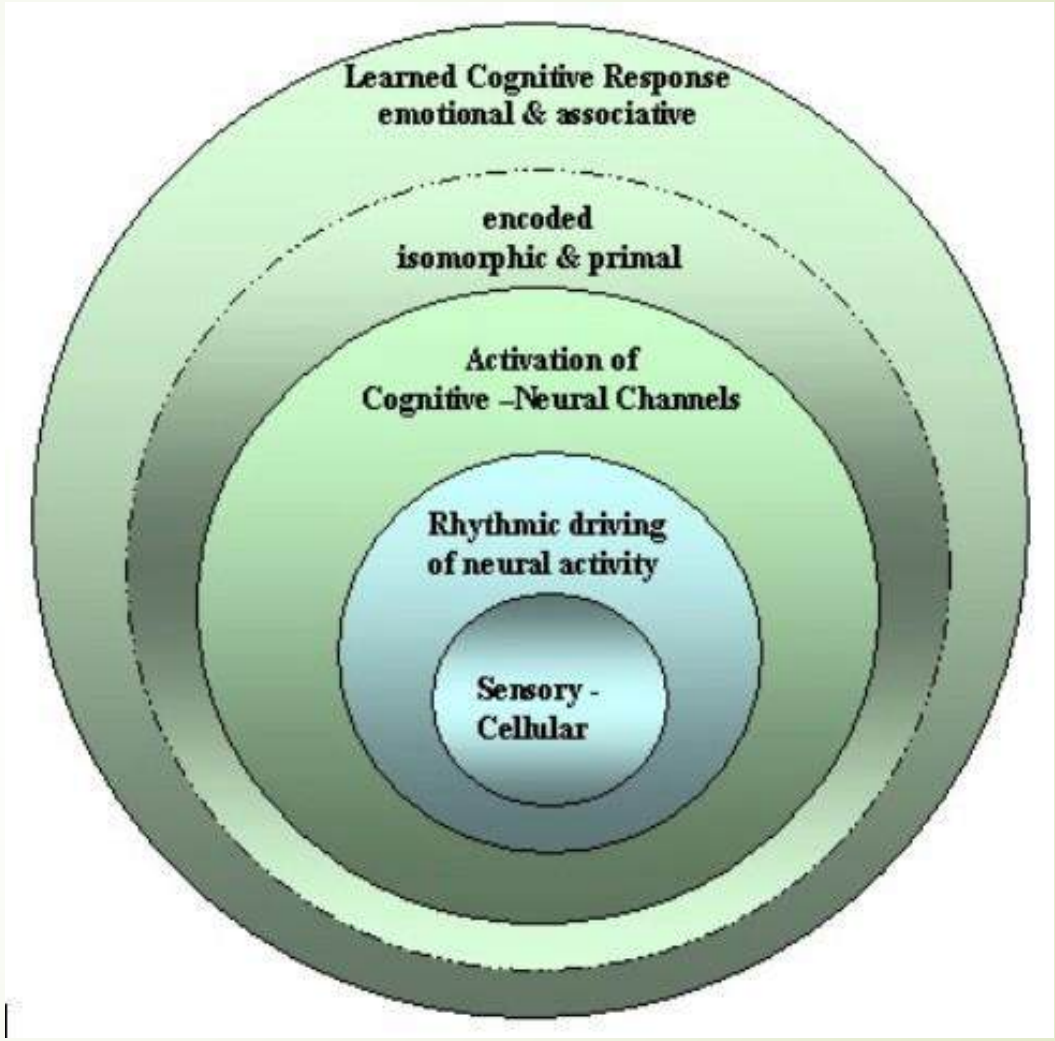
Psychology – personality

Thinking-feeling
Novelty – familiarity
Types of intelligence – kinesthetic – Howard Gardner

Type of listening

Hedonic – groove.
Expressive.
Analytic

Levels at which music (sound) affects us



Learned associations – Isomorphic-primal

- Cultural and personal
  - General associations with style, instrument, type of music, tonality, etc etc
  - Specific associations – "our song", peak experience, meaningful memory
  - Harmonic parameters

- Isomorphic and primal
  - Tempo
  - Timbre
  - Tonality

Activations of Cognitive – Neural Circuits

- Language – verbal
- Motor
- Memory - mnemonics
- Attention – Executive Function

Driving a neural response

- Entrainment
- Brain states
  - Delta – sleep
  - Theta – liminal, creative, meditative
  - Alpha – relaxed, awake
  - Beta – work, problem solving, Zone
  - **Gamma – circuits**
- Body effects
  - Heart rate
  - Breath

Cells, Proteins, Ions

Somewhat speaker/transducer dependent

- Vagus nerve stimulation
- Epigenetic effects – both performing and listening to music regulates genes up and down
- Blood flow – endothelial cells > nitric oxide > calcium ions
- Spinal vibration – mRNA up and down regulation – aggrecan, collagen type I and II, decorin, and versican
- Bone density – Lidan You – vibration increases bone cell density
- Auditory flicker – microglia activation

Applications

What do you want to affect with music and sound?

Moving the Mind

- Associations – Isomorphics
  - Arousal - frisson
  - Sedation
  - Memories
  - Anticipation
- Social Connection

Tool Box

- Rhythm
- Melody
- Harmony
- Timbre
- Form
- Style

Moving the Brain

Tool box

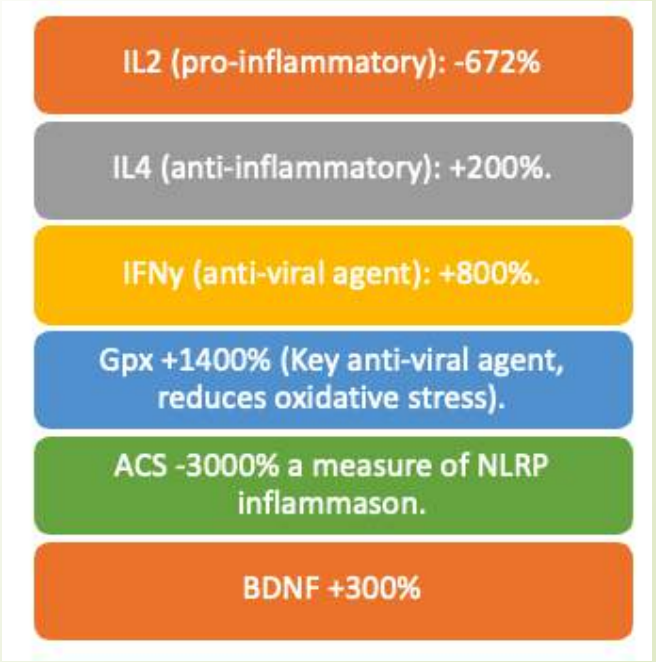
- Rhythm
- Melody
- Harmony
- Timbre
- Form
- Style

- Brain State Induction
  - Sleep - delta
  - Deeply relaxed - theta
  - Calm but awake - alpha
  - "The zone" - beta
- Brain function repair
  - Neurologic Music Therapy – Cognitive Circuit Employment Strategies

Moving the Brain continued

- Rhythm
- Melody
- Harmony
- Timbre
- Form
- Style

- Circuit regulation
  - Neuromodulation strategies
    - Thalamocortical Dysrhythmia
      - Alzheimer's, Parkinson's, Depression, Pain,
    - Bilateral asynchrony
      - Depression
- ElectroBioChemical
  - Inflammation reduction
  - BDNF – brain factors
  - Microglia activation
  - Blood flow increase



Reference: Mosabbir et al. Cognitive rehabilitation among long-COVID patients using Vibratory and Auditory treatment (VAT) is linked to BDNF. *Frontiers in Cognition 2025*

Moving the Body

- Rhythm
- Melody
- Harmony
- Timbre
- Form
- Style

- Walking – exercise support
- Blood flow -circulation – blood pressure
- Bone density
- Spinal alignment
- mRNA expression

Questions now or later?

Reasons for the effect of music.

- Situations where human mediation (relationship) may be the reason for the effect
  - Everything a music therapist does
  - Making music in a group
  - Music lessons – teacher relationship
- Act of music making may be reason for effect
  - Moving specific muscles of body parts
  - Breathing involved in singing of wind instrument
  - Bilateral coordination
  - NMT activities – related to brain rehab
- What can music/sound move without human or muscle mediation
  - Trigger associations
  - Activate circuits
  - Neuromodulation effects