

VR & Binaural Beat Applications

THE OVERVIEW

Serenity DTx has developed a Health Canada and FDA SaMD (Software as a Medical Device) platform based on 30 years of statistically significant primary research in virtual reality (VR) and binaural beats. The platform focuses on stress & anxiety management, pain management, relieving insomnia, and improving mental performance. The literature indicates improved management of these conditions with the use of VR, binaural beats and interactive guided meditations.

Between 2000-2021 a wide body of primary studies were conducted on virtual reality, binaural beats, and brainwave entrainment (the therapeutic synchronization of brainwaves). These studies further validated previous findings, some of them utilizing QEEG and fMRI analysis as a verification method. Based on these findings, demand is surging for scalable digital medical solutions. This white paper discusses some of the primary scientific literature and the associated range of medical applications.

KEY RESEARCH FINDINGS

Stress & Quality of Life:

- 1) VR Significantly decreases stress index, stabilizes physiological state, and has a positive impact on psychological state.
- 2) Binaural Beats significantly increases the effectiveness of managing high stress situations including healthcare workplaces.
- 3) Binaural Beats are an effective therapeutic tool for significantly addressing stress and improving quality of life.

Anxiety

- 4) VR resulted in a significantly greater immediate improvements of anxiety, sadness, cheerfulness & overall positive mood.
- 5) Binaural beats led to the significant reduction of state anxiety ($P < 0.001$) and trait anxiety ($P < 0.018$).

Pain Reduction:

- 6) VR alone is up to 2x as effective as morphine reducing pain by 70% without side effects or addiction potential.
- 7) Binaural Beats provided a 77% reduction of chronic pain and further improved pain reduction when paired with VR.
- 8) VR significantly reduced pain-related brain activity in all five regions of interest (fMRI); the anterior cingulate cortex, primary and secondary somatosensory cortex, insula, and thalamus ($p < 0.002$). Results showed direct modulation of human brain pain responses by VR distraction.

Insomnia & Vitality:

- 9) VR subjects reported significantly higher subjective sleep quality. The VR Group's awake time was shorter, deep sleep time was longer and sleep efficiency was significantly higher than the control group.
- 10) Binaural Beats promote deep sleep while increasing N3 (Regenerative and Healing) sleep cycles
- 11) Binaural Beats decrease physical and psychological indications of stress while improve cognitive functioning and sleep quality.

Cognitive Performance:

- 12) 60-85 year old's who experienced 3 months of video game engagement outperformed 20 years old's who had never played video games. The difference of performance was in enhanced sustained attention, working memory & multitasking. The older group's performance benefits extended to untrained cognitive abilities and lasted 6 months. This highlights the robust plasticity possible across all ages with virtual medical media.

1 "The Effects of Watching a Virtual Reality (VR) Forest Video on Stress Reduction in Adults" (2019)

2 "Binaural Tone Frequency: An Adjunct to Stress Management for Healthcare Workers" (2007)

3 "Binaural Beat Technology in Humans: A Pilot Study To Assess Psychologic and Physiologic Effects" (2007)

4 "Virtual Reality Stress Reduction For Patients With Psychiatric Disorders" (2020)

5 "Efficiency of Brainwave Entrainment by Binaural Beats in Reducing Anxiety" (2014)

6 "Virtual Reality Pain Reduction: University of Washington Snow World"

7 "Efficacy of Theta Binaural Beats (TBB) for the Treatment of Chronic Pain" (2016)

8 "Modulation of thermal pain-related brain activity with virtual reality: evidence from fMRI" (2004)

9 "Effect of virtual reality meditation on sleep quality of intensive care unit patients (2020)

10 "A Novel Insight of Effects of a 3-Hz Binaural Beat on Sleep Stages During Sleep" (2018)

11 "The Effect of Binaural Beat Technology on the Cardiovascular Stress Response in Military Service Members With Post deployment Stress" (2017)

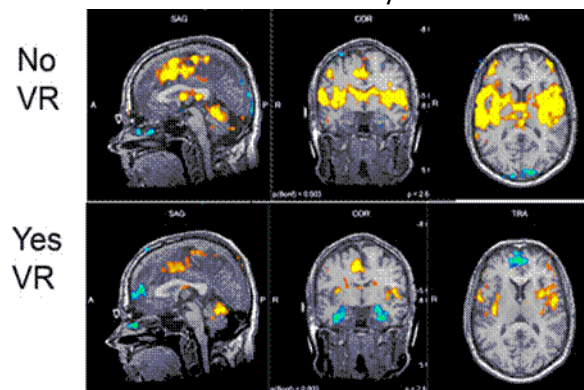
12 "Video game training enhances cognitive control in older adults" (2013)

The Integration of VR & Binaural Beats

Our immersive & interactive guided meditation sessions synergize with binaural beats therapies to boost the effectiveness of VR.



VR Reduces Pain Activity In The Brain



Neuroplasticity & Brainwave Synchronization:

- 1) Brainwave phase synchronization precedes the changes in synapses, or connections between neurons, believed to underlie synaptic plasticity including learning and long-term memory formation.
- 2) Binaural Beats increase cortical network strength and information transfer speeds during visuospatial working memory tasks
- 3) Brainwave phase synchronization is integral to cognition as it supports the processes of neural communication, neuroplasticity and memory formation.

Cognition & Mood:

- 4) VR produced significant increases in joy, surprise, calmness, and vigor, alongside significant decreases in sadness and anxiety.
- 5) Brainwave entrainment achieved through binaural beats are an effective tool for people suffering from behavioral problems, PTSD, stress, cognitive functioning deficits and headaches.
- 6) Binaural beats improve working, long and short term memory recall scores.

Substance Abuse:

- 7) Binaural Beats significantly reduce the probability of substance abuse & relapse.
- 8) VR produced statistically significant reductions in mean negative affect scores, heart rate as well as improvements in overall mood.
- 9) Mindfulness exercises produce a significant decrease ($p < .01$) in impulsiveness and a significant increase ($p < .05$) in perceived risk of drug use

Sports Performance:

- 10) Binaural Beats improve auditory and visual response times.
- 11) Binaural Beats lead to significant increases in hammer throwing distances.

VR Use in Patients with Severe Conditions:

- 12) 82% of medical patients with the most intense conditions would use VR again.

1 "Increases In Functional Connectivity Between Prefrontal Cortex And Striatum During Category Learning" (2014)

2 "The Effect of Binaural Beats on Visuospatial Working Memory and Cortical Connectivity" (2016)

3 "Auditory Beat Stimulation and its Effects on Cognition and Mood States" (2015)

4 "Virtual Reality for the Induction of Positive Emotions in the Treatment of Fibromyalgia" (2014)

5 "A Comprehensive Review of the Psychological Effects of Brainwave Entrainment" (2008)

6 "Effect of alpha and gamma binaural beats on reaction time and short-term memory" (2018) & "Binaural auditory beats affect long-term memory" (2017)

7 "Using sound to reduce the probability of recidivism and suffering following detoxification" (2018)

8 "Virtual Nature as an Intervention for Reducing Stress and Improving Mood in People with Substance Use Disorder" (2020)

9 "Mindfulness-Based Substance Abuse Treatment for Incarcerated Youth: A Mixed Method Pilot Study" (2011)

10 "Effect of alpha and gamma binaural beats on reaction time and short-term memory" (2018)

11 "Effect of Music with Brainwave Synchronizer on the Performance of Hammer Throw Athletes" (2019)

12 "Virtual Reality: A Distraction Intervention for Chemotherapy" (2007)