Bala-Aiyer A, et al., J Brain Neuros Res 2025, 9: 034
DOI: 10.24966/BNR-HSOA/100034

HSOA Journal of Brain & Neuroscience Research

Review Article

Enhancing Neuroplasticity in Traumatic Brain Injury Patients through Artificial Intelligence: A Multimodal Therapeutic Review

Adhvik Bala-Aiyer[1]* and Vaidya Bala[2,3]*

[1]*Bachelor of Medical Science, University of Sydney, Australia*

[2]*Medical Co-Director of Population and Public Health, Consultant Physician in Brain Injury Rehabilitation, ISLHD, Wollongong, NSW, Australia*

[3]*University of Wollongong and Campbell University, Raleigh, NC, USA*

Abstract

Background: Traumatic Brain Injury (TBI) remains a leading cause of long-term neurological disability worldwide, with current rehabilitation strategies often limited by accessibility, personalization, and efficacy. Neuroplasticity, the brain's intrinsic ability to reorganize and adapt, is critical to functional recovery. This review investigates the role of Artificial Intelligence (AI) in enhancing neuroplasticity through four emerging modalities: Brain-Computer Interfaces (BCIs), Virtual Reality (VR), Neurofeedback, and Non-Invasive Brain Stimulation (NIBS). Evidence from clinical trials demonstrates that associative BCIs, which synchronize neural intent with peripheral stimulation, significantly improve motor outcomes. Immersive VR interventions enhance executive function, mobility, and cognitive processing, while neurofeedback training yields substantial gains in attention regulation and response control. Preliminary findings on Non-invasive brain stimulation suggest potential for modulating cortical excitability, though further research is warranted. Collectively, these AI-driven approaches offer a promising paradigm for personalized, data-informed neurorehabilitation, with the potential to transform recovery trajectories for individuals affected by TBI.

Methods: This paper synthesizes findings from multiple clinical studies investigating four AI-driven therapeutic modalities: Brain-Computer Interfaces (BCIs), Virtual Reality (VR), Neurofeedback, and Non-Invasive Brain Stimulation (NIBS). Each modality was evaluated for its impact on neuroplasticity and functional recovery using standardized clinical and neurophysiological measures.

Results

- **BCIs:** Associative BCI systems that synchronize cortical intent with peripheral stimulation significantly improved gait speed, motor control (LE-FM), and reduced spasticity (ASS) in stroke patients, with implications for TBI rehabilitation.
- **VR:** Immersive VR interventions led to statistically significant improvements in executive function, mobility, and processing speed in patients with mild cognitive impairment, with reductions in theta wave activity and improved attention metrics.
- **Neurofeedback:** Two studies demonstrated that EEG-based neurofeedback training improved attention, response control, and cognitive consistency in mTBI patients, with significant gains in Full Scale Attention and Response Quotients.
- **NIBS:** Preliminary evidence from TMS studies suggests modulation of cortical excitability and inhibition, though findings are mixed and further research is needed to confirm efficacy in TBI populations.

Conclusion: AI-based interventions offer promising, multimodal strategies to enhance neuroplasticity and functional recovery in TBI patients. BCIs and VR show the most robust evidence for improving motor and cognitive outcomes, while neurofeedback demonstrates strong potential for attention and executive function rehabilitation. NIBS remains an emerging field that requires further validation. Collectively, these technologies represent a paradigm shift toward personalized, data-driven neurorehabilitation.

***Corresponding authors:** Adhvik Bala-Aiyer, Bachelor of Medical Science, University of Sydney, Australia. E-mail: abal0186@sydney.uni.edu.au

Vaidya Bala, Medical Co-Director of Population and Public Health, Consultant Physician in Brain Injury Rehabilitation, ISLHD, Wollongong, NSW, Australia. E-mail: vaidya.balasubramaniam@health.nsw.gov.au

Citation: Bala-Aiyer A (2025) Enhancing Neuroplasticity in Traumatic Brain Injury Patients through Artificial Intelligence: A Multimodal Therapeutic Review. J Brain Neuros Res 9: 034.

Received: July 12, 2025; **Accepted:** July 28, 2025; **Published:** August 05, 2025

Introduction

Neuroplasticity is a process that combines functional reorganization and neural regeneration, involving adaptive structural and functional changes in the brain. It can be defined as the ability of the nervous system to change its activity in response to external or internal stimuli by reorganising its structure, function, or connections after injuries, such as strokes, spinal cord injuries, or traumatic brain injuries [1]. Following a Traumatic Brain Injury, the process of Neuroplasticity occurs in a sequence of 3 phases. The First Phase occurs within the first 48 hours of the Injury, where initial damage causes cell death and an overall decrease in the activation of specific cortical inhibitory pathways (associated with the GABA neurotransmitter) that are affected. The activation of secondary neuronal networks (part of the somatosensory system, relaying info from the periphery to the nervous system) occurs, where the brain attempts to maintain function and reorganise itself after injury. The Second Phase occurs when cortical pathways shift from inhibitory to excitatory (utilizing the glutamate neurotransmitter) as neurons proliferate and synapses are formed. Following Weeks after Injury, new synaptic markers

(proteins between synapses) and axonal sprouting (growth of new nerve fibres in response to nerve injuries) are upregulated, allowing for remodelling and cortical changes during the recovery process [2].

Traumatic Brain Injury is a complex condition where an acquired insult to the brain from an external mechanical force may result in temporary or permanent impairment. Approximately 50-60 million Individuals have Traumatic Brain Injury every Year around the world [3]. However, the issue arises that current strategies often face limitations in accessibility, accuracy, and personalisation. The Relevance of AI treatment data from stroke studies analysed in this paper (Hara, 2015) [4] and (Kersting et al, 2016) [5] holds translational relevance for TBI populations due to the similar neurological and cognitive symptoms observed in both conditions, including difficulties with memory, attention, language, and executive functions like decision making. Given these shared symptom profiles, insights into AI-based intervention in stroke rehabilitation may inform and guide the development of similar strategies for individuals with TBI, particularly in treating and targeting common pathways of neuroplasticity and functional recovery.

However, Artificial intelligence offers transformative potential in addressing these issues by enhancing diagnostic precision, predicting patient outcomes, and personalising rehabilitation interventions. Artificial Intelligence has emerged as a prominent tool to enhance outcomes for traumatic brain injury. Particularly specific AI utilised Strategies, such as Brain-Computer Interfaces, Virtual Reality Strategies, Neurofeedback, and non-invasive brain stimulation, are becoming increasingly prominent in rehabilitation medicine to treat Traumatic Brain Injury [6,7].

A Brain-Computer Interface (BCI) refers to a system that creates a direct communication pathway between the brain and an external device. BCIs interpret brain activity (usually through EEG, fMRI, or implanted electrodes) that translates it into commands to control rehabilitation tools necessary for treating Traumatic Brain Injury. The sensors (usually EEG electrodes) first record the electrical activity of the brain. The raw data is then cleaned, and relevant patterns are extracted. Following this, brain signals are processed and converted into actionable commands, which are sent to an external device [7].

Virtual Reality Intervention is a type of therapy or rehabilitation method that utilizes immersive, computer-generated environments to help individuals enhance their physical, cognitive, or emotional functions. For patients with mild cognitive impairment or traumatic brain injury, this may involve playing VR-based games that require attention and hand-eye coordination [8].

Neurofeedback is a type of biofeedback that uses real-time displays of brain activity – most commonly EEG (Electroencephalogram) – to teach self-regulation of brain function. It is a non-invasive method where patients learn to modulate their brain waves through practice and reward systems [9]. Small Electrodes are attached to the scalp to measure brainwave activity in real time. Patients will then watch a moving bar graph, a game, or an animation that responds to their brainwaves. For example, when their brain produces the desired brainwave (13-20 Hz), the bar rises or the game character moves. The patient's task is to "figure out" what mental state keeps the bar above a threshold. They are not told precisely how to do this; they instead discover it through trial and error. If brain activity drops below the threshold, they could, for example, be instructed to perform silent arithmetic and identify target words, which are tasks that stimulate attention and help the patient re-engage [10]. The Purpose of the studies is to increase beta activity (associated with focus) and decrease theta or delta activity (linked to drowsiness or mind wandering), particularly in the frontal and temporal lobes.

Non-invasive brain stimulation refers to specific techniques that modulate brain activity without requiring surgery or implants. The Effectiveness of 4 Types of Non-Invasive Brain stimulation techniques will be investigated in this paper. These techniques include Transcranial Doppler sonography, Transcranial Magnetic Stimulation, Low-Level Laser Therapy, and Transcranial Doppler Sonography. Transcranial Doppler sonography is a diagnostic test utilising a transducer to emit and receive ultrasound waves to measure the velocity of blood flow through the brain's arteries. Transcranial Magnetic Stimulation involves placing a magnetic coil against the scalp, which then delivers targeted magnetic pulses to specific areas of the brain, which are thought to modulate the activity of nerve cells [11]. Low-level laser therapy at specific wavelengths safely penetrates the brain. Low-level laser therapy is thought to promote cellular survival in times of reduced energy substrate through interactions with cytochrome c oxidase to enhance oxidative phosphorylation, ultimately improving mitochondrial function and increasing adenosine triphosphate production. Finally, Transcranial direct current stimulation refers to when a low-amplitude direct current is used to alter neuron firing rates. Electrodes are placed on the scalp, and a low-intensity direct electrical current is delivered. This current alters the excitability of specific neurons in the targeted area [7]. The author aims to provide a scoping review of the current literature's evidence on the effectiveness of AI Treatment Strategies in treating Traumatic Brain Injury and improving Neuroplasticity.

Methodology and Review of Current Literature Reporting on AI and Neuroplasticity in Brain Injury

Brain Computer Interface Study

The Patient demographic data and baseline clinical evaluation of the First study (Kersting et al, 2016) [5] are shown in Table 1. Nineteen male and three female patients (49.57 ± 12.52 yr) underwent neuropsychological assessment, with none meeting criteria for diagnosis of dementia. Inclusion criteria encompassed age over 18 years, having suffered from superior division middle cerebral artery (MCA) stroke 3–24 months before recruitment, and ability to follow commands (no or limited cognitive impairment). Patients were excluded if they presented with concomitant neurological or other severe medical problems, seizure history, cognitive impairments, treatment with drugs that act on the central nervous system, complete paralysis of legs, cardiovascular or respiratory symptoms contraindicative of walking, contraindications to TMS or MRI, or any other significant non-stroke-related impairment affecting walking. The treatment involved the real-time detection of movement-related cortical potentials using EEG recordings while patients attempted to dorsiflex their foot. Once a movement-related cortical potential was detected, the BCI triggered a single electrical stimulation of the common peroneal nerve exactly at the peak negativity of the MRCP. The non-associative control group, in contrast, receives stimulations randomly. Procedures were approved by the Ethics Committee of the Clinical Centre of Serbia, and all patients provided their written informed consent.

Group	Patient No.	Age (yr)	Sex	Time After Stroke (mo)	MCA Stroke Side	Type of Ischemic Lesion
BCI-Associative	1	29	M	10	L	Cortico-subc
BCI-Associative	2	61	M	24	L	Cortico-subc
BCI-Associative	3	30	F	23	L	Cortico-subc
BCI-Associative	4	41	F	23	L	Cortical
BCI-Associative	5	53	M	11	L	Cortical
BCI-Associative	6	52	M	24	L	Cortical
BCI-Associative	7	58	M	9	L	Cortico-subc
BCI-Associative	8	43	M	19	R	Cortico-subc
BCI-Associative	9	57	M	12	L	Cortico-subc
BCI-Associative	10	23	M	12	R	Cortical
BCI-Associative	11	45	M	9	L	Cortico-subc
BCI-Associative	12	51	M	14	R	Cortico-subc
BCI-Associative	13	59	M	10	L	Cortico-subc
BCI-Associative	Mean	46.31		15.38		
BCI-Associative	SD	12.51		6.2		
BCI-Non Associative	14	55	M	20	L	Cortico-subc
BCI-Non-Associative	15	58	M	22	R	Cortico-subc
BCI-Non-Associative	16	63	F	15	R	Cortico-subc
BCI-Non-Associative	17	51	M	23	R	Cortico-subc
BCI-Non-Associative	18	59	M	14	L	Cortico-subc
BCI-Non-Associative	19	42	M	21	L	Cortico-subc
BCI-Non-Associative	20	36	M	22	R	Cortico-subc
BCI-Non-Associative	21	65	M	14	L	Cortico-subc
BCI-Non-Associative	22	68	M	11	R	Cortico-subc
BCI-Non-Associative	Mean	55.22		18.0		
BCI-Non-Associative	SD	10.63		4.47		

Table 1: Patient Demographic Data for Main BCI-Associative and Control BCI-Non-Associative Experiments.

A BCI associative System detects when the brain is trying to move and delivers a signal specifically to the relevant nerve at that precisely timed moment [5].

So, if Brain Signal and sensory feedback happen at the same time, it strengthens the connection between them. This, ultimately, in theory, should cause strong neuroplasticity.

Patient No. 1-13 Associative 14 22 Non-associative	10-m Walk Test Pre (m/s)	10-m Walk Test Post (m/s)	mRS Pre	mRS Post	LE-FM Pre	LE-FM Post	ASS Pre	ASS Post
1	0.99	1.08	2	2	24	26	2	2
2	0.36	0.37	3	3	11	11	5	5
3	1.37	1.39	1	1	32	32	0	0
4	0.88	1.01	2	2	30	30	2	2
5	0.33	0.34	3	3	18	18	4	3
6	0.85	0.98	2	2	25	27	2	2
7	0.65	0.73	2	2	22	24	2	2
8	0.65	0.95	2	1	30	32	0	0
9	0.78	0.79	2	2	31	31	0	0
10	0.93	0.97	1	1	32	32	0	0
11	0.74	0.76	2	2	26	27	2	2
12	0.99	1.09	2	2	26	27	3	3
13	0.39	0.4	3	3	17	17	4	3
Mean	0.76	0.84	2.08	2.0	24.92	25.69	2.0	1.85
SD	0.29	0.31	0.64	0.71	6.49	6.61	1.68	1.52
14	1.24	1.25	2	2	22	22	2	2
15	1.21							
16	0.98	0.96	1	1	32	23.5	0	0
17	1.09	0.98	2	2	22	22	2	2
18	1.09	1.12	2	2	32	32	0	0
19	1.32	1.29	1	1	27	27	2	2
20	1.8	1.51	1	1	33	33	0	0
21	0.82	0.79	2	2	21	21	2	2
22	0.87	0.84	3	3	22	22	3	3
Mean	1.16	1.09	1.75	1.76	26.44	24.44	1.38	1.39
SD	0.28	0.23	0.71	0.69	5.21	5.34	1.19	1.17

Table 2: Patient Clinical and Behavioral Data.

A BCI dissociative system randomly delivers signals, not timed when the brain wants to move. This group ultimately serves as the control to show that timing is key for neuroplasticity and functional improvement. This is likely to cause minimal or no effect on neuroplasticity.

In the Associative BCI group, gait speed as measured by the 10-meter walk test (10MWT) improved from 0.76 ± 0.29 m/s to 0.84 ± 0.31 m/s, demonstrating a small but consistent gain in walking ability. The modified Rankin Scale (mRS) showed a slight improvement from 2.08 ± 0.64 to 2.00 ± 0.71, indicating marginal functional gains. The Lower Extremity Fugl-Meyer score (LE-FM) increased from 24.92 ± 6.49 to 25.69 ± 6.61, suggesting a mild improvement in lower limb motor control. Additionally, Ankle spasticity, as measured by the Ashworth Spasticity Scale (ASS), decreased slightly from 2.00 ± 1.68 to 1.85 ± 1.52, reflecting a reduction in muscle tone in the lower limbs.

In contrast, the Non-Associative BCI group experienced a slight decrease in gait speed from 1.16 ± 0.28 m/s to 1.09 ± 0.23 m/s, suggesting no benefit or a minor deterioration in walking ability. The mRS remained essentially unchanged (1.75 ± 0.71 to 1.76 ± 0.69), while LE-FM scores declined slightly from 26.44 ± 5.21 to 24.44 ± 5.34, pointing to a potential reduction in motor performance. Lastly, spasticity (ASS) remained stable, changing only minimally from 1.38 ± 1.19 to 1.39 ± 1.17.

Virtual Reality and Augmented Reality Technology

First study

In a randomized controlled trial (RCT) by Thapa et al. [12], a full-immersive VR rehabilitation program, including four games (juice making, crow shooting, fireworks, and love house), was carried out with patients with Mild Cognitive Impairment (MCI) for 24 sessions (three times per week), resulting in improved executive and physical functions.

Variables	VR Intervention	Control
n (male)	34 (6)	34 (10)
Age (years)	72.6 ± 5.4	72.7 ± 5.6
Education (years)	9.3 ± 4.0	8.4 ± 3.5
Height (m)	1.58 ± 0.08	1.58 ± 0.08
No. of medication intake (n)	2.3 ± 1.4	2.12 ± 1.4
Weight (kg)	60.7 ± 9.8	61.3 ± 9.1
BMI (kg/m2)	24.3 ± 3.0	24.5 ± 2.7
SBP (mg/hg)	129.6 ± 15.8	129.6 ± 17.9
DBP (mg/hg)	74.8 ± 11.3	69.5 ± 11.8
Grip strength (kg)	22.2 ± 6.3	23.4 ± 5.7
Gait speed (s)	1.15 ± 0.33	1.18 ± 0.21
8-feet Up and Go (s)	6.27 ± 1.48	7.04 ± 2.02
MMSE (score)	26.0 ± 1.8	26.3 ± 3.3
TMT A (s)	26.3 ± 7.3	27.9 ± 9.2
TMT B (s)	56.6 ± 25.0	58.5 ± 28.1
SDST (score)	33.4 ± 9.0	32.4 ± 8.2

Table 3: Selected Anthropometric, Cognitive, and Physical Function Characteristics of the Subjects at Baseline.

BMI: Body Mass Index, **SBP:** Systolic Blood Pressure, **DBP:** Diastolic Blood Pressure, **MMSE:** Mini-Mental State Examination, **TMT A:** Trail Making Test A, **TMT B:** Trail Making Test B, **SDST:** Symbol Digit Substitution Test.

The values are expressed in mean and standard deviation (mean ± SD).

At baseline, there was no statistically significant difference between the VR Intervention and control groups in any anthropometric, cognitive, or physical functional variable.

Variables	VR Intervention Baseline	VR Intervention Follow Up	p-Value a	Control Baseline	Control Follow Up	p-Value a	Group x Time Interaction p-Value b	Effect Size
Grip strength (kg)	22.2 ± 6.3	24.4 ± 5.3	0.03	23.4 ± 5.7	23.9 ± 5.7	n.s.	n.s.	-
Gait speed (m/s)	1.15 ± 0.33	1.19 ± 0.37	0.04	1.18 ± 0.21	1.12 ± 0.26 *	0.01	0.02	0.143
8-feet Up and go (s)	6.77 ± 1.48	6.32 ± 1.92	0.02	7.04 ± 2.02	7.06 ± 1.87 *	n.s.	0.03	0.107
MMSE (score)	26.0 ± 1.8	26.9 ± 2.0	n.s.	26.3 ± 3.3	26.4 ± 2.7	n.s.	n.s.	-
TMT A (s)	26.3 ±7.3	24.2 ± 5.3	0.04	27.9 ± 9.2	27.8 ± 8.1	n.s.	n.s.	-
TMT B (s)	56.6 ± 25.0	51.3 ± 24.8	0.03	58.5 ± 28.1	63.2 ± 25.1 *	0.01	0.03	0.208
SDST (score)	33.4 ± 9.0	39.6 ± 9.5	0.02	32.4 ± 8.2	21.8 ± 8.2	< 0.01	0.03	0.264

Table 4: Comparison of Physical and Global Cognitive Function between Baseline and Post-Intervention.

Following the 24 sessions of the VR rehabilitation program, several significant improvements were observed

- Average Grip Strength improved in the VR Group from 22.2 kg to 24.4 kg, whereas no significant change was observed in the control group
- Gait Speed (m/s) Increased slightly in the VR Group (1.15-1.19), however, the average gait speed for the control group decreased (1.18-1.12)
- Mobility measured by the 8-Feet up and test, significantly improved in the VR Group (p=0.02), while the control group showed no change
- Executive Function, assessed using time taken to complete Trail Making Task A and B, showed meaningful gains in VR Group averages, decreasing from A (26.3 – 24.2) and Trail Making Task B (25-24.8)
- Processing Speed and Working Memory measured by the SDST score, where a higher score is associated with improved speed and working memory increased from 33.4-39.6 in the VR intervention group, whereas the Average across the group decreased from 32.4-21.8 in the control group, indicating a decreased ability.

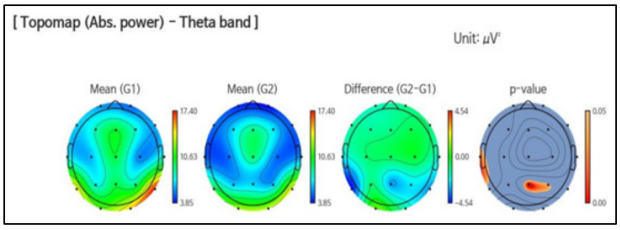

Figure 1: Power ratio.

In the elderly, increased Theta wave (>3.5 to <8 Hz) is associated with the risk of developing cognitive impairment [13,14]. In the Figure 1 the theta has been observed to be significantly decreased around the parietal (p = 0.013) and temporal (p = 0.036) regions at follow up (G2) compared to baseline (G1) in the VR intervention group [12]. This indicates that there is only a 1.3% chance that the reduction around the parietal happened due to random variation and 3.6% chance that the reduction around the temporal is due to random variation. Therefore, it can be concluded that VR Intervention causes these reductions and that these P values are significant.

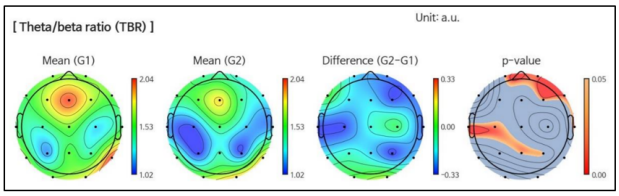

Figure 2: Power ratio.

The higher Theta Beta Ratio is related to mind wandering, which is associated with reduced attention. In this study, within the VR intervention group, the Theta/Beta ratio (TBR) decreased in the temporal (p = 0.035) and parietal (p = 0.027) regions at follow-up. In the control group, none of the power ratios showed any changes [12].

Neurofeedback

First neurofeedback study

The First Study consists of sixteen patients who have mild traumatic brain injury and undergo treatment, and fifteen healthy patients who make up the control group [10].

Each treatment session was thirty to forty-five minutes long and consisted of Audio and Visual Feedback from the Biolex EEG computerized biofeedback software. The electrode placement and type of feedback were based upon clinical symptoms and a 19-channel brain map from the Thatcher Reference Database (Thatcher, 1987). The electrode placement could change in a session, given the current symptoms and performance from the previous session.

The neurofeedback (NF) intervention group of individuals with mild traumatic brain injury (mTBI) demonstrated marked improvements across several attention and response measures following treatment. Pre-treatment, mTBI participants scored significantly lower than the healthy control group across nearly all domains. However, post-intervention, the mTBI group showed significant gains, closing the gap with the control group. Specifically, Full Scale Attention Quotient improved from 74.3 (27.3) to 97.1 (19.3), and Full-Scale Response Quotient increased from 91.2 (19.9) to 104.7 (9.1), both representing statistically significant improvements ($p < 0.01$). Similarly, both Auditory Attention and Visual Attention Quotients improved substantially, from 75.7 (27.6) to 94.7 (13.4) and 77.0 (29.5) to 97.8 (19.9), respectively.

Variable	Control Pre	Control Post	mTBI Pre	mTBI Post
Full Scale Attention Quotient	100.7 (8.9)	104.3 (11.0)	74.3 (27.3) *	97.1 (19.3) **
Full Scale Response Quotient	117.6 (8.3)	112.2 (12.4)	91.2 (19.9) *	104.7 (9.1) **
Auditory Attention Quotient	102.0 (9.3)	104.8 (10.6)	75.7 (27.6) *	94.7 (13.4) **
Visual Attention Quotient	98.7 (13.1)	103.2 (12.5)	77.0 (29.5) *	97.8 (19.9) **
Auditory Response Control Quotient	115.3 (8.7)	108.8 (10.6)	90.7 (20.9) *	103.8 (10.6) **
Visual Response Control Quotient	117.1 (11.0)	113.5 (14.8)	93.2 (14.6) *	106.9 (10.4) **
Prudence Auditory	107.0 (6.5)	105.7 (9.1)	91.7 (23.8)	103.1 (10.2)
Prudence Visual	105.3 (6.9)	106.5 (8.4)	91.5 (15.9) *	100.7 (14.3) **
Consistency Auditory	111.5 (10.7)	108.0 (10.8)	87.5 (18.3) *	97.6 (12.0) **
Consistency Visual	115.2 (17.7)	116.1 (16.2)	98.7 (12.9)	111.6 (13.5)

Table 5: Attention and Response Quotients by Group.

Notable improvements were also seen in Auditory Response Control and Visual Response Control Quotients, with auditory increasing from 90.7 (20.9) to 103.8 (10.6) and visual from 93.2 (14.6) to 106.9 (10.4). Measures of executive control, including Prudence Visual, improved from 91.5 (15.9) to 100.7 (14.3), and Consistency Auditory improved from 87.5 (18.3) to 97.6 (12.0). These gains indicate improved response control and sustained attention following the neurofeedback treatment.

In contrast, the control group (who did not receive NF) showed minimal or no improvements across the exact domains, with some measures even slightly declining (e.g., Auditory and Visual Response Control).

Variable	Time	Control	mTBI
Inconsistency	Pre	3.7 (2.6)	7.9 (3.6) *
Inconsistency	Post	3.8 (2.8)	5.0 (2.3) **
General Measure of Impairment	Pre	46.7 (30.8)	147.0 (44.9) *
General Measure of Impairment	Post	44.1 (29.0)	107.6 (57.6) **
Total Items Checked	Pre	31.1 (16.6)	60.7 (10.0) *
Total Items Checked	Post	32.9 (19.3)	53.7 (15.4) **
Attention	Pre	8.7 (7.5)	22.4 (6.8) *
Attention	Post	7.5 (6.2)	15.8 (8.4) **
Language-Verbal Learning	Pre	2.7 (2.6)	12.9 (4.9) *
Language-Verbal Learning	Post	3.5 (2.8)	8.4 (6.2) **
Academic Problems	Pre	6.4 (4.3)	18.8 (7.0) *
Academic Problems	Post	7.7 (5.2)	18.6 (16.3) **

Table 6: Neuropsychological variables over time.

In the mTBI group, there was an apparent reduction in response inconsistency, with scores improving from 7.9 (3.6) to 5.0 (2.3), while the control group remained essentially unchanged (3.7 to 3.8). The general measure of impairment also significantly decreased in the mTBI group, dropping from 147.0 (44.9) to 107.6 (57.6), whereas the control group showed only a slight decrease (46.7 to 44.1). In terms of task performance, the total number of items checked by mTBI participants improved from 60.7 (10.0) to 53.7 (15.4), indicating greater focus and accuracy post-intervention. The control group showed a minor increase from 31.1 to 32.9.

Attention scores in the mTBI group improved significantly, decreasing from 22.4 (6.8) to 15.8 (8.4), which reflects a reduction in attentional symptoms. The control group showed a modest improvement from 8.7 to 7.5. However, verbal learning scores in the mTBI group declined from 12.9 (4.9) to 8.4 (6.2), suggesting some loss in this cognitive domain, while the control group improved slightly from 2.7 to 3.5. Lastly, academic problems remained essentially unchanged in the mTBI group (18.8 to 18.6), while the control group showed a minor increase from 6.4 to 7.7.

Neurofeedback study 2

The second study consisted of 21 patients with a history of Traumatic Brain Injury. 12 patients received 10 sessions of Neurofeedback, whereas 9 patients received computer-based attention training. Their ability to perform various tasks within the Wilcoxon Test was tested Pre-treatment and Post-treatment.

Task	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)	Level of Significance
Cancellation Task	17.2 (3.2)	6.2 (2.1)	p = 0.032
Choice Reaction Task	2.7 (1.1)	1.9 (0.9)	Not Significant
Sustained Attention Task	6.6 (2.1)	4.0 (2.5)	Not Significant

Table 7: Neurofeedback Group (N = 12): Mean and Standard Deviation of Errors before and after Treatment.

Test used: Wilcoxon test for matched samples

Participants who underwent neurofeedback training showed a significant improvement in performance on the Cancellation Task, with error rates decreasing from a pre-treatment mean of 17.2 (3.2) to 6.2 (2.1) ($p = 0.032$), indicating enhanced attentional control and visual scanning efficiency. While improvements were also observed in the Choice Reaction Task (from 2.7 to 1.9 errors) and the Sustained Attention Task (from 6.6 to 4.0 errors), these changes did not reach statistical significance. This suggests that neurofeedback may be particularly beneficial for tasks that require focused attention and inhibition.

Task	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)	Level of Significance
Cancellation Task	13.5 (4.8)	11.5 (2.8)	Not Significant
Choice Reaction Task	2.5 (1.2)	1.5 (0.7)	Not Significant
Sustained Attention Task	8.5 (3.3)	5.5 (0.9)	Not Significant

Table 8: Computer-Based Training Group (N = 9): Mean and Standard Deviation of Errors before and after Treatment.

In the control group receiving standard computer-based attention training, none of the changes across the three measured tasks reached statistical significance. Although there was a slight reduction in errors for the Cancellation Task (13.5 to 11.5), Choice Reaction Task (2.5 to 1.5), and Sustained Attention Task (8.5 to 5.5), these improvements were modest and not statistically meaningful. This contrasts with the neurofeedback group, highlighting the specific advantage of neurofeedback interventions for certain attentional outcomes.

Non-Invasive Brain Stimulation

Non-invasive brain stimulation refers to techniques that modulate brain activity without surgery or implants. The Specific Technique Transcranial magnetic stimulation was primarily investigated in this paper, where a magnetic coil is placed at the region of the scalp and targeted magnetic pulses are delivered to specific areas in the brain, which are thought to modulate nerve cell activity. The studies investigated, Chistyakov et al., De Beaumont et al, and Crossley et al., all resulted in various conclusions. Chistayakov et al. reinforced the importance of timing when implementing rehabilitation strategies, observing how key neurophysiological markers such as Motor Evoked Potentials (MEPs), Motor Threshold (MT), and MEP/M wave ratio changed between the initial two-week stage of recovery and the three-month stage, where these markers had returned to baseline. The silent period (SP)—an index of intracortical inhibition following TMS during active muscle contraction—has also been explored in the TBI population. A longer SP indicates increased cortical inhibition. Chistyakov and colleagues found that SP duration was significantly prolonged in TBI patients, but only when TMS was applied at 130% of MT, implying that distinct neurophysiological mechanisms may influence SP and MEP. Supporting this dissociation, Bernabeu et al. reported that while SP remained unchanged in severe TBI patients, MEP parameters were significantly altered, further highlighting that inhibitory and excitatory motor processes may be differentially impacted depending on injury severity. Longer SP durations have also been linked to repeated concussive injuries, rather than single events. De Beaumont et al. demonstrated that athletes with multiple concussions exhibited persistent SP prolongation even decades after the initial trauma, and that this was associated with motor function loss, suggesting lasting deficits in motor system inhibition. This points to the possibility that cumulative injury has a more profound effect on intracortical inhibition than injury severity alone.

Evidence from neurophysiological studies suggests that cortical excitability undergoes distinct changes across the recovery trajectory of traumatic brain injury (TBI) [2,11]. In the early post-injury period, Chistyakov reported increased motor threshold (MT), heightened motor-evoked potential (MEP) variability, prolonged central motor conduction time, and a decreased MEP/M wave ratio in patients with mild to moderate TBI. These changes reflect diminished cortical excitability and impaired corticomotor transmission shortly after injury. Importantly, these abnormalities were observed as early as two weeks post-trauma and returned to baseline by three months, suggesting a window that may be critical for the implementation of effective rehabilitation strategies. However, due to the limited number of studies, more evidence would need to be gathered to determine the impact of Non-Invasive Brain stimulations on improving neuroplasticity.

NIBS Method	Cortical Excitability	Motor Function	Cognitive Function	Key Findings
TMS	Increased Motor Threshold and decreased MEP/M Wave Ratio shortly after injury; returned to baseline by 3 months	Prolonged Silent Period in cases of repeated injury; persistent Motor deficits	Not assessed in included studies	Timing of intervention is critical (Chistyakov); prolonged inhibition linked to cumulative injury (De Beaumont); early excitability changes observed (Crossley)
Neurofeedback	Modulates excitability indirectly via EEG self- regulation	Not the primary focus of studies	Improved attention, reduced impulsivity, and enhanced response control	Significant cognitive improvements post treatment (Tinius, Keller); beta-wave training enhances attention and neuroplasticity

Discussion

The First AI treatment, the Brain Computer Interface, involved investigating two groups: the B Computer Interface associative Group and the Non-associative Group, to examine their respective impacts on Neuroplasticity in stroke patients. The Associative Group was sent transmissions of signals when the brain was trying to move, to the relevant nerve at a specific time, strengthening connections between the signal and the sensory feedback pathway. The Non-associative Group was randomly sent signals to nerves, not necessarily at the appropriate timing, serving as a control group, revealing the impact that appropriately sent, timed signals have on the brain's Neuroplastic ability. 22 Patients were included in the study, 13 belonging to the B associative Group and eight belonging to the non-associative Group [5].

The mean improvement of speed of 10m walking distance (0.76-0.84), mRs score measuring disability from 0-6 where 0 is no symptoms and 3-6 is moderate to severe symptoms decreasing from (2.8-2.0), Lower extremity Fugl-Meyer Assessment (LEFM) measuring motor ability after neurological damage, where higher is deemed a better outcome increasing from (24.92-25.69) and ASS score decreasing (2-1.85) in the associative group ultimately indicate functional recovery. These improvements reflect strengthened sensorimotor pathways facilitated by precisely timed afferent stimulation, which promotes synaptic plasticity and motor relearning in chronic stroke patients. Both stroke and Traumatic Brain Injury involve damage to the brain and result in similar motor and cognitive impairments, which is why the use of a study investigating BCI's impact on neuroplasticity of recovering Stroke Patients could potentially be applied to improving Neuroplasticity in Traumatic Brain Injury Patients. In contrast, the control group that received the same stimulation randomly rather than in synchrony with cortical activity showed either no change or minimal change across the various categories. This discrepancy underscores the importance of temporal precision in BCI therapy and strongly supports the idea that neuroplastic changes require precise cortical-peripheral synchronization. These findings suggest that associative BCIs can be an effective intervention to restore motor function in chronic stroke patients and traumatic brain injury patients, likely by re-establishing functional neural networks.

However, the non-associative groups mean values were antithetical of that of the Associative Group with the 10m Mean speed of the Group decreasing from 1.16m/s to 1.09m/s, the mean mRs score increasing from 1.75 to 1.76 m/s, the mean LEFM score decreased from 26.44 to 24.44 for the group and the ASS score increasing from 1.38 to 1.39. The results indicate that patients receiving treatment in the BCI Associative Group experienced significant improvements in their walking speed, overall disability level, motor ability, and muscle tightness in specific regions. In contrast, patients in the control non-associative group who did not receive BCI treatment experienced a stagnation or even worsening of existing symptoms following their stroke. These findings support the idea that the timing of sensory signals sent in response to brain signals is critical for inducing a neuroplasticity response and facilitating the functional recovery of patients.

Virtual reality section

The studies examined the effect of a VR game intervention on cognitive and brain activity in older adults with Mild Cognitive Impairment [12,13]. The findings prove that the VR game intervention is an effective way to improve cognitive and frontal brain function in Mildly Cognitively Impaired patients. The contents of the VR Simulations in this study required subjects to memorise the position of objects, recipes, and numbers respectively, highly involving their use of working memory, and cognitive functions such as attention and processing speed [12]. Brain electrical activity throughout this study was also measured at rest and then measured after the VR intervention, following up. Following the 24 sessions of the VR rehabilitation program, several significant improvements were observed in the VR treatment Group including improved Average Grip Strength (22.2kg-24.4kg), Gait Speed (1.15-1.19), improved mobility, and improved executive function proven by the decreased time taken to complete Trail Making Task A and B post treatment. The Control Group, however, across the categories did not show significant change and in specific categories had a decrease in ability like Gait Speed (1.18-1.12), Processing Speed and Working Memory (32.4-21.8), and Executive Function, where the time taken to complete Trail Making Task A and B increased. Virtual Reality is incredibly practical in its ability to create engaging, immersive, and customisable domains, proving that when patients receive multimodal visuals and auditory stimuli, their ability to complete functional reality tasks in fully immersive scenarios, which use over time, continuously develops patients' ability to practice perpetual and attentional simulation aspects. Theta Power was observed to have decreased after VR intervention. Increased Theta, in the elderly, is associated with developing more significant cognitive impairment. In Table 3 and 4, TMT B time significantly reduced in the intervention group compared to the control group ($p = 0.03$). This indicates that there is only a 3% chance that the time taken to complete the trail making test B in the VR Group happened by random chance. Due to this value $0.03<0.05$, this result is statistically significant, proving that VR intervention helped improve executive function (Task B is associated with mental flexibility and task switching). Similarly, small, but not significant, positive changes were observed in MMSE and SDST. The physical function, such as gait speed ($p =0.02$) and 8-feet Up and Go, was significantly improved ($p = 0.03$) in the intervention group. The p-values obtained from the T tests conducted prove that the probability of random events resulting in these positive changes is <0.05, thus can be rejected, proving that VR Intervention is what resulted in these changes.

Several other studies conducted by Park et al. [13,15] have also found that after full immersive VR program (30 min per day, 5 days per week, for 6 weeks), improvements in general cognitive functions, divided attention, and short-term memory were found, as well as interest and motivation higher than in the control group, who carried out traditional rehabilitation. A Few other studies conducted by Kwan et al. [16] also applied VR to the cognitive rehabilitation of patients with cognitive frailty. This VR motor cognitive training program included cycling on an ergometer and cognitive games carried out over 8 weeks with nine patients with cognitive frailty. The intervention group showed a significantly larger improvement in cognitive function than the control group (who carried out motor and cognitive rehabilitation on a non-VR platform); instead, the reduction in physical frailty was similar in both groups. These significant changes prove how VR Intervention is an effective AI treatment to improve the cognitive and frontal brain function in mildly cognitively impaired individuals improving their neuroplasticity and offering a solution to help patients suffering from TBI to recover and improve their ability to perform increasingly complex functions.

Neuro feedback

Neurofeedback is a form of biofeedback that enables patients to learn how to control measurements of brain activity, such as those recorded by an electroencephalogram (EEG), which measures electrical activity in the brain. Neurofeedback is a non-invasive brain training method. It helps individuals self-regulate their brain activity using real-time feedback from EEG recordings. Of the Studies conducted, two met the criteria of Level 5 evidence, being a trial with a control group but no blinding or placebo. This was the highest level of evidence obtained. From the source material, a Level 8 is a Double Blind, randomised, placebo-controlled trial. The First Study conducted (Tinius et al, 2008) [10] involved the participation of 16 Patients with Mild Traumatic Brain Injury and 15 healthy patients as part of the control group. The Control group did not receive any Neurofeedback treatment. All individuals in the study completed the Intermediate Visual and Auditory (IVA) CPT (Sandford & Turner, 1995), the Neuropsychological Impairment Scales (NIS; O'Donnell, DeSoto, Desoto, & Reynolds, 1984), the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981) and the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) pre- and post-treatment. The full-scale attention reveals how Traumatic Brain Injury patients had a substantially lower attention quotient of 74.3 compared to the control group.

However, following Neural Feedback treatment, the attention quotient Average of TBI patients substantially increased to 97.3 while the Control group's Average marginally increased to 104.3. Again, for the Full-scale Response Quotient, the average of the traumatic Brain injury patients increased from 91.2 to 104.7 whereas the Control group experienced another marginal decrease from 117.6 to 112.2. This occurred for all variables investigated where traumatic Brain injury patients began with significant deficits in attention, response control and impulsivity compared to healthy controls. After Neurofeedback training, most of these deficits significantly improved, reaching levels close to or that of the control group of healthy patients. No significant changes were seen in the Control Group, expected, as they were not given any treatment.

This supports the effectiveness of Neural feedback as a rehabilitation strategy where the brain learns to regulate its own activity by receiving real time feedback on its electrical patterns (brainwaves) allowing for individuals to learn consciously and disrupt patterns of reduced alpha activity which is commonly observed after Traumatic Brain Injury [9]. The second table represents the same study investigating cognitive and behavioural outcomes where a higher score corresponds with a more erratic response, with worse outcomes and more problems. Pre Treatment averages for Inconsistency for the mTBI group were much more inconsistent (7.9) compared to the control group (3.7). Post Neurofeedback treatment however, mTBI improved to 5.0 (still worse than control at 3.8 but a significant improvement). The General Measure of Impairment revealed how pre-treatment MTBI had severe impairment (147 vs 46.7 in the Control Group). Post treatment it dropped to 107.6, still impaired but a significant improvement. The mTBI group started with significantly worse cognitive and behavioural outcomes than the control group. However, after the neural feedback intervention, they showed improvements across all domains, reaching a lower average score.

This study exemplifies Neurofeedbacks ability to leverage Neuroplasticity, where repeated practice and feedback, individuals strengthen beneficial brainwave patterns, improve cognitive function and neuroplasticity. In the Second Level 5 study conducted on 21 Patients with history of Closed head injury participated in the study [17]. Twelve patients received 10 Neurofeedback sessions whereas nine patients received computer attention training. Patients improved significantly relative to controls in measures of attention; patients showed increased time spent in beta rhythm during NF. In this case, the focus is on increasing mean brainwave activity (13-20hz), which is linked to attention, focus and mental engagement. Neurofeedback helped patients learn how to manipulate Twelve CHI patients who participated in the NFT. Before treatment all patients signed a consent for treatment. Following preparation, a five-minute baseline-EEG was recorded for an eye-open listening condition. The mean amplitude of beta-activity (13-20 Hz) during baseline was then used as the threshold during NFT. The first aim of beta training was to increase the mean amplitude of 13-20 Hz EEG activity. The second aim was to extend the time in which patients were able to hold their beta activity above the threshold. The training was conducted with eyes open watching a bar graph on the monitor for beta activity. The threshold was superimposed as a dotted line on the bar graph. The patients were instructed about the concept of attention and beta-activity. Then they were asked to exceed the pre-set beta amplitude threshold setting. Patients were told to learn to discover the mental set or strategy that would keep the bar above the threshold. When beta-activity dropped below the threshold, patients had to perform silent arithmetic's (e.g., counting backwards from 200 in steps of 7) or to detect defined words in an acoustically presented story. This was done until the beta amplitude exceeded the threshold again. Ten NFT sessions were conducted in two weeks. Each session lasted 30 minutes. During NFT, patients were instructed to avoid eye movements and motor acts of their limbs. The Average Score of Patients who received Neurofeedback treatment from Pre to Post Treatment for the cancellation task changed from 17.2 to 6.1, being tested through the Wilcox test where a lower score indicates greater ability. The Pre and Post ability of the Choice reaction task also changed from 2.7 to 1.9 and the sustained attention ability also improved from 6.6 to 4.0. The computer-based training group of 9 patients also improved in all 3 metrics tested however, there was not as significant improvement in comparison to the

Neurofeedback group in the cancellation task where the computer-based training group only changed from 13.5 to 11.5 following the Computer Based training.

Neurofeedback Treatment protocols, for example training to improve beta wave activity, improves attention and concentrations and allows for an individual to have greater autonomy and control in their recovery process [9]. Neurofeedback improves all metrics in the Wilcox Test following treatment, proving as an effective strategy to improve cognitive ability and enable greater neuroplasticity in patients with history of closed head injury.

Non-Invasive brain stimulation

Non-Invasive Brain Stimulation (NIBS) represents a promising frontier in neurorehabilitation for patients with Traumatic Brain Injury (TBI). Techniques such as Transcranial Magnetic Stimulation (TMS), Transcranial Direct Current Stimulation (tDCS), and Low-Level Laser Therapy have demonstrated potential in modulating cortical excitability and promoting neuroplasticity. Evidence from studies indicates that TMS can influence motor thresholds, silent periods, and motor-evoked potentials, suggesting its role in restoring excitatory-inhibitory balance in the injured brain [11]. However, findings remain mixed, with variability in outcomes depending on timing, intensity, and individual patient profiles. The reviewed literature underscores the importance of precise timing and targeted stimulation in achieving therapeutic effects. While some studies report normalization of neurophysiological markers within three months post-injury, others highlight persistent alterations in cortical inhibition, particularly in cases of repeated concussions. These discrepancies point to the need for personalized protocols and further investigation into optimal stimulation parameters.

Conclusion

The investigation of Various AI technologies and their implications on improving Neuroplasticity following Traumatic Brain Injury has revealed how beneficial Brain Computer Interfaces, Virtual Reality, Neurofeedback, and Non-Invasive Brain Stimulation treatments can be for patients.

Brain Computer Interfaces, when utilised in a system to deliver appropriately timed signals, are proven to be an effective Artificial Intelligence treatment for recovering Traumatic Brain Injury Patients to improve their neuroplasticity. In the associative BCI group, the mean improvement of speed of 10m walking distance, mRs score, LEFM Score, and ASS score ultimately indicates functional recovery and reflects strengthened sensorimotor pathways facilitated by precisely timed stimulation, which promotes synaptic plasticity and motor relearning in chronic stroke patients.

Virtual Reality simulation in this study required subjects to memorise the position of objects, recipes, and numbers respectively, highly involving their use of working memory, and cognitive functions such as attention and processing speed. Following the 24 sessions of the VR rehabilitation program, several significant improvements in Average Grip Strength, Gait Speed, decreased theta power, improved mobility, and enhanced executive function were observed in the VR Treatment group. This evidence is conclusive that VR Training is an effective treatment and strategy to promote neuroplasticity in recovering TBI patients.

Following Neural Feedback treatment, improvements were observed in the average attention quotient, full-scale Response Quotient, and all variables investigated, where traumatic Brain injury patients began with significant deficits in attention, response control, and impulsivity compared to healthy controls. After Neurofeedback training, most of these deficits significantly improved, reaching levels close to or those of the control group of healthy patients. Together, the Tinius and Keller studies provide converging evidence that neurofeedback significantly enhances attention and cognitive function in TBI patients. While the studies differ in approach, one focusing on broader cognitive outcomes and the other on targeted beta wave training, both demonstrate the capacity of neurofeedback to drive neuroplastic change in patients. This converging evidence, supported by deficits in TBI patients in the studies significantly improving, reaching levels close to or those of the control group of healthy patients, strengthens the case for neurofeedback as a promising and adaptable rehabilitation tool. Together, the Tinius and Keller studies provide converging evidence that neurofeedback significantly enhances attention and cognitive function in TBI patients. While the studies differ in approach, one focusing on broader cognitive outcomes and the other on targeted beta wave training, both demonstrate the capacity of neurofeedback to drive neuroplastic change in patients. This converging evidence, supported by deficits in TBI patients in the studies significantly improving, reaching levels close to or those of the control group of healthy patients, strengthens the case for neurofeedback as a promising and adaptable rehabilitation tool.

Overall, NIBS offers a non-invasive, scalable, and potentially transformative approach to enhancing neuroplasticity in TBI patients. Yet, its integration into clinical practice requires more robust, longitudinal studies to establish efficacy, safety, and standardized treatment guidelines. As part of a multimodal AI-driven rehabilitation strategy, NIBS holds promise but must be supported by continued research and technological refinement.

References

1. Pudderbaugh and Emmaudy (2023) Traumatic brain injury: A disease process, not an event. In RA Zasler, DI Katz & D Zafonte (Eds.), Brain injury medicine (2nd ed.). StatPearls Publishing.
2. Magee and Grienberger (2020) Strategic control of working memory in older adults. Neurobiology of Aging 36: 123–132.
3. Su, YS Veeravagu and Grant (2016) Neuroplasticity after traumatic brain injury: From bench to bedside. Translational Neuroscience and Clinical Applications 6: 847–857.
4. Yukihiro Hara (2015) Recovery after brain injury: Mechanisms and principles. Frontiers in Human Neuroscience 9: 313.
5. Mrachacz-Kersting N, Jiang N, Stevenson AJ, Niazi IK, Kostic V, et al. (2016) Efficient neuroplasticity induction in chronic stroke patients by an associative brain-computer interface. Journal of Neurophysiology 115: 1410–1421.
6. Orenuga S, Jordache P, Mirzai D, Monteros T, Gonzalez E, et al. (2025) Traumatic Brain Injury and Artificial Intelligence: Shaping the Future of Neurorehabilitation-A Review. Life 15: 424.
7. K Jayasankara Reddy (2025) Harnessing neuroplasticity through emerging technologies. In Advances in Brain-Computer Interfaces. 123–144.
8. Yu J, Song J and Shen Q (2024) Advances in immersive virtual reality for neurological recovery. Frontiers in Human Neuroscience 18: 1467697.
9. Loriette C, Ziane C, Ben Hamed S (2021) Neurofeedback for cognitive enhancement and intervention and brain plasticity. Rev Neurol (Paris) 177: 1133-1144.

10. Tinius TP and Tinius KA (2000) Changes after EEG biofeedback and cognitive retraining in adults with mild traumatic brain injury and attention deficit hyperactivity disorder. Journal of Neurotherapy 4: 27–44.

11. Demirtas-Tatlidede A, Vahabzadeh-Hagh AM, Bernabeu M, Tormos JM, and Pascual-Leone A (2012) Noninvasive brain stimulation in traumatic brain injury. Journal of Head Trauma Rehabilitation 27: 276–292.

12. Thapa N, Park HJ, Yang JG, Son H and Jang M, et al. (2020) The effect of a virtual reality-based intervention program on cognition in older adults with mild cognitive impairment: A randomized control trial. Journal of Clinical Medicine 9: 1283.

13. Park JS, Jung YJ, Lee G (2020) Virtual reality-based cognitive-motor rehabilitation in older adults with mild cognitive impairment: A randomized controlled study on motivation and cognitive function. Healthcare 8: 335.

14. Prichep LS, John ER, Ferris SH, Rausch L, Fang Z, et al. (2006) Prediction of longitudinal cognitive decline in normal elderly with subjective complaints using electrophysiological imaging. Neurobiology of Aging 27: 471–481.

15. Park JH, Liao Y, Kim DR, Song S, Lim JH, et al. (2020) Feasibility and tolerability of a culture-based virtual reality (VR) training program in patients with mild cognitive impairment: A randomized controlled pilot study. International Journal of Environmental Research and Public Health 17: 3030.

16. Kwan RYC, Liu JYW, Fong KNK, Qin J, Leung PK, et al. (2021) Feasibility and effects of virtual reality motor-cognitive training in community-dwelling older people with cognitive frailty: Pilot randomized controlled trial. JMIR Serious Games, 9: 28400.

17. Keller I (2001) Neurofeedback therapy of attention deficits in patients with traumatic brain injury. Journal of Neurotherapy 5: 19–32.

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752