ผลของโปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิดต่อคลื่นไฟฟ้าสมองในผู้สูงอายุที่มีภาวะสมองเสื่อม: การศึกษาเบื้องต้น

Effects of the Cognitive Stimulation Therapy on Electroencephalogram among the Older Adults with Dementia: A Preliminary Study

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาผลของโปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิดต่อคลื่นไฟฟ้าสมองในผู้สูงอายุที่มีภาวะสมองเสื่อม

วิธีการศึกษา: การศึกษากึ่งทดลองแบบกลุ่มเดียวทดสอบก่อน-หลัง กลุ่มตัวอย่างเป็นผู้สูงอายุที่มีคะแนนทดสอบสภาพสมองเบื้องต้นมีภาวะสมองเสื่อมระดับเล็กน้อยถึงปานกลางในสถานดูแลผู้สูงอายุของหน่วยงานภาครัฐ จำนวน 30 คน คัดเลือกโดยการสุ่มอย่างง่าย ดำเนินการทดลองเดือนกุมภาพันธ์-เมษายน 2567 ได้รับโปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิดภายใต้บริบททางวัฒนธรรมอีสาน สัปดาห์ละ 2 ครั้ง เป็นเวลา 7 สัปดาห์ บันทึกคลื่นไฟฟ้าสมองขณะพักแบบลืมตา เป็นเวลา 5 นาที โดยใช้อุปกรณ์สวมศีรษะไร้สายสำหรับตรวจวัดคลื่นไฟฟ้าสมอง Emotiv EPOCX วัดก่อนและหลังได้รับโปรแกรม คำนวณกำลังสัมพัทธ์ของคลื่นธีตาและอัลฟาแบบออฟไลน์ในโปรแกรม MATLAB (เวอร์ชัน R2023B) ด้วย EEGLAB plugin Darbeliai (เวอร์ชัน 2023.0) ทดสอบความต่างของกำลังสัมพัทธ์ของคลื่นธีตาและอัลฟาก่อนและหลังโปรแกรมโดยใช้สถิติ paired *t*-test

ผลการศึกษา: ผลของโปรแกรมทำให้ศักยภาพสมองเกิดการพัฒนา แต่ขนาดอิทธิพลน้อย ($d = 0.38$) พบว่ากำลังสัมพัทธ์คลื่นไฟฟ้าสมองเพิ่มขึ้นอย่างมีนัยสำคัญจากก่อนและหลังได้รับโปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิด ค่าเฉลี่ยของแต่ละย่านความถี่คลื่นไฟฟ้าสมองคำนวณจากค่าเฉลี่ยของอิเล็กโทรดบริเวณหน้าผากและส่วนกลางสมอง (FC5-FC6) คลื่นความถี่ต่ำชนิดธีตา (4-8 เฮิรตซ์) ลดลงอย่างมีนัยสำคัญทางสถิติ ($p < .05$) และคลื่นความถี่สูงชนิดอัลฟา (8-12 เฮิรตซ์) เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ($p < .01$) ที่สมองส่วนหน้าผากและข้างขมับทั้งสองซีก

สรุป: ผลการศึกษาชี้ให้เห็นว่า โปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิดภายใต้บริบททางวัฒนธรรมอีสานเป็นวิธีการบำบัดแบบกลุ่มที่มีประสิทธิภาพในการปรับปรุงภาวะสมองเสื่อมในผู้สูงอายุ พยาบาลควรได้รับพัฒนาให้มีสมรรถนะที่เพียงพอในการใช้โปรแกรม ควรมีการศึกษาวิจัยเพิ่มเติมเพื่อส่งเสริมผลลัพธ์ในระยะยาวของโปรแกรมกระตุ้นศักยภาพสมองด้านการรู้คิด

คำสำคัญ: การกระตุ้นการรู้คิด, คลื่นไฟฟ้าสมอง, กระบวนการรู้คิด, สมองเสื่อม

Abstract

Objective: To determine effects of a Cognitive Stimulation Therapy (CST) program on the Electroencephalogram (EEG) in demented older adults.

Methods: This quasi-experimental study use the one-group pretest-posttest design. The participants were 30 older adults who had Mini-Mental State Examination (MMSE) score of mild to moderate dementia in the government elderly nursing home selected by simple random sampling. The study was conducted from February to April 2024. The participants received the 14 theme sessions of CST program based on the Isan cultural context twice a week over 7 weeks. A 5-minute resting-state EEG (eyes open) was collected by the Emotiv EPOCX Neuroheadset for pre- and post-test measurements. The EEG relative powers for theta and alpha oscillations were performed offline in MATLAB (version R2023b) with EEGLAB plugin Darbeliai (version 2023.0). A paired *t*-test one group pre-test and post-test design was used for analyses of theta and alpha relative powers.

Results: The intervention yielded improvement, but the effect size was small ($d = 0.38$). Significant pre- to post-intervention increases were observed in relative EEG power following completion of the CST program. The average of each frequency band was calculated across the average of fronto-central (FC5-FC6) electrodes. The theta (4-8 Hz) wave, as a low-frequency wave, was significantly decreased ($p < .05$), and also the Alpha wave (8-12 Hz), as a high-frequency wave pattern, significantly increased ($p < .01$) at the fronto-parietal lobe of both cerebral hemispheres.

Conclusion: The findings suggest that the CST program, adapted to the Isan cultural context, is an effective group intervention to improve cognitive decline in demented older adults. Nurses should be trained to have adequate competency to provide the CST program. Further research is required to promote the maintenance longer-term effects of cognitive intervention.

Keywords: Cognitive stimulation therapy, Electroencephalogram, Cognitive function, Dementia

Introduction

Dementia has emerged as a major global public health concern due to the rapid expansion of the aging population. Recent estimates from the World Health Organization indicate that approximately 55 million individuals worldwide are currently living with dementia, and this number is expected to escalate to 78 million by 2030 and reach 139 million by 2050.[1,2] Thailand reflects a similar demographic trajectory; the country officially entered a complete ageing society in 2022 when older adults constituted 20% of the population.[3] Findings from the Thai National Health Examination Survey further show that 732,509 older adults were living with dementia in 2021, with projections suggesting this figure will exceed one million by 2030 and rise to two million by 2050.[4,5] These trends highlight an urgent need to address the rising prevalence of dementia and its associated societal challenges.

Cognitive Stimulation Therapy (CST) is one evidence-based, non-pharmacological intervention designed for individuals with mild to moderate dementia. Grounded in the principles of reality orientation and cognitive stimulation[6], CST emerged from a systematic review of psychosocial interventions including reality orientation, validation therapy, and reminiscence therapy followed by pilot testing and a full randomized controlled trial.[7] The standard CST program consists of 14 themed group sessions delivered twice weekly, aimed at enhancing cognitive processing and behavioral functioning through structured, engaging activities and group discussions.[8] Each approximately 45-minute CST session incorporates therapeutic elements shown to be effective in previous research.[7,9,10] Activities are designed to support emotional, relational, and social engagement, emphasizing a respectful, and person-centered approach essential for optimal outcomes.[11] Empirical evidence demonstrates that activating neural networks promotes neuronal survival, enhances brain function, and contributes to cognitive reserve and neuroplasticity processes by which the brain adapts to age-related changes through strengthened or newly formed neural connections.[12,13]

Electroencephalography (EEG) is widely recognized as a cost-effective and informative electrophysiological biomarker for detecting cognitive impairment and monitoring disease progression in dementia.[14] EEG wave patterns including delta, theta, alpha, beta, and gamma can be quantified using relative power analyses.[15] Dementia is typically associated with marked shifts in EEG relative power, characterized by increased low-frequency activity (delta, theta) and reduced higher-frequency activity (alpha, beta, gamma).[16,17] Moreover, these changes seem to develop gradually, that is as an early increase in theta, followed by a decrease in alpha, present in more severe stages of AD. The EEG, particularly at the central region (Cz), has demonstrated strong diagnostic sensitivity for mild to moderate Alzheimer's disease and is considered a robust indicator of dementia severity.[18]

CST is a version of cognitive stimulation that was developed on the basis of theory and evidence from a Cochrane review of reality orientation (RO) and subsequently evaluated in a pilot trial, followed by a full RCT. Although CST has been culturally

adapted in countries such as Japan, Tanzania, and Nigeria[19-21], there remains a scarcity of evidence regarding the effectiveness of CST in Asian populations, particularly in Thailand.[22] These prevalence of 8.7% was reported in the northern region, 8.8% in the central region, 7.9% in the northeastern region, and 6.7% in the southern region of Thailand. Further, while the psychological testing is widely used for dementia screening, its performance is often constrained by cultural, linguistic, educational, and practice-effect limitations.[23] EEG, by contrast, offers a non-invasive, repeatable, and learning-effect–free alternative or supplement to traditional screening approaches.

To address these gaps, this study developed and evaluated a culturally adapted CST program specifically designed for older adults in the Isan (Northeastern) region of Thailand, this study aimed to investigate its effectiveness on frequency EEG wave patterns among individuals with mild to moderate dementia who had completed the CST intervention.

Research objectives

1. To determine effects of a CST program on frequency EEG wave pattern in older adults with mild to moderate dementia

2. To compare the differences of theta and alpha EEG relative powers for frequency wave pattern between pre- (week 0) and post- CST program (week 7)

Conceptual Framework

The present study was conducted following the theoretical concepts of reality orientation (RO) and cognitive stimulation[6], which were developed from the systematic review of the standard therapies of psychosocial interventions, which include RO, validation therapy (VT), and reminiscence therapy (RT). The central assumption underlying cognitive stimulation is that a lack of cognitive stimulation can hasten the decline in dementia. Then this study was thought to provide the person with a greater understanding of their surroundings, possibly resulting in an improved sense of control and self-esteem on a regular basis to engage in orientation-related activities.[24]

Incorporating elements of evidence-based non-pharmacologic interventions, such as CST, offers a structured psychosocial intervention developed for participants, and challenges them cognitively[7], along with reflecting summated electrical activity at the level of functional units of the brain synapses through the amplitude and frequency of EEG signals. Therefore, CST can link to promote cognitive function, and EEG signal modification in the demented elderly through the process of brain structure and function stimulation, then the brain can preserve as better new ones.[12] The conceptual framework of this study is illustrated in Figure 1.

Figure 1 Conceptual framework of this study

Methods

Research design

The quasi-experimental one-group pretest-posttest design was employed in this study.

Population/Samples

The target population in this study is the older adults with mild to moderate dementia in a government-operated elderly nursing home overseen by the Provincial Administrative Organizations (PAOs) in Northeastern Thailand. Among the three available facilities, there are including 1) The Elderly Nursing Home “Ban Thamma pakorn-Banphoklang”, Nakhon Ratchasima, Thailand; 2) The Elderly Nursing Home “Ban Thamma pakorn-Watmoung”, Nakhon Ratchasima, Thailand; and 3) The Elderly Nursing Home “Ban Maha Sarakham”, Maha Sarakham, Thailand. There are approximately total 70 older adults living in the Elderly Nursing Home Ban Maha Sarakham. In this number, it was found that approximately estimate 41.6% of them were facing demented problems. One was selected through simple random sampling using a lot-drawing procedure performed by the research assistant [RA-1]. As a result, “Ban Maha Sarakham” Elderly Nursing Home in Maha Sarakham Province was selected as the research site.

The older adults with mild to moderate dementia were recruited to the samples based on the following inclusion criteria:

1. MMSE-Thai 2002 score between 10–22, consistent with the Functional Assessment Staging Test (FAST) for Alzheimer’s disease;[25]
2. Age $\geq$ 60 years;
3. Residence in the nursing home for at least one month;
4. Ability to communicate effectively;
5. Ability to read and write Thai;
6. Adequate vision and hearing to participate in group tasks; and
7. Willingness to participate throughout the full intervention period.

The participants who had severe complications or neurological severe or musculoskeletal conditions and serious conditions from comorbidity (e.g., diabetes mellitus, hypertension, stroke, cardiovascular disease, etc.), which make them unable to continuously participate in the intervention.

Exclusion criteria: Participants were excluded if they had a learning disability following the DSM-5 diagnostic criteria for Specific Learning Disorder (SLD), or communication difficulties of a degree likely to impede participation, and a major physical illness or disability too severe to allow travel to the group or to sit comfortably in a group environment for one hour which limit

their participation. Decisions on inclusion/exclusion were made by a multidisciplinary team taking into account the local environment with regard to transport, quality of seating available for the sessions, levels of lighting, external noise levels, and participants' disabilities within the context of local healthcare resources.

Sample size

Sample size was estimated using G*Power (Version 3.1.9.7) for quasi-experimental one-group pretest-posttest interactions. Using an effect size of 0.31 derived from a comparable CST study,[7] a power level of .90, with an alpha level of .05, the required sample size was 24. Accounting for a 20% attrition rate,[26] the final sample was set at 30 participants.

Sampling technique

Individuals who met the inclusion criteria were selected for participation through simple random sampling by RA-1. A research assistant (RA-1) performed randomization. One elderly nursing home of all three government elderly nursing homes in the Northeast region of Thailand under the control of the Provincial Administrative Organizations (PAOs) was randomly selected with a simple random sampling method by random of drawing a lot number.

Research Instruments

1. Mini-Mental State Examination–Thai version 2002 (MMSE-Thai 2002)

The MMSE-Thai 2002,[27,28] used with permission from the Institute of Geriatric Medicine, is a 30-item screening tool widely validated for the Thai population. Scores between 10–22 were used to classify mild to moderate dementia in accordance with FAST criteria.[25] The MMSE Thai 2002 was validated against the original version of the MMSE in English. It has been normed, validated and extensively used in in the Thai population to screen cognitive impairment and dementia.

2. Demographic and Clinical Characteristics Form

A researcher-developed questionnaire collected sociodemographic information (age, gender, education, marital status, previous occupation) and clinical characteristics (dementia subtype, comorbidities, medication use).

3. Emotiv EPOC EEG Neuroheadset

EEG data were collected using the Emotiv EPOC neuroheadset, which contains 14 active electrodes over frontal (AF3, AF4, F3, F4, FC5, FC6, F7, F8), temporal (T7, T8), parietal (P7, P8), and occipital (O1, O2) regions, with CMS and DRL reference electrodes, following the international 10–20 system.[29] The device is validated for research use with acceptable signal reliability.[30,31] EEG signals were processed using MATLAB (R2023b) with the EEGLAB Darbeliai plugin to compute relative power (RP) across delta, theta, alpha, beta, and gamma frequency bands.

Intervention

The CST program was developed based on the theoretical foundations of reality orientation and cognitive stimulation[6], supplemented by contemporary literature. All session themes were culturally adapted to reflect the daily experiences, language, and traditions of older adults in the Isan region. Activities requiring extensive reading or abstract reasoning were avoided. Instead, culturally familiar materials-traditional music, images, films, objects, and "Isan" dialect expressions were incorporated to enhance engagement. The 14 themed sessions activities of the initial CST program including: 1) Orientation, 2) Childhood, 3) Art discussion, 4) Using money, 5) Food, 6) Sensory stimulation, 7) Number games, 8) Current affairs, 9) Current affairs, 10) Being creative, 11) Calculate, 12) Categorizing objects, 13) Sounds, and 14) Team quiz.

The intervention consisted of 14 total theme sessions, delivered twice weekly for 7 weeks to all participants. Participants were subdivided into smaller groups of 7–8 individuals and met in separate rooms to prevent cross-interaction. Each 45-minute session followed a standardized structure:

1. Introduction (10 min): rapport building, casual conversation, and refreshments
2. Cognitive stimulation activities (25 min): theme-based tasks
3. Conclusion (10 min): reflection, discussion, and next-session reminders

The intervention content and procedures underwent expert validation by a panel comprising specialists in psychiatric nursing, cognitive psychiatry, occupational therapy, and Isan cultural studies. A pilot test with six older adults in the private nursing home demonstrated that the program was feasible and acceptable.

Data Collection

Data were collected between February and April 2024. After consent, RA-2 collected demographic and clinical characteristics form. The five minutes of resting-state, eyes-open EEG recordings were conducted by a researcher with certified training in portable EEG methodology at two time points: pre-CST (Week 0), and post-CST (Week 15). The EEG recording was conducted in a quiet, dimly lit room with a temperature-controlled room (20–25 °C), following established neuroscience protocols.[32] Sessions occurred in the morning to minimize agitation or fatigue. Participants were instructed to avoid substances or medications that could alter EEG activity prior to recording.

EEG data were captured using Emotiv EPOC sensors with a 0.5–45 Hz band-pass filter of 128 sampling rate. Impedance was maintained below 5 kW using saline solution. Artifacts were removed using Independent Component Analysis (ICA) according to Makoto's preprocessing pipeline.[33] Frequency-domain analysis was conducted offline with MATLAB (version R2023b) using FFT

algorithms to compute relative power for each frequency band as Delta (0.5-4 Hz.), Theta (4-8 Hz.), Alpha (8-12 Hz.), Beta (12-30 Hz.), and Gamma (30-45 Hz.). The average of each frequency band was calculated across the average of fronto-central (FC5-FC6) electrodes from the fronto-parietal lobe of both cerebral hemispheres. The relative power in each band was derived by expressing absolute power in each frequency band as a percent of the absolute power (AP) summed over the five frequency bands.

Ethical Considerations

Ethical approval was granted by the Institutional Review Board of Burapha University (IRB3-113/2566; approved 13 November 2023). Permission to conduct the study was obtained from the nursing home director. The trial was registered with the Sri Lanka Clinical Trials Registry (SLCTR/2024/004). Written informed consent was secured from all participants, who were informed of their rights, confidentiality safeguards, and the voluntary nature of participation. Permissions for copyrighted instruments were obtained from original authors.

Data Analyses

The data were analyzed using a statistical SPSS software package version 26. A significance level of $p < .05$ was established. Descriptive statistics encompassed frequency and percentage, along with mean and standard deviation (SD) were used to analyze the demographic characteristics and study variables. The statistical model were robust for distribution and homogeneity assumption and there was a sufficient sample size to test for with this statistic. A paired *t*-test one group pre-test and post-test design was used for analyses of theta and alpha relative powers.

Results

Part 1 Demographic characteristics of participants

Of the 30 participants, with an equal distribution of gender (50% male, and female). Most of them were widowed (46.67%), had no formal education (46.67%), and had not previous occupation (40.00%). All of them had comorbid chronic illnesses such as diabetes and hypertension. The average cognitive impairment severity that screening by MMSE, was 16.93 (SD=2.34), ranging from 11 to 20.

Part 2 Comparison of Theta and Alpha EEG relative powers of the older adults with mild to moderate dementia, Before and After the Intervention

The retention rate was 100%. No participants dropped out during the study. From the results of the comparison of Theta and Alpha EEG relative of the participants, before and after the CST program, the intervention yielded improvement, but the effect size was small ($d = 0.38$). The mean score of Theta (4-8 Hz) wave, as a low-frequency wave, was significantly decreased from

3.82 (SD=2.78) to 2.90 (SD=1.43) (p <.05), while the mean score of Alpha wave (8-12 Hz), as a high-frequency wave pattern was significantly increased from 1.14 (SD=1.02) to 1.94 (SD=1.51) (p < .01) at the fronto-parietal lobe of both cerebral hemispheres (Figure 2).

Figure 2 Comparisons of mean scores of Theta and Alpha EEG, before and after the CST program

Discussion

The findings of this study demonstrate that the CST program exerted a beneficial effect on cognitive function among older adults with dementia. After completion of the CST program intervention, there were significantly different of both of low-frequency and high-frequency wave patterns EEG between pre and post CST program intervention. Correspondingly, EEG analysis revealed a continued shift in relative power from low-frequency waves (theta) toward higher-frequency waves (alpha), a pattern consistent with improved neural functioning.

From a theoretical perspective, these results are consistent with the principles of reality orientation and cognitive stimulation[6] and with systematic review evidence.[34] Cognitive stimulation programs that use ecologically relevant or simulated environments can effectively compensate for age-related cognitive decline, especially in the context of brain aging and Alzheimer's disease.[6]

The CST intervention in this study was developed based on established psychosocial group therapies incorporating reality orientation, validation therapy, and reminiscence therapy. These approaches repeatedly present orientation cues and memory-related information concerning time, place, and person.[9,35] Each session adhered to core CST principles that aim to strengthen individuals' understanding of their environment, thereby fostering a sense of control and self-esteem through regular engagement in orientation-based activities. In addition, the sessions encouraged participants to recall and revisit personally meaningful experiences. Such reminiscence processes can help reduce stress, boredom, and loneliness and promote emotional well-being.[11] The program emphasized implicit rather than explicit learning, and provided structured cues to support memory retrieval. A growing body of evidence indicates that people with dementia retain some capacity for learning and rehabilitation, and that mental stimulation can enhance cognitive reserve.[8,34]

In this study, each thematic session was carefully adapted to the Thai Isan cultural context, considering participants' age, language, and educational background. Tasks requiring extensive reading or abstract reasoning were avoided, and culturally familiar resources such as images, films, songs, real-life objects, and Isan dialect terms were used, especially in "word association" activities.

The cognitive outcomes observed here are consistent with earlier CST trials. Spector, Thorgrimsen, Woods, Royan, Davies, Butterworth and Orrell [7], in the first large RCT involving 201 people with dementia, reported significant improvements in cognitive function following CST. Similar benefits have been documented across multiple studies [9,22,36,37], showing that CST improves cognitive functioning in people with dementia. Mechanistically, cognitive stimulation has been linked to enriched environments that upregulate neurotrophic factors, promote synaptogenesis, and enhance dendritic complexity, thereby supporting neuroplasticity and improved cognitive performance. Moreover, many neuroimaging studies have interpreted structural and functional changes as evidence of neuroplasticity across a variety of behavioral interventions, including cognitive stimulation. These changes include increased gray matter volume, improved white matter integrity, enhanced cerebral perfusion or metabolism, and strengthened functional connectivity.[38] Therefore, CST may not only reflect pre-existing reserve, but also contribute to its development through mechanisms such as increased dendritic branching that appear to exert both protective and enhancing effects on cognitive functioning.[13]

The present findings indicate that CST can modulate resting-state EEG by shifting relative power away from low-frequency (theta) toward high-frequency (alpha) bands. This is particularly important in dementia, where typical EEG patterns include decreased alpha and beta power and increased theta and delta power.[16] Meghdadi, Stevanović Karić, McConnell, Rupp, Richard, Hamilton, Salat and Berka [39] reported that dementia-related EEG changes often begin as localized theta-band power and coherence increases in temporal regions, accompanied by decreased alpha coherence, and may later progress to widespread alterations. Thus, the observed shifting relative power away from low-frequency toward high-frequency bands following CST that presented from this study are consistent with an EEG pattern indicative of improved cognitive functioning.

At the end of each session of intervention, open-ended feedback from participants indicated high satisfaction. Most participants perceived the activities as suitable for their age, cognitive level, and cultural background, and highlighted that the sessions were enjoyable, easy to follow, and supportive of social interaction within the nursing home.

Implications of the Study

This study provides important evidence for the integration of CST as a non-pharmacological nursing intervention in the care of older adults with dementia. The CST program enhances nursing practice by shifting the focus from solely managing symptoms to understanding and supporting the person's identity, preferences, and daily life. Engaging older adults in structured, enjoyable, culturally sensitive cognitive activities can strengthen the therapeutic relationship, foster communication, and promote well-being. The sustained cognitive and EEG benefits observed in this study support the feasibility of incorporating CST into standard care protocols within long-term care facilities, especially in culturally specific settings such as the Isan region.

Limitations and Recommendations

This study was conducted in a single elderly nursing home in Maha Sarakham Province. Future research should replicate and extend these findings in other regions with distinct cultural contexts, and include larger and more diverse samples. Longitudinal follow-up beyond the post-intervention period is necessary to determine the durability of cognitive and electrophysiological benefits. Additionally, it would be valuable to compare EEG recordings obtained under eyes-open and eyes-closed conditions, and to examine region-specific cortical changes to enhance the precision of neurophysiological interpretations.

Conclusion

This study demonstrates that a 7-week CST protocol and adapted to the Thai Isan cultural context, can produce improvements in cognitive function among older adults with mild to moderate dementia. Furthermore, EEG analyses showed a sustained shift in relative power from low- to high-frequency bands, indicating beneficial changes in neural functioning. Nurses and multidisciplinary healthcare teams are encouraged to incorporate CST into daily activity schedules in order to promote and maintain cognitive functioning in older adults living with dementia.

Conflict of Interests

The authors have no conflict of interest to disclose.

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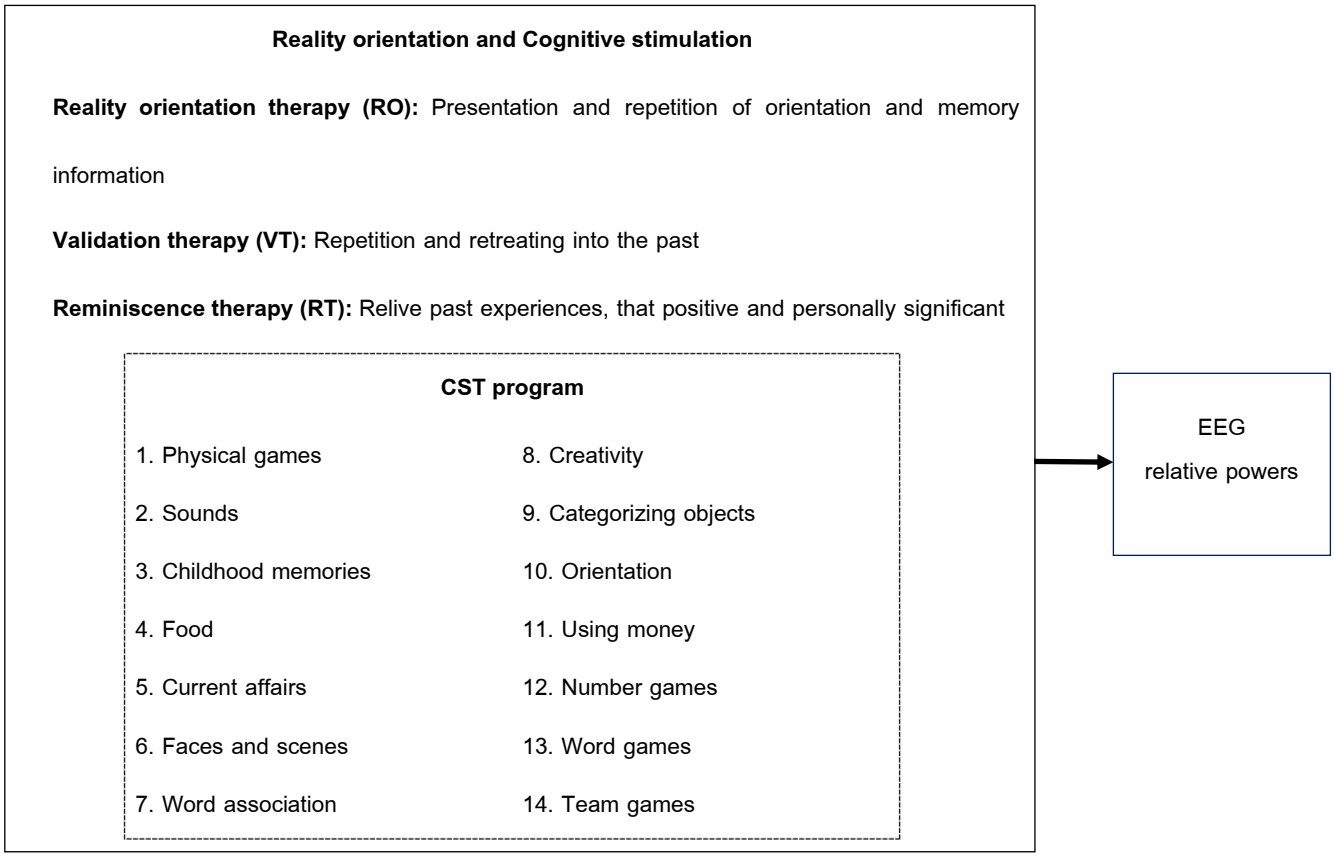

Figure 1 Conceptual framework of this study

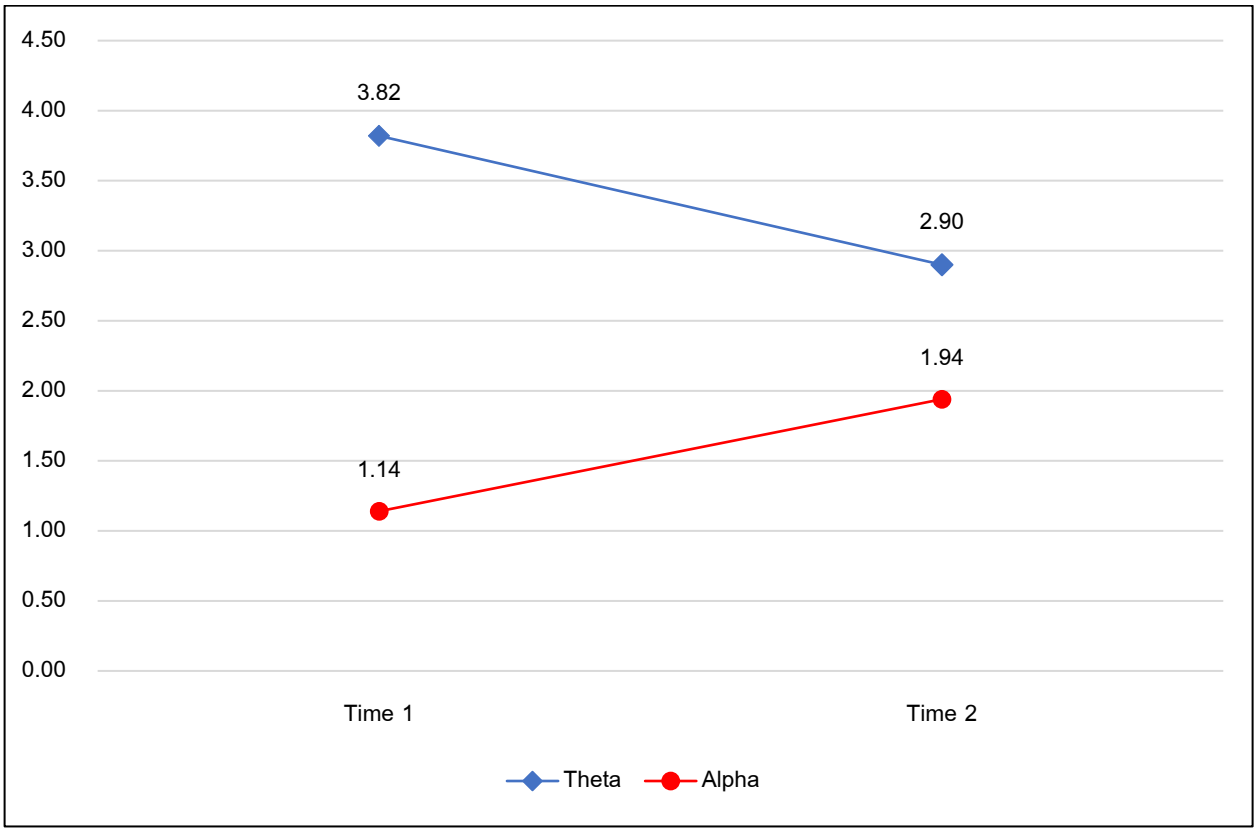

Figure 2 Comparisons of mean scores of Theta and Alpha EEG, before and after the CST program