International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

Effect of Brain Gym Therapy on Working Memory, Attention and Mood in People with Smartphone Addiction

Dr. Vishwa Mehta (PT)[1], Dr. Adyata Dave (PT)[2]

[1]Department of Physiotherapy, C.M. Patel College of Physiotherapy, KSV University, Gandhinagar, Gujarat, India
Email: *mehtavishwa0[at]gmail.com*

[2]Department of Physiotherapy, C.M. Patel College of Physiotherapy, KSV University, Gandhinagar, Gujarat, India

Abstract: ***Background: Smartphone addiction (SA) is the theoretically defined criteria of behavioral addiction, which include the psychological physical dependence saliency, impulsivity, spotlight behavior and relapse. It is particularly common among individuals aged 18–25. Smartphone has detrimental effects on Working Memory, Attention and Mood. Brain Gym Therapy is series of simple motion exercises and connecting the body and mind. Purpose: The Smartphone Addiction is common in young Individual. It affect the Working Memory, Attention and Mood. Thus present study is to evaluate the effect of brain gym therapy on working memory, attention and mood in people with Smartphone addiction. Methodology: After receiving ethical clearance all participants selected and included as per criteria. 126 Participants were divided into 2 groups by convenient method. Smartphone Addicted Group (n=63) received Brain Gym Therapy for 60 min. 5 session/week for 4 weeks. And Non Smartphone Addicted Group received Ergonomics Education on 1st day and follow up weekly. Outcome Measure was Digit Span Test, Stroop Test and Positive and Negative Affect Schedule (PANAS). Analysis was done at baseline and after 4 weeks. Result: All the statistical analysis was done by using SPSS 20.0 software for windows. Normality of data was obtained by Kolmogorov-Smirnov. Intragroup comparison of post intervention scores of variables was done by Non parametric Wilcoxon Test. Both Groups improve significantly at the end of 4th week. Conclusion: The finding of this study suggested that Brain Gym Therapy and Ergonomic Education both are significantly effective. Brain Gym therapy provide potential benefits in reduction of adverse effects of Smartphone and it reached parallel with people with Non Smartphone addicted. In additional Ergonomic education also provide significant improvement and prevent the adverse effect of Smartphone addiction.***

Keywords: Smartphone Addiction, Brain Gym Therapy, Working Memory, Attention, Ergonomical Education

1. Introduction

Working memory has historically been characterized as a key component of higher cognitive functions with a constrained capacity to briefly store information by actively controlling and regulating cognitive processes, but separate from attentional processes. Working memory is a foundational stage of brain development that is essential for learning. It provides the short-term information storage required for more difficult learning tasks. The dorsolateral prefrontal cortex is important for spatial processing of afferent information and for the organization of self-ordered working memory tasks, including verbal working memory[1].
The capacity for focus on particular elements or things is known as **Attention**. It contains the skills necessary to take in information and filter out the irrelevant stimuli. The prerequisite for memory to interact and carry out brain functions is attention. Frontal lobe is responsible for concentration and fixing Attention[2].

"Mood" can be defined as "a conscious state of mind or predominant emotion". Even though it is an internal and subjective state, it often can be inferred from behaviors of individuals. Amygdala is responsible for emotion[3].

In 1997, Ericsson coined the word "Smartphone" when it described its GS 88 "Penelope" A 2017 study unveiled that around 300 million people in India were avid Smartphone users, thereby placing a substantial portion of the Indian population at potential risk of addiction. One survey found that college students use their phones for nearly 9 hours per day, which is an excessive amount of time for a student population. (Roberts et al., 2014). In India, the prevalence of Smartphone addiction was 23% among 400 college students aged 18-24[4].

Smartphone addiction (SA) is the theoretically defined criteria of behavioral addiction, which include the psychological (craving, cognitive salience, loss of control and mood modification), physical dependence (tolerance and withdrawal symptoms), saliency, impulsivity, spotlight behavior and relapse[5].

Smartphone has negative impact on health affects the cognitive functions such as attention[5,6,7], working memory[6,7], mood changes (mood modification)[7,8], tolerance[7,8], withdrawal symptoms[7,8], conflict[7,8], relapse[7,8], anxiety[9,10], depression[9,10].

Brain gym therapy is a form of exercise that involves simple movements of the head, eyes and limbs to stimulate both hemispheres of the brain. It is claimed to improve various aspects of cognitive function such as memory, concentration, attention and learning[11].

Some tactics for reducing the negative consequences of Smartphone addiction include taking breaks and changing postures often while using a Smartphone. Maintain the wrists when holding or typing. To reduce typing frequency, use technologies such as predictive text or auto complete. Hold the Smartphone at chest level rather than waist level[12].

Need of study

Smartphone addiction is type of behavior addiction. It is very common problem in young adulthood. Smartphone addiction can impair working memory, attention and mood by disrupting the brain's neural pathways, increasing stress hormones and reducing positive emotions. Brain gym therapy is a set of movements, processes and programs that aim to improve learning, performance and well-being by enhancing the brain-body connection. There are many studies available for brain gym therapy to improve cognition level. Thus present study is to evaluate the effect of brain gym therapy on working memory, attention and mood in people with smartphone addiction.

Aim & Objectives

Aim

To find the effect of brain gym therapy on working memory, attention and mood in people with smartphone addiction.

Objectives

Primary objectives

- To evaluate the effect of brain gym therapy on working memory in people with Smartphone addiction.
- To evaluate the effect of brain gym therapy on attention in people with Smartphone addiction.
- To evaluate the effect of brain gym therapy on mood in people with Smartphone addiction.

Secondary objectives

- To evaluate the effect of ergonomic education on working memory in people with non-Smartphone addiction.
- To evaluate the effect of ergonomic education on attention in people with non-Smartphone addiction.
- To evaluate the effect of ergonomic education on mood in people with non-Smartphone addiction.

Hypothesis

Null hypothesis

(H_{01})- There was no statistically significant effect of brain gym therapy on working memory in people with Smartphone addiction.

(H_{02})- There was no statistically significant effect of brain gym therapy on attention in people with Smartphone addiction.

(H_{03})- There was no statistically significant effect of brain gym therapy on mood in people with Smartphone addiction.

Alternative hypothesis

(H_{11}) - There was statistically significant effect of brain gym therapy on working memory in people with Smartphone addiction.

(H_{12})- There was statistically significant effect of brain gym therapy on attention in people with Smartphone addiction.

(H_{13})- There was statistically significant effect of brain gym therapy on mood in people with Smartphone addiction.

2. Literature Survey

Tanil CT, Yong MH. et al. (2020) did a study on Mobile phones: The effect of its presence on learning and memory. This experimental study was conducted on 119 college students. They were randomly assigned in two group (1) low-phone salience (LS) (2) high-phone salience (HS). They were Performed a memory exercise and the Smartphone Addiction Scale. (SAS). As anticipated, those without smart phones had better recall precision than those who did. This experimental study concluded that the presence of the Smartphone and frequent thoughts of their Smartphone significantly affected memory recall accuracy, demonstrating that they contributed to an increase in cognitive load 'bandwidth effect' 164 interrupting participants' memory processes[6] .

Kulkarni C. et al. (2019) did study on "Effect of brain gym exercises on the attention span in young adults." This interventional study were included 16 subjects according to inclusion criteria Pre interventional attention span calculated by mindful attention awareness scale then brain gym exercises were thought to the subjects and continued for 1 month. The outcome measure for the subjects was the mindful attention awareness scale. This study concluded that brain gym exercises are effective in the improvement of the attention span in youngadults[11]

3. Materials & Methods

Study Design: An Experimental Study
Study Population: Young Adulthood
Study Setting: C.M. Patel College of Physiotherapy
Duration of Study: 1.5 Year
Intervention Duration: 4 Week
Sampling Technique: Convenient Sampling
Allocation Technique: Convenient Sampling
Sample Size: 126 (63 in each group)[13]
Source of data collection: C.M Patel College of Physiotherapy, C.M. College of Nursing, K.B. Institute of Pharmaceutical Education and Research, Pearl Girl Hostel

Tools and apparatus

- Chair
- Pen – Pencil
- Paper
- Assessment Sheet
- Color Sheet
- Word Sheet

Inclusion criteria

Age between: - 18-25 years[4, 14]
Smartphone usage: Since > 3 years[4]
Duration of Smartphone Usage: Average 1 to 10 hours/day.
Males and Females both are included.
Participants who understand English language[15]

Exclusion criteria

Visual deficiency[6]
Auditory deficiency[6]
Participates who are not following commands
History of Neurosurgery that affect working memory, mood and attention[16, 17].
Any Neurological condition and Psychological which affects the working memory, mood and attention diagnosed by Neurologist and Psychiatris[16, 17].
Substance abuse

Any Musculoskeletal Pain: Numerical Pain Rating Scale Score >4
Headache: Headache disability Index Score <50
Electronic Gadgets such as (Laptop, Television and Tablets) usage > 4 hours[18].

Data Collection Procedures
After receiving ethical approval (IEC/CMPP/04/2022), from the Institutional Ethics committee, certain center were approached for data collection. Participants who were suitable for participation asked to sign informed consent form. All the study participants were selected through the convenient sampling method. Before Participating, study participants were instructed and explain about the training procedure and outcome measures. Whole Assessment were taken. The outcome measure Digit span test, Stroop test and Positive and Negative affect Schedule were taken at baseline and post training (4weeks) The selection and allocation of study participants were divided into two groups through the Convenient Sampling method. Those who were using smartphone between 5-10 hours/day[19] and smartphone addicts as per smart phone addiction scale- short version[20] included in Smartphone Addicted Group.

Smartphone Addicted Group	Non- Smartphone Addicted Group
Participants were received Brain gym Therapy in group for 60 mins/session/day (5 session per week for 4 week)	Participants were received Ergonomics Education on 1st day and follow up weekly.

Outcome measure
Digit span test[21]
Stroop Test[22]
The Positive and Negative Affect Schedule[23]

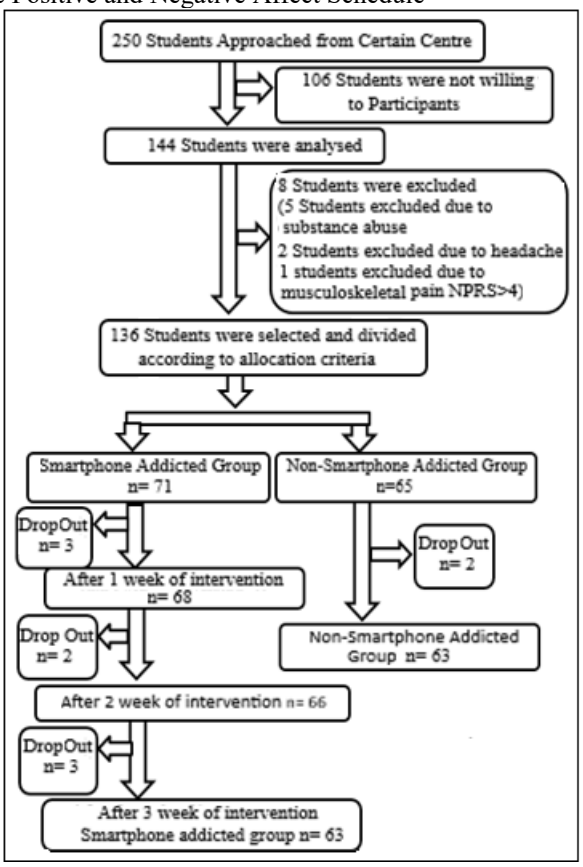


Figure 1: Study Flow Chart

4. Intervention

Smartphone Addicted Group was received Brain Gym Therapy

Table 1: Protocol for Brain Gym therapy

Exercise	Duration
Warm Up[24,25]	**10 minutes**
Walking in different directions such as forward, backward, side walking.	
Walking with long deliberate steps	
Walking with small deliberate steps	
General Exercises	**45 minutes**
Belly breathing[16,26]	3 minutes
Neck roll[26]	3 minutes
The owl[16,26]	3 minutes
Arm activation[16,26]	3 minutes
Gravity glider[17,26]	3 minutes
The Energizer[16,17]	3 minutes
Foot flex[17,26]	3 minutes
Lazy eight[17,26]	3 minutes
Elephant[16,26]	3 minutes
Calf pump[26]	3 minutes
The grounder[26]	3 minutes
Cross crawl[16]	3 minutes
Hook up[16,17]	3 minutes
Brain buttons[26]	3 minutes
Cross lateral waking in place[26]	3 minutes
Cooling off activities[26]	**5 minutes**
General Stretching exercises Self-Stretching of Biceps, Triceps, calf, hamstring	

Total Duration: For 60 minutes/session, 1 session/day, 5 session/week for 4 weeks.

Non-Smartphone Addicted Group was received Ergonomic Education
Participants were received Ergonomically Education on 1st day and follow up weekly.

Participates in the group were received a specific program regarding posture, ergonomics education by physiotherapist. The training was carried out interactively. The training theoretically was providing information regarding about posture, things to pay attention using a smartphone, Ergonomics education regarding about prevention of adverse effects of smartphone on Working memory, attention, mood, mental health, physical health, sleep quality. In the presentation risk situation that may occur and ergonomic recommendation were included. Follow up was taken on regular basis.

Statistical analysis
Data analysis was done for outcome measure: Digital Span Test, Stroop Test, Positive and Negative Affect Schedule.
Statistical analysis was done using SPSS (Statistical Package for Social Science) version 20.
Mean and SD were calculated for numerical data.
Pre and Post data analysis of Smartphone Addicted Group and Non-Smartphone Addicted Group were done by Non-Parametric Wilcoxon Test.
For all statistical analysis with $P< 0.05$ with confidence interval 95% was found to be significant.

5. Result

Normality of data was obtained by Kolmogorov-Smirnov. The most of variables were not normally distributed so Non parametric test was used. Descriptive analysis was done by mean and standard deviations.

Intragroup comparison for Digital Span Test, Stroop Test and Positive and Negative Affect Schedule were done by Non Parametric Wilcoxon Test

Demographic Data:

Analysis of Age distribution in both the group:

Table 2: Mean Age (in years) of subjects of both the group

Group	Mean (in years)	SD (in years)
Smartphone Addicted Group	21.13	2.23
Non-Smartphone Addicted Group	21.1	1.36

Analysis of gender distribution in both the group:

Table 3: Gender distribution of subjects of both the group

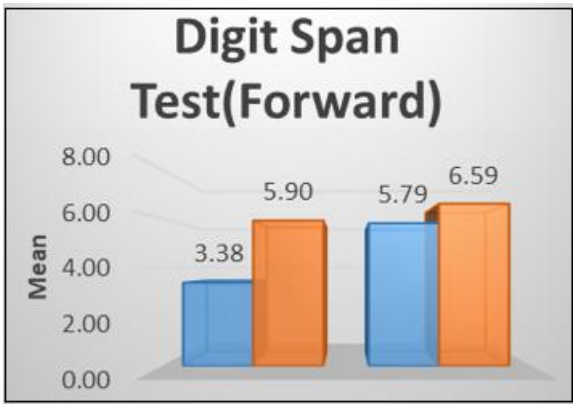
Group		Subjects	Percent
Smartphone Addicted Group	Female	47	74.6
	Male	16	25.4
Non-Smartphone Addicted Group	Female	57	90.5
	Male	6	9.5

Duration of usage of Smartphone:

Table 4: Duration of Smartphone Usage of both group

Group		Subjects	Percent
Smartphone Addicted Group	5-7 Hours	21	33.33%
	8-10 Hours	42	66.67%
Non-Smartphone Addicted Group	1-2 Hours	14	22.22%
	3-4 Hours	49	77.77%

Intra and Inter Group Analysis of Digit Span Test (Forward):

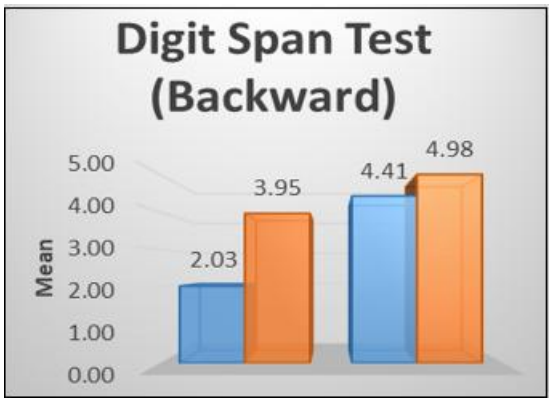


Graph 1: Intra and Inter Group Analysis of Digital Span Test Forward

In Smartphone Addicted Group analysed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M = 3.38, SD = 0.68) and After (M = 5.90, SD = 1.25) t 6.866 P< 0.001.

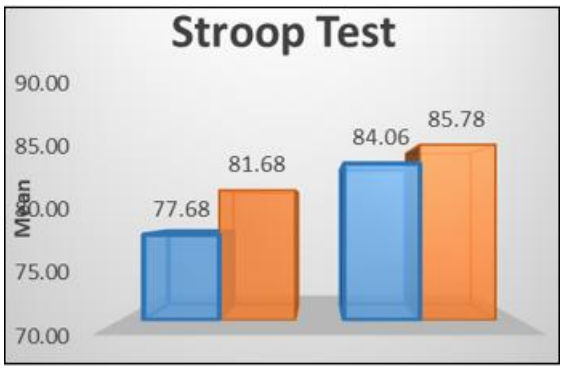
In Non-Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M = 5.79, SD = 1.12) and After (M = 6.59, SD = 1.25) t 5.634 P< 0.001.

Intra and Inter Group Analysis of Digit Span Test (Backward):



Graph 2 Intra and Inter Group Analysis of Digital Span Test Backward

In Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M = 2.03, SD =0.76) and After (M = 3.95, SD = 1.13) t 6.804 P< 0.001.



Graph 3: Intra and Inter Group Analysis of Stroop Test

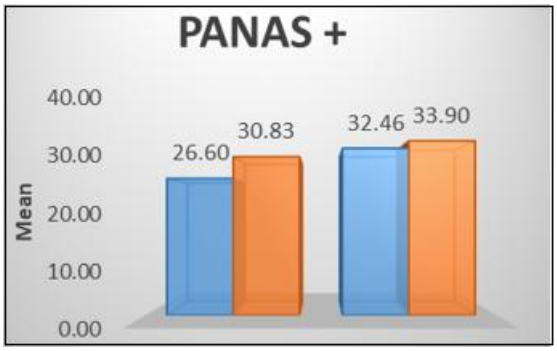
In Non-Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M = 4.41, SD =0.85) and After (M = 4.98, SD = 0.89) t 5.245 P< 0.001.

Intra and Inter Analysis of Stroop Test:

In Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M =**77.**68, SD =7.26) and After (M =81.68, SD =7.46) t 6.879 P< 0.001.

In Non-Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M = **84.06**, SD = 3.58) and After (M = 85.78, SD =3.69) t 6.208 P< 0.001.

Intra and Inter Analysis of Positive and Negative Affect Schedule Positive Score:

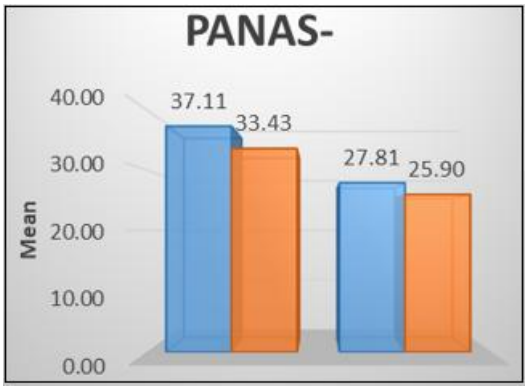


Graph 4: Intra and Inter Group Analysis of Positive and Negative Affect Schedule Positive Score

In Smartphone Addicted Group analysed with using Wilcoxon Test. Result of the Wilcoxon Test indicated there was large difference between before (M =26.60, SD = 4.77) and After (M =30.83, SD =5.48) t 6.867 P< 0.001.

In Non-Smartphone Addicted Group analysed with using Wilcoxon Test. Result of the Wilcoxon Test indicated there was large difference between before (M =32.46 , SD =3.81) and After (M =33.90, SD =3.95) t 6.474 P< 0.001.

Intra and Inter Analysis of Positive and Negative Affect Schedule Negative Score:



Graph 5: Intra and Inter Group Analysis of Positive and Negative Affect Schedule Negative Score

=

In Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M **=37.11**, SD =4.71) and After (M =33.43, SD =5.35) t 6.87 P< 0.001.

In Non-Smartphone Addicted Group analyzed with using **Wilcoxon Test.** Result of the Wilcoxon Test indicated there was large difference between before (M **= 27.81**, SD =3.30) and After (M = 25.90, SD = 4.28) t 6.555 P< 0.001.

6. Discussion

Age Distributions:
In the present study, the age distribution was homogeneous. Experimental Group's Mean Age was 21.13 and Control Group's Mean Age was 21.10.

It is particularly common among individuals aged 18–25, who reportedly spend approximately 5 h per day using their smartphones (Alhazmi et al., 2018; Puntumetakul et al., 2022)[27]

Gender Distributions:
In the present study, the gender distribution was heterogeneous. Among total 63 participants in Smartphone Addicted Group there were 47 Female and 16 Male. In Non-Smartphone Addicted Group there were 57 Female and 6 Male. According to previous research by (Sinem Can Erçok Güler et.al. 2023) According to the findings, female students had a higher frequency of smartphone addiction than males. Women's higher scores may be due to their greater willingness to socialise than men. Furthermore, Kwon, Kim, et al. (2013) emphasise that women tend to be more conscious and communicate their difficulties more freely than males in self-reporting instruments, which may explain the discrepancy in their mean scores[28]

Duration of usage of Smartphone:
In the present study, those who were using smartphone between 5-10 hours/day and smartphone addicts as per smart phone addiction scale- short version included in one group (Smartphone Addicted Group) and those who were using smartphone between 0-4 hour/day and non addicts as per smartphone addiction scale – short version included in other group (Non-smartphone addicted Group)

According to MS& ICT (2021), those who spend an average of 4.47 hours a day on their smartphones are at a very high risk of addiction[29]

Effect of Brain Gym therapy on working memory
In The Present study Brain Gym therapy was given to the 63 Subjects. It Found Significantly Improve Working Memory After 4 Week.
These Brain Gym activities were found to excite (Laterality Dimension), release (Focusing Dimension), and relax (Centering Dimension) [30].

Brain gym activities can assist balance brain function in several areas, including the left and right hemispheres (lateral dimension), the back/brainstem and frontal lobes (focus dimension), the limbic system (midbrain), and the cerebral cortex[30].

Brain Gym Exercise control the function that demands focus, intelligence, and the regulation of false stimulus, such as reasoning, working memory, and inhibitory control. (Owen, et al., 2010; Howard-Jones, 2014; Ballesteros et al., 2015)[1]

Bungawali Abduh, Mohd Mokhtar Tahar, et al.'s study found that brain gym and brain training interventions improved working memory performance on students with learning disabilities[1].

Effect of Brain gym Therapy on Attention
In The Present study Brain Gym therapy was given to the 63 Subjects. It Found Significantly Improve Attention After 4 Week.

Brain Gym is a workout that improves brain function in humans. Brain gymnastics can increase brain oxygenation, which improves memory, concentration, balance, and

coordination. Brain gymnastics tries to open up the brain's physiological channels in order to boost learning abilities. Brain gymnastics can boost concentration, attention, awareness, and the brain's ability to plan motions. Individuals' ability to use thinking skills improves as they gain prior information. As a result, brain gymnastics can help you perform activities effectively[31].

Kulkarni et al. did a study to see how brain gym activities benefited young pupils' concentration spans and found that reading, recoding, and comprehension mechanisms improved. Furthermore, the outcomes of these activities revealed an increase in hand-eye coordination and the capacity to retain focus when reading and writing concurrently[11].

Effect of Brain Gym therapy on Mood

In The Present study Brain Gym therapy was given to the 63 Subjects. It Found Significantly Improve Mood Function After 4 Week.

Brain gymnastics motions excite the left and right brains, relax the back and front brains, activate the limbic system (a system that regulates emotional or feeling movement), and stimulate the gigantic brain[31]. Brain gymnastics can activate three different areas of the brain. The concentration dimension can boost blood flow to the brain and enhance oxygen intake. The lateral dimension will encourage coordination between the left and right hemispheres of the brain (better respiration, stamina, stress release, and tiredness reduction) [32].

Ginting S. et al. (2021) investigated the effect of brain Gym on dementia and depression decrease in the elderly. They discovered that Brain Gym reduces the incidence of dementia and depression in elderly persons[32].

Effect of Ergonomic Education

The Present study Ergonomics Education was given to the 63 Subjects. It Found Significantly Improvement in Working Memory, Attention and Mood.

Knowledge of ergonomics is necessary to help smartphone users avoid risk factors that can lead to the development of musculoskeletal problems. A good understanding of correct ergonomic posture for smartphones would involve knowledge of the best posture to assume in various circumstances[33].

Gustafsson E (2012) conducted a study on ergonomic suggestions for messaging on mobile phones. According to these findings, it is advisable to support the forearms, use both thumbs, avoid sitting with the head tilted forward, and avoid texting with high velocity in order to prevent musculoskeletal issues when using mobile phones for messaging[34].

Comparison of Both Group

The Study Participants were divided into two groups through the Convenient Sampling method. Those who were using Smartphone between 5-10 hours/day and Smartphone addicts as per smart phone addiction scale included in one group (Smartphone addicted group) and Those who were using Smartphone between 0-4 hour/day and non addicts as per Smartphone addiction scale included in other group (Smartphone Non addicted group). In Both the group found significant difference between pre and post data.

In both the group found significant difference in working Memory, Attention and mood. Brain Gym therapy Enhance Working memory, Attention and provide positive effects on mood. After 4 week of intervention Smartphone addicted group scores reached similar with pre data of Non smartphone Addicted. It suggested Brain Gym therapy is reduce the adverse effects of Smartphone addiction regarding working memory, attention and mood. In Additional Ergonomic education also provides significant improvement and prevents the adverse effect of smartphone addiction.

7. Limitations

- Male and female ratio was unequal (Male were less than female).
- Long term follow up of the intervention was not done as the study duration was short.

8. Future Scope of the Study

- This study can be carried out in adolescent people or elder people with smartphone addiction.
- Brain Gym Therapy Protocol can be carried for other component of cognition, sleep, anxiety, Depression in people with smartphone addiction.

9. Clinical Implication of the Study

The present study has important clinical implication because it provide support for using Brain Gym Therapy to improve working memory, attention and mood in smartphone addicted people. Brain Gym Therapy can be also implicate in School, colleges to prevent the adverse effect of Smartphone addiction on working memory, Attention and mood.

10. Conclusion

Smartphone addiction has adverse effects on Working Memory, Attention and Mood. The finding of this study suggested that Brain Gym Therapy and Ergonomic Education both are significantly effective. Brain Gym therapy provide potential benefits in reduction of adverse effects of Smartphone and it reached parallel with people with Non Smartphone addicted. In additional Ergonomic education also provide significant improvement and prevent the adverse effect of Smartphone addiction.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

References

[1] Abduh B, Tahar MM. The effectiveness of brain gym and brain training intervention on working memory performance of student with learning disability. Journal of ICSAR. 2018 Jul 31; 2(2):105-11.
[2] Liebherr M, Schubert P, Antons S, Montag C, Brand M. Smartphones and attention, curse or blessing? A review on the effects of smartphone usage on attention, inhibition, and working memory. Computers in Human Behavior Reports. 2020 Jan 1; 1:100005.
[3] Bangamuarachchi W, Chamantha A, Meegahapola L, Kim H, Ruiz-Correa S, Perera I, Gatica-Perez D. Inferring Mood-While-Eating with Smartphone Sensing and Community-Based Model Personalization. arXiv preprint arXiv:2306.00723. 2023 Jun 1.
[4] Sonawane PP, Mahajan A, Shinde CS. Association between smartphone addiction and sleep quality along with objectively measured sleep. 2019 Oct;13(4):491.
[5] Liu H, Soh KG, Samsudin S, Rattanakoses W, Qi F. Effects of exercise and psychological interventions on smartphone addiction among university students: A systematic review. Frontiers in Psychology. 2022;13.
[6] Tanil CT, Yong MH. Mobile phones: The effect of its presence on learning andmemory. PloS one. 2020 Aug 13;15(8):e0219233.
[7] Putchavayala CK, Singh D, Sashidharan RK. A perspective of yoga on smartphone addiction: A narrative review. Journal of Family Medicine and Primary Care. 2022 Jun 1;11(6):2284-91
[8] Csibi S, Griffiths MD, Demetrovics Z, Szabo A. Analysis of problematic smartphone use across different age groups within the 'components model ofaddiction'. International Journal of Mental Health and Addiction. 2021Jun; 19: 616-31
[9] Sohn SY, Rees P, Wildridge B, Kalk NJ, Carter B. Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: a systematic review, meta-analysis and GRADE of the evidence. BMC psychiatry. 2019 Dec;19(1):1-0.
[10] Manzoor A, Basri R, Ali I, Javaid S, Amjad M, Amin U, Kamran H. Smartphone Addiction/Overuse and Its Effect on Dietary Behavior and Lifestyle-A SystematicReview. EAS J Nutr Food Sci. 2020; 2: 289-97
[11] Kulkarni C, Khandale SR. Effect of brain gym exercises on the attention span in young adults. International Journal for Advance Research and Development. 2019;4(4):71-5.
[12] Shete MG, Shah R. Effect of posture correction exercises and ergonomic advices in people having postural abnormalities among chronic smartphone users. International Journal of Health Sciences & Research. 2019;9(7):121-5.
[13] Hulley SB, Cummings SR, Browner WS, Grady D, Newman TB. Designing clinical research: an epidemiologic approach. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2013. Appendix 6C, page 79.
[14] Sin RM, Tan WY, Yuon JX. Relationship between anxiety, self-esteem and internet addiction among emerging adults in Malaysia (Doctoral dissertation, UTAR.
[15] Tanaya K, Jayakrishnan K. Effect of brain gym exercise on self-esteem, quality of life and symptoms among schizophrenic patients. International Journal of Health Sciences & Research. 2018 Mar;8(3):173-9
[16] Siroya VV, Naqvi WM, Kulkarni CA. Importance of Brain gym as exercise in physiotherapy and rehabilitation. Int J Res Pharm Sci. 2020;11:1386-9.
[17] Seth NH, Kulkarni CA, Naqvi WM. Efficacy of brain gym exercises for improving quality of sleep in physiotherapy students. J Med Pharm Allied Sci. 2021; 10: 3819-22.
[18] Twenge JM, Campbell WK. Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. Preventive medicine reports. 2018 Dec 1; 12: 271-83
[19] Woo KS, Bong SH, Choi TY, Kim JW. Mental health, smartphone use type, and screen time among adolescents in South Korea. Psychology research and behavior management. 2021 Sep 14:1419-28
[20] Kwon M, Kim DJ, Cho H, Yang S. The smartphone addiction scale: development and validation of a short version for adolescents. PloS one. 2013 Dec31;8(12):e83558.
[21] Waters GS, Caplan D. The reliability and stability of verbal working memory measures. Behavior Research Methods, Instruments, & Computers. 2003 Nov;35(4):550-64.
[22] Franzen MD, Tishelman AC, Sharp BH, Friedman AG. An investigation of the test-retest reliability of the stroop color word test across two intervals. Archives of clinical neuropsychology. 1987 Jan 1;2(3):265-72.
[23] Crawford JR, Henry JD. The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. British journal of clinical psychology. 2004 Sep;43(3):245-65.
[24] Cano-Estrada A, Jimenez-Mendoza A, Contreras-Guerrero D, Hernandes-lejandro M, Salas-Casas A. The effect of Brain Gym on global cognitive function of institutionalized older people. International Journal of Mental Health Promotion. 2022;24(3):375-83.
[25] Ratan ZA, Parrish AM, Zaman SB, Alotaibi MS, Hosseinzadeh H. Smartphone addiction and associated health outcomes in adult populations: a systematic review. International journal of environmental research and public health. 2021 Nov 22;18(22):12257
[26] Cancela JM, Suárez MH, Vasconcelos J, Lima A, Ayán C. Efficacy of brain gym training on the cognitive performance and fitness level of active older adults: a preliminary study. Journal of aging and physical activity. 2015 Oct 1;23(4):653-8
[27] Metin G, Topuz S, Yagci G. Smartphone use affects gait performance, spinal kinematics and causes spinal musculoskeletal discomfort in young adults. Musculoskeletal Science and Practice. 2023 Aug 1; 66: 102819.
[28] Winskel H, Kim TH, Kardash L, Belic I. Smartphone use and study behavior: A Korean and Australian comparison. Heliyon. 2019 Jul 1;5(7).

[29] Park HJ. Unlocking Puzzle: Serial Mediation Effect of Social Withdrawal and Aggression on the Relationship between Impulsivity and Problematic Smartphone Use. Available at SSRN 4676255.
[30] Nissim NR, O'Shea AM, Bryant V, Porges EC, Cohen R, Woods AJ. Frontal structural neural correlates of working memory performance in older adults. Frontiers in aging neuroscience. 2017 Jan 4; 8:328.
[31] Selano MK**.** Brain Gym Learning: Focus Attention As An Effort To Improve Student Learning Concentration. Stipas Tahasak Danum Pambelum Keuskupan Palangkaraya. 2023 Jun 9;1(2):66-78.
[32] Ginting S, Afniwati Y. The effect of brain GYM on the dementia and depression reduction of the elderly. Journal of Advanced Pharmacy Education & Research| Apr-Jun. 2021;11(2):41
[33] Okafor UA, Akinbo SR, Takuro NV, Oghumu SN. Knowledge and practice of proper ergonomic posture during smartphone use by undergraduate students in college of Medicine University of lagos, Nigeria. Nigerian Journal of Orthopaedics and Trauma. 2021 Jan 1;20(1):1.
[34] Gustafsson E. Ergonomic recommendations when texting on mobile phones. Work. 2012 Jan 1;41(Supplement 1):5705-6