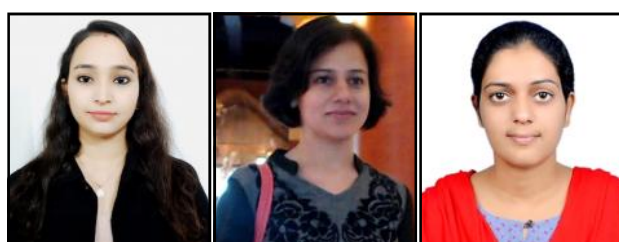




Effect of 4 Week Mindfulness on n-Back Task Performance and Mathematical Performance of Adolescents

Sant Pyari Saxena, Research Scholar, Sona Ahuja, Research Guide, Shivani, UGC Senior Research Fellow, Department of Education Dayalbagh Educational Institute, Dayalbagh, Agra, Uttar Pradesh, INDIA

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Authors

Sant Pyari Saxena, Research Scholar

Sona Ahuja, Research Guide

Shivani, UGC Senior Research Fellow

shodhsamagam1@gmail.com

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ABSTRACT

The goal of this study was to compare the effects of focused attention meditation (Surat-Shabd-Yoga meditation) and a mindfulness meditation intervention on adolescents' performance on an n-Back problem and their aptitude for math. In a randomised controlled trial, mindfulness and Surat-Shabd-Yoga practitioners were compared to a control group. The participants in experimental group were exposed to mindfulness practises for four weeks, whereas the participants in the active control group continued to read for the length of the study. Pre-intervention and post-intervention, participants completed a computerised assessment of working memory capacity (WMC), n-Back task. Using the results of mathematics class assessments taken both before and after intervention, mathematical performance was evaluated. The research endorses up the advantages of practising short-term focused attention meditation for enhancing WMC and mathematical performance in teens. The value of mindfulness practitioners among adolescents is highlighted by the findings of the study, given that such therapies may increase task performance and mathematical achievement. Therefore, mindfulness practices may be provided in schools, increasing the likelihood that they will be integrated into educational environments.

KEY WORDS

Mindfulness, n-Back Task Performance, working memory, Mathematical Performance.

INTRODUCTION

Adolescence years are a time of stress and storms (Hall, 1994). During this time, the child undergoes mental, emotional, and physical development. Life becomes more challenging as a person transitions from adolescent to young adulthood because of increased responsibilities, knowledge retrieval tasks, and skill acquisition. (Venketasan & Gangadharan, 2016) It is the period in an individual's life when they get increasingly distracted and confused. Rapid population expansion, lack of housing and support services, poverty, unemployment, and underemployment among youth, overcrowding in poor metropolitan areas, family disintegration, and ineffective educational systems have a negative impact on the young minds, making it difficult for them to successfully deal with situations (World Youth Report, as cited in Gupta, Singh, Bhatt & Gupta, 2015). An individual may experience a great deal of stress and challenges throughout this crucial time in their lives, which could impair their ability to concentrate and recall information. At this stage, declining concentration and rising stress levels could have a significant impact on children's early cognitive and emotional development. Decreasing concentration level and increasing stress level at this age may impact their cognitive and emotional development and in turn may have a great impact on their future. Guiding and helping adolescents at this point may be the best way to solve problems in their lives; this in turn can improve their quality of life. As meditation is found to be positively correlated with most cognitive and psychological aspects of individual life, it can be helpful to improve such distracting and stressful situations along with their cognitive development. Meditation practices are becoming increasingly popular among researchers. Many researchers have shown the positive effect on mind and body. Most of the researchers have studied the efficacy of meditation practices on experienced meditators. Only a few meditation practices have been conducted to study the effect of different meditation practices. Meditation includes practice of controlling mind and body, the practice of regulating one's attention, regulating breathing and focussing attention on any given object. Given the cognitive and psychological benefits of meditation practices, meditation based interventions are being introduced in clinical trials. Meditation based therapies and treatments are being used to treat mental illnesses and psychological problems. Many researchers have also studied mediation practices in school settings and their effects on students of different levels of education. Recent studies have found that meditation practices, yoga, and physical activities are beneficial to use at school level (Goldschmidt, 2019; Daya, & Hearn, 2017). Given the nature and benefits of these practices (i.e., attention regulation training, cognitive control and physical, mental and psychological) efforts have been made to study their potential benefits to different aspects of health, cognition, and psychological well-being. But the question that is left unanswered is which kind of meditation will be most beneficial for improving such cognitive aspects, specifically the n-back task performance and mathematical achievement of adolescents.

The n-back task is a continuous performance task majorly used as an assessment in the field of psychology as a measure of working memory capacity. This task was introduced by Wayne Kirchner in 1958. Owen et.al (2005) mentions that n-back task is a widely used measure for the assessment of working memory functions. Working memory is one of the core executive functions and responsible for holding information in mind and mentally working with it (Diamond, 2013). Recent research is bringing to light the importance of working memory in everyone's daily life in academic, professional, and social settings. Working memory has been shown to play a significant role in many other cognitive functions, such as learning, reasoning, intelligence, and problem solving (Alloway, 2009). Mathematical achievement is the competency shown by students in subject mathematics. It measures the score on achievement in mathematics (Pandey, 2017). Research shows that the knowledge of mathematics is a strong foundation for a student's future academic performance and also plays an important part in the educational development of youths. Further, mathematics achievement can be considered to be the vital factor that contributes to the excellence of the education sector. Thus, it is necessary to improve the mathematics achievement of adolescents so that they can succeed in future life. Working memory plays a vital role in mathematics performance. Meditation practices play an important role in such scenarios. Open monitoring meditation is a subtype of mindfulness practise. Open monitoring meditation (OMM) entails the

expansion of one's awareness to encompass a diverse range of continuous cognitive occurrences and experiences. During the meditation, rather than fixating on a particular object, one develops awareness and attentiveness towards the experiences and events that transpire. Every perception is acknowledged and perceived in its true nature, whether it be internal (thoughts, emotions, memory, etc.) or external (sound, smell, etc.). Mindfulness has been associated with several positive outcomes, such as enhanced emotional regulation abilities (Holzel et al., 2011), reduced mental stress (Khoury, Sharma, Rush, & Fournier, 2015), diminished anxiety (Hofmann, Sawyer, Witt, & Oh, 2010), and improved physical health (Creswell et al., 2012). Many researchers and educators tried to integrate meditation in the teaching learning process or in education. But this is still a question of reasoning: which meditation is best to include in educational processes? Which meditation practice is more appropriate to use in education to fulfil the needs of adolescents? Though efforts have been made, more work needs to be done to identify the impact of other meditation practices on students. In the light of fulfilling the existing research gap, the present research aimed at comparative effect of open monitoring (Mindfulness) meditation practices on working memory and mathematics achievement of adolescents? The research aimed at answering the question which kind of meditation is better for enhancing the working memory capacity and mathematical performance of adolescents.

Method

Sample

Sixty one adolescent subjects (age range: 13 to 16 years) were included from two schools of D.E.I., Agra. Schools were selected purposely. The sample was randomly divided into two groups using simple random sampling - experimental group and active control group. In the sample selection for behavioural data analysis, 61 high school students were selected using simple random sampling (Experimental Group: 31 subjects, Active Control Group: 30 subjects) from Prem Vidyalaya Girls Intermediate College and R.E.I Boys Intermediate College of Agra city. One hundred and ten adolescents received the information about the study. Sixty one turned in their signed parental consent forms. However 72 students participated in the study. Sixty one students were the study completers and included in statistical analyses. 30 girls and 30 Boys were selected for the study (Experimental Group: 30 subjects (Girls: 15, Boys: 16), Active Control Group: 30 subjects (Girls: 15, Boys: 15)).

Intervention

Mindfulness Training

The participants underwent training in Mindfulness Meditation, a form of meditation that is monitored openly. Comprising a sequence of guided breath awareness and sitting meditation, the mindfulness meditation practise entails recognising and releasing unintentional or automatic thoughts or emotions that arise as distractions. Experimental group (N=31) members practised it for 20 minutes daily, three alternate days per week, for four weeks, prior to assembly time, under the guidance of an expert.

Measures

n-Back task

Participant working memory was evaluated using a computerised version of the n-back task. A two-back trial design was implemented for the present investigation. The participants were presented with a sequence of images representing various objects and given the task with determining whether the image being viewed at that moment was identical to the image that was presented two trials prior. A series of stimulus representations (e.g., shapes, images) were displayed in front of each participant at regular intervals of several seconds. The participant is tasked with determining whether the current stimulus is identical to the one that was presented n trials prior, for each stimulus.

Mathematical Performance Report

Mathematical performance was measured using mathematics class test marks records of the students. The class test marks of mathematics of the students from the office records were obtained. Pre-intervention and post-intervention class test marks of the mathematics subject were taken as the index of measurement of mathematical performance of the adolescents.

Results and Discussion

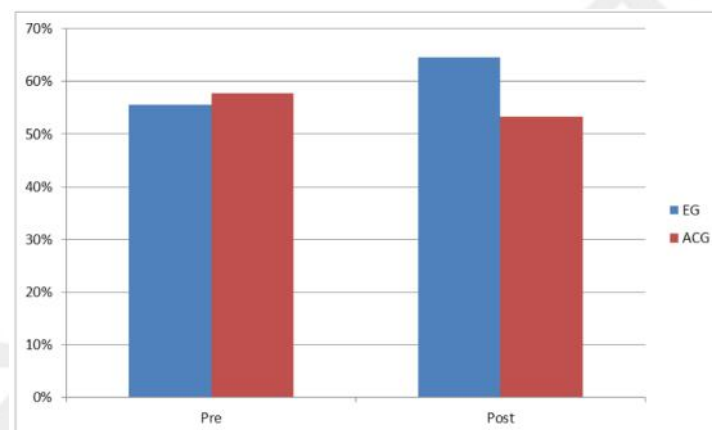
Demographic Data

A total of sixty one subjects were included in this study (Mean age: 14.85 years). Participants were randomly divided into three groups study Experimental Group: 31 subjects (Mean age: 14.89); Active Control Group: 30 subjects (Mean age of ACG: 14.90)). These findings suggested that the demographic characteristics of both groups were sufficiently homogeneous. Besides, our results showed that there was no significant difference in the baseline measures of n-back task and mathematical performance of adolescents.

Comparisons of Both Experimental Groups and Control Group for n-Back task Performance

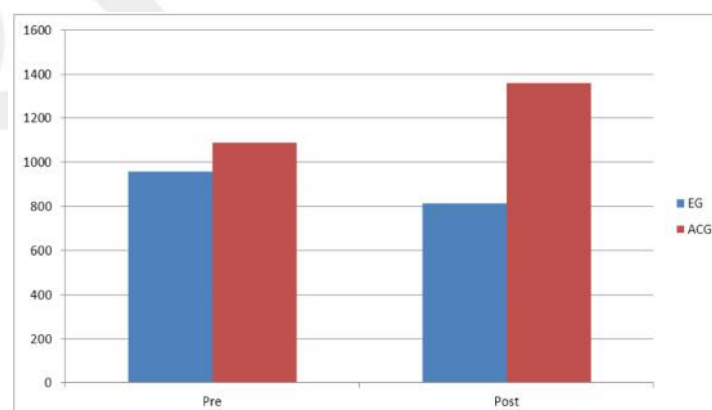
To compare every aspect of the groups and variables t- test was performed in this study. While there were no significant changes observed between the pre-test and post-test *n*-Back task scores of the active control group ($t=0.873, p < 0.05$). The Results of effect analysis also showed that the participants of the Mindfulness group also significantly improved post intervention ($t=3.682; p < .05$). Findings of the statistical analysis imply that mindfulness practices have a positive effect on n-Back task performance of the high schoolers (Figure 1).

Figure 1: Performance on n-Back Task at Pre-tests and Post-Tests



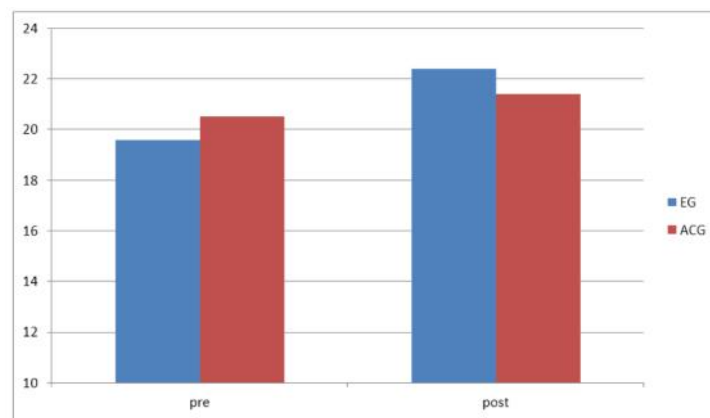
Analysis found no significant difference in reaction time taken in *n*-back task performance of participants of both experimental groups and active control group (Figure 2).

Figure 2: Performance on n-Back Task Reaction Time at Pre-tests and Post-Tests



An investigation carried out by Lohot (2017) demonstrated that 45 days of meditation practise led to an enhancement in reaction time for task performance, and 90 days of practise resulted in an even greater improvement, as determined by repeated effect analysis. A cohort of 45 participants, ranging in age from 16 to 24 years, participated in the research for a duration of 12 weeks, with each session lasting 20 minutes. In addition, the research leads to a decrease in reaction time and an increase in alertness following meditation. Additionally, research by Chawala & Phatak (2018) and Atchley, Klee, & Oken (2017) indicates that prolonged meditation practise improves the reaction time required to complete tasks. The findings presented in this study were further corroborated by research studies conducted by Kang, Chan-An, Kim, Sung, Knag, Lee, and Yang (2020), Pandya and Strickland and Selwyn (2019), and Kalmennndal (2017). Mindfulness practices found to have no effect on mathematical performances of adolescent participants ($t= 1.483, p < 0.05$) (Figure 3). No difference was found in control ones also ($t= 0.725, p < 0.05$). Studies conducted Results of further pre-test post-test analysis of scores of Mathematical performance of all three groups have shown no significant differences.

Figure 3: Performance on Mathematical Performance at Pre-tests and Post-Tests



CONCLUSION

The statistical analysis revealed the positive effect of Mindfulness practices on *n*-Back task performance and mathematical performance of high schoolers. The scores of *n*-Back task were found to be improved after meditation intervention, while no significant difference were found in the scores of mathematical performance of adolescents. Analysis further indicates if the intervention duration of meditation practices were to be increased then results may vary. Present study provides sufficient evidence to conclude that the meditation practices have a positive effect on the *n*-Back task performance of high schoolers.

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