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Research Paper

Enhancing working memory by performing agriculture work

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ABSTRACT

Working memory is the capacity for keeping current information in mind for a brief period, while using this information for the task at hand. It is the 'workbench' where current thinking takes place. Children having working memory problems take a longer time to process information. They are not capable to cope with timed activities and speedy demonstration of information. As an effect, they often end up deserting the activities out of frustration. The current research attempts to compare the working memory of university students who were involved in voluntary agriculture work as selfless work, and those not involved in voluntary agriculture work. A sample of 100 female students was selected, out of which 50 students were regularly doing voluntary agriculture work as social/ community service and 50 students were not involved in voluntary agriculture work. To measure the working memory, three sub-tests from WAIS-IIIUK, Third Edition (Wechsler, 1998) was used. The data was analysed on the basis of Mann-Whitney U Test. Results showed that students involved in voluntary agriculture work have better working memory ($Zu = 2.730$, $p < 0.01$) than those students not involved in voluntary agriculture work. The present investigation is unique in taking up agriculture work as a physical activity to improve the working memory of students. It can be rightly implied that the fitness of the body carry inferences for the fitness of the mind.

Keywords: *Working memory, agriculture work.*

In any country of the world, the utilization of its youth population can directly influence the growth and prosperity. The youth, especially the students have to realize their power, their role, their duties and their responsibilities and positively contribute towards them. They must aim at creating a world full of creative challenges and opportunities to conquer them. The irony of the present times is that the youth is involved in all the pleasurable things of the modern age, and are getting inclined towards the hedonistic tendencies. The need of the hour is to develop and expand their consciousness in order to make their lives more fruitful and productive. Self-service, dedication to their work and dignity of labour should be inculcated in them. The dignity of labour propagates that no job is big or small and no

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occupation should be discriminated on any basis. Maintaining discipline, punctuality, and selfless service to mankind would make the youth better equipped to face the challenges and hardships. Voluntary social service would promote self-satisfaction, happiness and well-being. They would also develop healthy body in a healthy mind. Service to man is said to be the highest worship of God.

Selfless service of humanity or philanthropy can be the first step in the spiritual path. Selfless service of humankind prepares the aspirant for the attainment of cosmic consciousness or unity with God. Selfless service or *Seva* is a service which is performed without any expectation of result or award for the person performing it. The notion of selfless service is an important concept in most religions of the world. Through selfless service and charity, one can purify the heart and cleanse the lower mind, fill it with divine virtues and make it a fit abode for God to dwell. Only the pure in heart will have the vision of God and attain self-actualization.

The unique leadership of Mahatma Gandhi (1941) during the freedom struggle was instrumental to a large extent in creating greater awareness about the role of voluntary or selfless service. He motivated many to simultaneously join hands in nation building programs. He also appealed to the youth in the country to get involved in voluntary service and dedicate them in nation growth. He appealed to the youth to come forward and work as full-time voluntary servants of the people. He believed a lot in dignity of labour, both in word ("Mine is the life of joy in the midst of incessant work") and deed.

There are several researches that prove that exercise can improve the brain functioning. First, exercise leads to increased blood flow to the brain, providing the brain with vital nutrients such as glucose and oxygen, and exercise helps regulate blood sugar levels. Children involved in physical exercises show improvement in cognitive function, and improved motor skill development. Such children do better on standardized tests and have better grades. As one gets older, regular physical activity increases memory, keeps one away from memory loss and slows the aging process of the brain. According to National Academy of Sports Medicine (2018), various studies show that people who engage regularly in physical activities have much lower rates of memory loss; Alzheimer's and do better on cognitive function tests over time.

Physical exercise also helps memory and thinking through both direct and indirect means. The physical activities can decrease insulin resistance, inflammation, and stimulate the release of growth factors pertaining to chemicals affecting the brain cells, the growth of new blood vessels in the brain, and the large quantity and presence of new brain cells. According to McGinnis (2011), "…. engaging in a program of regular exercise of moderate intensity over six months or a year is associated with an increase in the volume of selected brain regions".

Working memory refers to the temporary workspace where we manipulate and process information. No particular physical location in the brain appears to be accountable for producing the ability of working memory. The new concept of working memory clarifies the short-term memory by focusing more on how we attend to, rehearse, and manipulate information in temporary storage (Engle, 2002). Working memory is roughly like a computer's random-access memory (RAM), which integrates information coming in from our keyboard with that retrieved from long-term storage on the hard drive. Part of this Working memory is visible on our short-term screen.

Baddeley and Hitch (1974) developed a model of working memory in which they proposed two slave systems, the articulatory loop or phonological loop (or the verbal working memory) and the visuospatial sketchpad (the visual-spatial working memory), along with the central executive system (the attentional control system**)**, which are responsible for the short-term maintenance of information. They anticipated that the central executive system is responsible for coordinating the slave systems, as well as for integrating information. Baddeley (2000) proposed an additional slave system called the episodic buffer. Episodic buffer was regarded as a brief storage system that modulates and integrates different sensory information (Baddeley, 2000a). It plays a vital role of aiding and retrieving information to and from the episodic long-term memory (Baddeley, 2000). In short, the central executive functions is the 'control centre' that manages manipulation, recall, and processing of information (non-verbal or verbal) for important functions such as decision-making, problem-solving or even writing.

Baddeley (1986, 1992) distinguishes between a short-term memory (STM) that holds verbally produced sounds, which he calls the articulatory loop, and another STM that holds visual and spatial information, which he calls the visuospatial sketchpad. The articulatory loop is like a continuous-play loop on a tape recorder, on which the sound impulses fade when the tape isn't being played; individual need to rehearse repeatedly to carry on to accumulate sounds in the articulatory loop. In contrast, the visuospatial sketchpad is like a notepad with patterns drawn in fading ink; it briefly retains mental images of the locations of objects (Logie, 1986; Logie and Marchetti, 1991; Quinn, 1991). Both types of STM are temporary stores of the information individual is working on; depending on what he is doing, he add and delete sounds from the taped loop or sketch and revise diagrams on the pad. The fact that these STMs are distinct is demonstrated not only by the finding that different neural patterns of activation occur when they are used (Smith, 2000), but also by the finding that the functioning of the visuospatial sketchpad is more strongly influenced by genetics than is that of the articulatory loop (Ando et al., 2001). The theory of WM includes a function known as the central executive, which operates on information in one or another of the two STMs to plan, reason, or solve a problem. WM's central executive uses the articulatory loop and the visuospatial sketchpad to help individual to do different sorts of reasoning. The central executive is at work when individual plan what he will say on a first date or when he think about what he would like to do tomorrow. This function of WM relies in large measure on a part of the frontal lobes that is crucially involved in managing information in order to carry out specific plans.

Hence, working memory is essential for remaining engrossed on a task, obstructing distractions, and keeping one updated and mindful of things that are working on in the environment. Traditional views considered mind as an abstract information processor divorced from the physical activity but now researchers suggest a strong link between cognition and action. Research literature in this area show that a humongous pool of studies can be found on working memory concerning both psychological and neurological perspective.

Dodwell, Muller and Tollner (2019) aimed to elucidate the influence of aerobic exercise on the temporal dynamics of concurrent visual working memory (VWM) performance. A sample of 24 adult volunteers were paid to participate performed a VWM retro-cue task at rest and during aerobic exercise across two postural modalities: seated (using a stationary bicycle) and standing upright (using a treadmill). Assessment was done by means of lateralized ERPs having three consecutive phases of the VWM processing (access of VWM representations, response selection, and response execution). It was found that both aerobic exercise and upright posture have significant effects on VWM performance while facilitating processing speed in the retro-cue task.

Chai, Hamid and Abdullah (2018) provide an overview of several working memory-relevant studies in order to harmonize the findings of working memory from the neurosciences and psychological standpoints, especially after citing evidence from past studies of healthy, aging brains. Commencing the neuroscience viewpoint, it has been recognised that working memory stimulates the frontal-parietal brain areas, as well as the prefrontal, cingulate, and parietal cortices. Additionally, working memory discrepancies are obvious in older individuals, being susceptible to cognitive decline. Younger residents with working memory deficiency often have mental, developmental, and/or neurological disorders for instance major depressive disorder and others. A less lucid and structured neural pattern has been steadily conveyed in these deprived Groups. Interpreting the basic neural processes of working memory favours the current theoretical understandings concerning rehabilitation programs that target working memory from neuro physiological or psychological aspects.

Koutsandreou, Wegner, Niemann and Budde (2016) investigated how different types of exercise effects working memory (WM) of primary school children. Sample consisted of 71 children (32 boys and 39 girls) and was randomly assigned to a cardiovascular exercise (CE), a motor exercise (ME), or a control Group (CON). They underwent a letter digit span task (WM) before and after an intervention period that involved 10 week of an additional afterschool exercise regimen, which took place three times a week for 45 min. To prevent attention bias and to control for retest effects, students in the control Group participated in assisted home work sessions. WM performance of the 9- to 10-yr-old children was found to be benefited from both the cardiovascular and the motor exercise programs. The increase in WM performance was significantly larger for children in the ME compared with the CE or CON which shows the importance of motor exercise on working memory.

Li, et al. (2014) examined the effects of a session of acute aerobic exercise on working memory as well as task performance. Sample consisted of fifteen young female participants (M=19.56, SD=0.81) and were scanned using f-MRI while performing a working memory task (the N-back task), following an acute exercise session with 20 minutes session of moderate intensity and a control rest session. Precisely, acute exercise encouraged increase in brain activation particularly in the right middle prefrontal gyrus, the right lingual gyrus, and the left fusiform gyrus. It reflects the improvement of executive control processes, which indicates that acute exercise could benefit working memory at a macro-neural level.

Gallotta, et al. (2012) found that different types of exertion contributed to student's (ages 8-11) immediate attention performances. Three types of controlled lessons were provided, traditional physical education lesson, corresponding to physical exertion; coordinative physical education lesson, corresponding to a mixed cognitive and physical exertion; and school curricular lesson, corresponding to cognitive exertion. It was found that children showed higher working speed and concentration scores after each of three controlled lessons. The instigator proposed that children demonstrate higher attention levels at the end of physical education lessons versus the beginning due to the arousal hypothesis (Budde, 2008), which relates attention to increase in cerebral blood volume and excited cerebellum and frontal cortex.

Building on the significant and compelling body of research demonstrated a link between physical activity and cognitive functioning in youth, research on the brain neurochemistry of mice suggested that there can be supplementary cognitive benefits that have not until now been perceived in youth. Such studies showed that light to moderate physical activity lead to increased brain-derived neurotropic factor (BDNF) levels in the brain due to stimulation of the hippocampus, a part of the prefrontal cortex that houses executive control functions. Although this has yet to be demonstrated in children, it had been shown that higher-fit children show greater bilateral hippocampus volumes and superior relational memory task performance compared to lower-fit children, leading to enhanced memory performance (Chaddock, et al., 2010b) and that childhood aerobic fitness is associated with less behavioral interferences on a selective attention paradigm tool, greater basal ganglia volume and higher task recital, and better dorsal striatal volumes, prominent to improved cognitive control (Chaddock et al., 2010a). Additional physical activity is also beneficial.

Van Dusen, et al. (2011) found that all fitness variables except body mass index (BMI) are positively associated with academic performance; measures of cardiovascular fitness were found to have the highest connection to cognition. In addition, each further unit of cardiovascular aptness across quintiles was associated with enhanced performance on a standardized test, explicitly the Texas Assessment of Knowledge and Skills. Also using the fitness test, preliminary results presented at the American College of Sport Medicine conference by Bass, Brown and Laurson (2010), suggested that students in the healthy fitness zone for cardiorespiratory capability were six times more likely to meet or exceed the Illinois Standardized Achievement Test (ISAT) reading test requirements and over two and a half times more likely to meet or exceed ISAT math test requirements than students who were not in the healthy fitness zone. In addition, Srikanth, Petrie, Greenleaf and Martin (2010) found that when comparing the effect of social support, self-esteem and cardiorespiratory fitness on middle school students' reading and math tests, the only factor that correlated with higher scores was cardio-respiratory fitness.

Best (2010) explained that cognitive function, and specifically executive functioning, is enhanced through aerobic physical activity. In a review of eight studies (two chronic exercise studies and six acute exercise studies), he found that chronic and acute aerobic exercises affect cognition differently and that every component of cognitive functioning can be impacted distinctively depending on individual's developmental stage. For instance, in one study of chronic exercise, running programs that became more physiologically demanding over time were found to enhance mental flexibility and divergent thinking associated with executive function in 4th-8th graders (Tuckman and Hinkle, 1986). Children in intense exercise trainings were found to have enhanced concentration, response accuracy, reading comprehension, task accuracy and completion of task.

Similarly, Ellemberg & St. Louis Deschenes (2010) established that 7-10 years old boys who participated in 30 minutes of aerobic exercise at moderate intensities showed significant improvement in cognitive function, as demonstrated by simple reaction response time (tapping low level sensori-motor functions associated with primary visual and motor cortices) and choice response time tasks (cognitive task involving decision making processes that tap executive functioning), compared to those who watched TV.

Lambourne (2006) examined the relationship between physical activity and cognitive function in younger adults. It was assumed that there would be a relationship between the exercise rates of adults (aged 19-30) and working memory capacity. The participants in Group one (n = 23) followed the physical activity requirements stated by the Centre for Disease Control and Prevention (CDC), and the other Group participants (n = 19) acted as the control. A reading span task was used to evaluate the participant's working memory capacity. ANOVA results confirmed that exercise was associated with enhanced memory ($F = 9.06$, $p = 0.05$). The finding supports the hypothesis that exercise is related to working memory capacity in younger adults.

Motivation

The researchers were inspired by the existing literature that reported that a positive relationship exists between physical exercise and cognitive functioning, yet none had explored the impact of agriculture operations as a physical exercise, on cognitive functioning. On these lines, the present study was formulated to compare the students who were involved regularly in agriculture work with those who were not involved in voluntary agriculture work. Voluntary agriculture work is being regularly done by one group of university students as selfless service. These young adults participate in all kinds of agriculture operations such as weeding, sowing, cutting, harvesting, thrashing, picking etc. They work passionately in the agriculture fields as service towards their community without any monetary benefits.

METHODOLOGY

Aim

The aim of the present investigation was to compare the Working memory of University Students selflessly participating in agriculture work and those not doing Voluntary agriculture work.

Operational definitions of the terms used

1. **Working memory:** It is the organization that dynamically holds multiple pieces of transitory information in the mind, where they can be manipulated.
2. **Voluntary agriculture work:** It refers to voluntary work done by a Group of people in agriculture fields, early in the morning as selfless service.

Objective

To compare the working memory of university students involved in voluntary agriculture work with those not involved in voluntary agriculture work.

Hypothesis

There is a significant difference between the working memory of university students involved in voluntary agriculture work and those not involved in voluntary agriculture work.

Tools

Working memory:

WAIS-III^{UK}, Third Edition by Wechsler (1998) - Three sub-tests from WAIS-III^{UK}, Third Edition, a revised form of the WAIS and the WAIS-R, was released in 1998. This scale delivers scores for Verbal IQ, Performance IQ, and Full-Scale IQ, constituting 4 secondary indices - Verbal Comprehension, Working memory, Perceptual Organization, and Processing Speed. The working memory was measured by using the Working Memory Index (WMI) of the above test which includes the following three sub tests:

1. ***Arithmetic*** - For this subtest, the examinee is presented with a series of arithmetic word problems to be solved mentally, without the use of pencil or paper, and responds orally within a time limit.
2. ***Digit Span*** – Digit Span is composed of two tasks administered independently of each other: Digit Forward and Digit Backward. For each Digits Forward item, the examinee is required to repeat the number sequence in the same order as presented by examiner.

For Digit Backward, the examinee is required to repeat the number sequence in the reverse order.

3. ***Letter-Number Sequencing*** – For this subtest, the examinee is read a combination of numbers and letters and is asked to recall the numbers first in ascending order and then the letters in alphabetical order.

Variables

Independent variable
Voluntary agriculture work
Dependent variable
Working memory

Relevant variables

Gender: Only female students were taken for the study.
Age: Female students between 18-25 years were selected.
Educational qualifications: Students enrolled in the university were selected.
Discipline: Students from Faculty of Social Sciences, Science and Arts of Dayalbagh Educational Institute were included in equal proportion in both the Groups.

Sample

The study was conducted on a sample of 100 students out of which 50 female students involved in voluntary agriculture work and matched Group of 50 female students not involved in voluntary agriculture work was selected.

Design

Matched-Group design was used for the investigation.

Analysis and interpretation

Mann-Whitney U test was used to analyse the data.

Table-1: Mean, SD, & Zu for Working memory of Students Involved in Voluntary agriculture work (Group I) and those not Involved in Voluntary agriculture work (Group II)

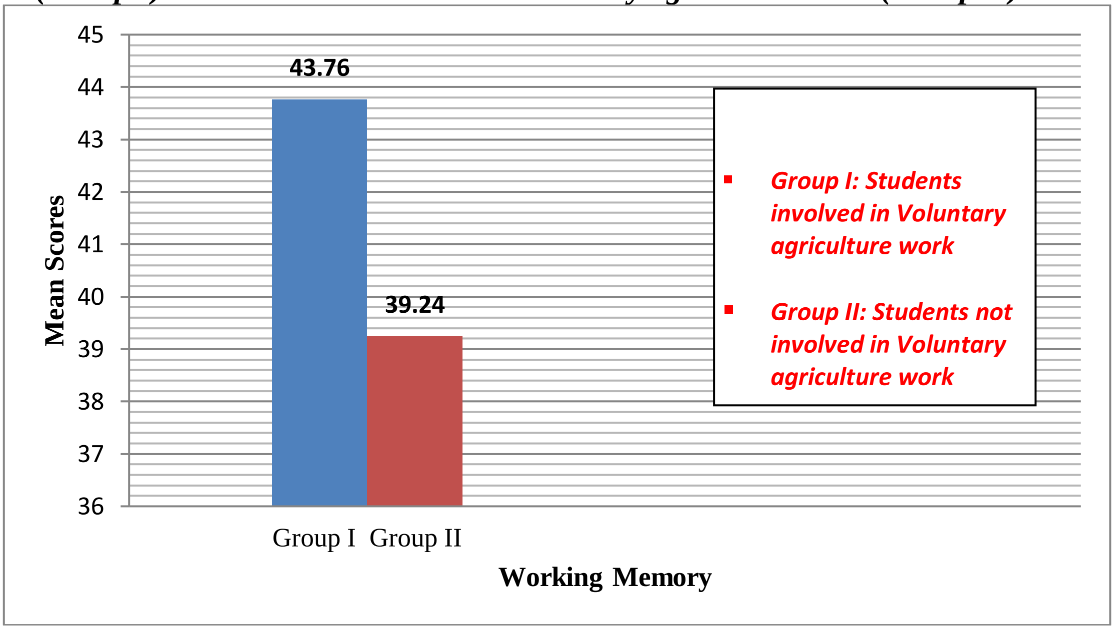
Groups	N	Mean	SD	Zu	Level of Significance
Students involved in Voluntary agriculture work (Group I)	50	43.76	7.941	2.730	$p < 0.01$
Students not involved in Voluntary agriculture work (Group II)	50	39.24			

Table-1 depicts the mean scores, SD, and Zu of students involved in voluntary agriculture work (Group I) and those not involved in voluntary agriculture work (Group II) on Working memory scores. Table-1 shows that students involved in voluntary agriculture work have considerably higher working memory (M = 43.76) as compared to their counterparts i.e., those not involved in voluntary agriculture work (M = 39.24). The obtained Mann-Whitney U value is highly significant at 0.01 level of significance (Zu = 2.730, $p < 0.01$), which suggests that there is a significant difference between the two Groups of students on Working memory. Therefore, the hypothesis stating that, **"*There is a significant difference between the working***

memory of university students involved in voluntary agriculture work and those not involved in voluntary agriculture work", is accepted.

The mean scores of the two Groups of students on working memory are graphically depicted in Figure-1.

Figure-1: Mean Scores of Working memory of Students involved in Voluntary agriculture work (Group I) and those not involved in Voluntary agriculture work (Group II)



Student life is the most precious and memorable phase of life where mental, physical, social and spiritual development takes place. If the students follow a disciplined life and honor the significance of social service and dignity of labor, it will definitely make them a better person. In the current study the students involved in voluntary agriculture work (Group I) are selflessly occupied in agricultural activities where they have their fixed schedule of going to fields and willingness to do physical activities at agriculture farms which eventually enhanced their working memory.

Barner, et al. (2018) used Mental Abacus (MA) technique in which students learnt to solve math problems by visualizing a physical abacus structure. Prior studies conducted in Asia have found that MA can lead to exceptional mathematics achievement in highly motivated individuals, and that extensive training over multiple years can also benefit students in standard classroom settings. Here they explored the benefits of shorter-term MA training to typical students in a US school. They wanted to test whether MA (1) enhances arithmetic performance relative to a standard math curriculum, and (2) results in changes in spatial working memory, as stated by several reports. To address these questions, they conducted a one-year, classroom-randomized trial of MA instruction. They found that first-graders students struggled to achieve abacus expertise over the course of the year, while second-graders were more successful. No significant age group advantage in cognitive abilities or mathematical computation relative to controls was observed, although older children showed some clues of an advantage in learning place-value concepts. Overall, their results suggest caution in the adoption of MA as a short-term educational intervention.

Peterson, et al. (2018) explored the feasibility of a quasi-randomized, controlled, exploratory, repeated-measures aerobic and cognitive training intervention on cognitive function in participants undergoing treatment for cancer. They found that aerobic training for cancer-related cognitive impairment (CRCI) may positively impact cognitive function. Separately, these methods may suitably address CRCI, but combined training of this nature may be too challenging for patients undergoing treatment for cancer. However, larger randomized trials are needed to substantiate this protocol in large-scale cancer rehabilitation centres.

Orun and Akbulut (2019) conducted two experiments to investigate the role of multitasking, physical setting and electroencephalography use on retention and cognitive load among undergraduate students in a computer supported learning environment. First experiment included 129 randomly assigned subjects to three multitasking situations simultaneously studying a biology video as a Concurrent multitask activity. In the second experiment the impact of EEG headsets was checked. The results showed that there is a correlation of working memory components and perceived mental effort with retention in both experiments.

Findings from Ratey and Loehr (2011) have shown that how physical activity positively impacts cognition throughout adulthood. Their research suggested that learning the basic skills necessary to engage in physical activity at a young age will be beneficial for future cognitive functioning.

As noted by the Centers for Disease Control and Prevention (CDC) (2011), research has shown that physical activity can affect the physiology of the brain by increasing cerebral capillary, flow of blood, level of oxygen, formation of neurotrophins, growth in hippocampus nerve cells (center of learning and memory), neurotransmitter levels, development of nerve connections, density of neural network, and brain tissue volume. These changes may be associated with improved cognitive functions including attention, information processing, storage, and retrieval, enhanced coping, enhanced positive affect, reduced sensations of cravings and pain (Trudeau and Shephard 2008, Rosenbaum, Carlson and Gilmore 2001). The above researches support the findings of the present investigation that physical exercise, whether mental or physical would certainly enhance working memory capacity.

CONCLUSION

Agriculture basically involves the cultivation, nurturing and production of crops and livestock products. Agriculture work or farming is in fact substantially physical and laborious in nature. This study is one of a kind to provide empirical evidence that there is a significant effect of doing agriculture work on working memory. India is a land of agriculture; therefore, children should be exposed to agriculture work from a very young age. Working in fields, early in the morning is beneficial to health. Being involved in agriculture field work with others enhances the spirit of team work, co-operation and adjustment. Physical work and disciplined life style performed with dedication, punctuality and honesty would not only improve working memory; but generate the nature of philanthropy and closeness with Mother Nature. In today's age of technological advancement and modernization, people are running away from nature. This study is an eye opener that doing physical works in farms/agriculture fields regularly proves to be highly beneficial to one's cognitive functioning.

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Conflict of Interest

The author declared no conflict of interest.

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