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INFLUENCE OF EARLY RISING ON PERFORMANCE IN TASKS REQUIRING ATTENTION AND MEMORY

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Abstract : Rising early in the morning has been a prescribed discipline of ancient Indian tradition. While there are no scientific studies comparing early rising volitionally versus circumstantially, selected studies on the latter (rising forcefully) have shown negative impact on an individual's peroformance. Hence the present study was undertaken to assess the influence of early rising (during *Brahma-muhurtha*) on tasks requiring attention and the ability to recall. Fifty four normal healthy male volunteers, with ages ranging from 16-22 years from a residential school were selected. They were randomly allocated to two groups (*Brahma-muhurtha* and control). They were assessed on day 1, day 10 and day 20 of the intervention, using a digit letter substitution task and verbal and spatial memory task. The *Brahma-muhurtha* group were asked to rise before 4:30 am in the morning based on the traditional Indian astrological calculations, while the control group were allowed to wake up just before 7 am which was their regular timing for waking. *Brahma-muhurtha* group after 20 days showed a significant improvement in the net scores for digit letter substitution task as well as scores for verbal and spatial memory tasks. The control group also showed an improvement in the memory task but not in the task requiring attentional processes. The present study suggests that rising early in the morning as described in ancient Indian tradition influences the process of attention and can improve the ability to recall.

Key words : *Brahma-muhurtha* early rising memory attention

INTRODUCTION

Circadian rhythm is a roughly 24-hour cycle in the biochemical, physiological or behavioral processes of living beings. The influence of the time of the day on daily activities has been attributed to the circadian rhythm (1). While no scientific basis can be found for specific time to wake up in the morning, the descriptions from ancient Indian literature, suggests *Brahma-muhurtha* (a fixed time early in the morning, based on the traditional Indian astrological calculations) as the time for rising (2). *Vishnu*

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smriti, an ancient Indian text describes Brahma-muhurtha as forty eight minutes before sun rise which is the sacred time to rise in the morning (3). Hence, rising at *Brahma-muhurtha,* individuals are prescribed to engage in doing all focused activities including meditation (4). Also, the time of rising in the morning has been believed to influence an individual's performance across the day (5).

Over generations, it has been a convention for people to get up early in the morning. However, the reasons behind rising early in the morning can be classified as (i) volitional (as a discipline/routine) and / or (ii) circumstantial (present day due to job requirements). While no rigorous documentation has been made to illustrate the influence of rising early in the morning volitionally, studies on the latter suggested adverse effects.

An earlier study reported the relationship between Brazilian airline pilot errors and time of the day (6). It was shown that the risk of errors increased by almost 50% in the early morning relative to the morning period (ratio of 1:1.46). For the period of the afternoon, the ratio was 1:1.04 and for the night, a ratio of was 1:1.05. Hence, the authors speculated that the period of the early morning represented a greater risk of attention problems and fatigue. Another study on twenty-two airline cabin crew members, suggested that early morning work causes a reduction of sleep time and an increase in stress (7). A previous study which compared the early rising and delayed bedtime found that the early rising appeared to be more disturbing than the late bedtime (8).

In contrast to the above mentioned adverse effects of early awakening, a recent study evaluated the cognitive performance of 2030 normal older adults across the day. Since, elderly people have been shown to have cognitive deficits; an attempt was made to evaluate the role of early morning awakening and the ability to remember. The best performance on a task requiring episodic memory was during early morning hours and late afternoon, worst performance occurred in mid-day (9).

It is evident from the above mentioned reports the time of the day in general and early morning in particular has a definite influence on an individuals' performance. But no attempts have been made to understand the impact of rising early in the morning volitionally on performance oriented tasks. Moreover, there are no scientific studies available on the influence of early morning awakening (*Brahma-muhurtha*) on focused attention & concentration as well as a memory task. Hence the present study was designed to evaluate the influence of rising at a particular time of early morning (*Brahma-muhurtha*) on the ability to remember and focus attention in healthy male volunteers.

METHODS

Participants

Fifty four normal healthy male volunteers with ages ranging from 18 to 22 years participated in the study. They were randomly allocated to two groups i.e., Experimental (*Brahma-muhurtha) and Control* with 27 subjects in each group using a random number table (group mean age±SD, 19.07±2.09 years and 20.67±1.27 years respectively). All of them were students of a residential school for spiritual studies. A routine clinical examination showed that they all had normal health. Sleep disorders and allergic to the ambience of the morning weather were pre-set conditions for exclusion from the study. All participants expressed their willingness to participate in the experiment. The study protocol was explained to the subjects and their signed consent was obtained.

Design

Participants were assessed on day 1 (pre-assessment), day 10 (middle-assessment) and day 20 (post-assessment) of the intervention using digit letter substitution task and verbal and spatial memory test. The intervention was supervised by two senior faculty members of the school who also marked their daily attendance. The investigators were not aware of the groups which received the intervention and which was control till the data analysis was over as the data were coded. Hence, it was a single blind Randomized Control Trial.

Assessments

Digit-Letter Substitution Task (DLST)

The digit-letter substitution task comprised of a worksheet on which digits (1 to 9) were arranged randomly in 12 rows and 8 columns (10). An instruction key for "letter-for-digit" substitution was given at the top. Participants were required to make as many letter-for-digit substitutions as possible in 90 seconds. They were asked to choose any of the two possible strategies, i.e., marking all nine digits in the random order they occurred, or selecting any one digit at a time. Also, they were free to follow a horizontal, vertical, or random path according to their choice. The total number of substitutions as well as wrong substitutions was counted. The net scores were calculated by deducting wrong substitutions from the total substitutions attempted. Since the test was repeated thrice, (on day 1, day 10 and day 20), to prevent retest effect three separate sheets were prepared by changing the digit-letter pairs in the key and by randomly changing the sequence of digits in the working section (11).

Verbal and Spatial Memory Test

The verbal and spatial memory tests (12) were conducted by projecting the test material on a screen, allowing 10 sec. for each slide. After the 10 slides were shown, a mathematical problem (e.g., + 8 – 4 + 9 – 3 + 6 – 5 – 7 + 2) was projected. Immediately after this, the subjects were asked to recall and write down (or in the case of spatial memory, to draw) within 60 sec. the 10 test items which were shown to them. For the verbal memory test standard nonsense syllables of three letters, e.g., XOL, were selected from a prepared list (13). Three different sets of 10 nonsense syllables were presented on Day 1, Day 10 and Day 20. The test for spatial memory consisted of 10 simple line drawings. Geometrical or other shapes which cannot be described verbally, e.g., a square or a circle, were not used. As described for verbal memory, there were three separate, similar sets of 10 line drawings used for Day 1, Day 10 and Day 20 to overcome the learning effect due to repeated measurements.

Interventions

The early rising (Brahma-muhurtha) group

The participants were asked to rise at *Brahma-muhurtha*, i.e., before 4:30 am based on traditional Indian astrological calculations (*Jyothishya*) and sleep at 9:00 pm. As described else-where, *Vishnu smriti*, an ancient Indian text describes Brahma-muhurtha as forty eight minutes before sun rise which is the sacred time to rise in the morning (3).

The late rising (control) group

The participants were asked to wake up at 7:00 am and sleep at 11:30 pm. This was decided based on (i) astrological calculations (48 minutes after sunrise) as well as (ii) based on the subjective reports of the time of rising normally (7:00 am) at home before joining the residential school.

Participants were acclimatized for a week to follow the timing of waking and sleeping based on the intervention. Both groups followed this routine for twenty days regularly. There were no differences in the routine activity except their waking and sleeping time. Their classes and other activities were adjusted according to waking time. The early rising group had time for self-study in the morning (i.e., 5:00 am – 7:00 am) whereas late rising group had in the night (i.e., 9:30 pm – 11:30 pm). The total number of hours slept was same (7 hours 30 minutes) for both the groups.

Data analysis

Statistical analysis was done using SPSS (Version 16.0). Repeated measures analysis of variance (RM ANOVA) were performed with one 'within subject's factor' (assessments, i.e., Day 1, Day 10 and Day 20) and one between subjects factor (groups i.e. *Brahma-muhurtha* and control group). The interaction between assessments and groups was also analyzed. This was followed by a *post hoc* analysis with Bonferroni adjustment for multiple comparisons (day1, day 10, and day 20). All comparisons were made with respective day 1 values.

RESULTS

For both digit letter substitution task and verbal and spatial memory tasks, the assessments were made on day 1 (pre-assessment), day 10 (middle-assessment) and day 20 (post-assessment) of the intervention. The group means and standard deviations for scores obtained in the digit-letter substitution task, and the verbal and spatial memory tasks taken on day 1, day 10 and day 20 in both groups (*Brahma-muhurtha* and control) are presented in Table I & Table II respectively.

Digit Letter Substitution Task (DLST)

The repeated measures analysis of variance (RM ANOVA) followed by post hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparisons were made with the respective day 1 values. The RM ANOVA for the net scores showed a significant difference in the within-subjects factor i.e., assessments (day 1, day10 and day 20) [$F=9.557$, $df=(1.812, 94.212)$, hence $P<0.001$], while the between-subjects factor i.e., groups (*Brahma-muhurtha* and Control) and the

TABLE I : Total score, net score and score for wrong substitution in a digital letter substitution task in *Brahma-muhurtha* (Early rising) group and control (Late rising) group recorded on day 1, Day 10 and Day 20. Values are group mean±SD.

Variables	*Brahma-muhurtha Group (Early rising group)*			*Control Group (Late rising group)*		
	Day 1	*Day 10*	*Day 20*	*Day 1*	*Day 10*	*Day 20*
Total Score	56.78±11.76	58.04±10.12	61.52±9.80*	56.70±8.36	56.63±8.91	59.15±7.09
Score for wrong Substitution	1.59±1.58	2.19±1.76	1.96±1.74	1.48±1.48	1.04±1.35	1.15±1.32
Net Score	55.15±10.98	55.96±9.89	59.52±8.98*	55.22±8.31	55.59±8.88	58±6.77

*P<0.05, RMANOVA with Bonferroni adjustment comparing Day 10 and Day 20 values with respective Day1 values.

TABLE II : Scores for verbal and spatial memory tasks in *Bramha-muhurta* group and control group recorded on Day 1, Day 10 and Day 20. Values are group mean±SD.

Variables	*Brahma-muhurtha Group (Early rising group)*			*Control Group (Late rising group)*		
	Day 1	*Day 10*	*Day 20*	*Day 1*	*Day 10*	*Day 20*
Verbal memory	3.67±2.00	4.96±1.89**	6.48±1.60***	3.41±1.62	4.00±1.62	5.52±1.60***
Spatial memory	4.44±1.63	5.82±1.59**	6.07±1.64**	4.11±1.74	5.11±1.25*	5.78±1.39**

*P<0.05, **P<0.01, ***P<0.001; RM ANOVA with Bonferroni adjustment comparing Day 10 and Day 20 values with respective Day1 values.

interaction between the assessments and groups were not significantly different. The post hoc analysis with Bonferroni adjustment for *Brahma-muhurtha* group showed that there was a significant increase in net score (P<0.05) on day 20 as compared day 1 values. The other comparisons with in the group were not significant, while the control group showed no change.

Verbal and Spatial Memory

The repeated measures analysis of variance (RM ANOVA) followed by Post hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparison were made with the respective day 1values. The RM ANOVA showed a significant difference in the within-subjects factor i.e., assessments (day 1, day 10 and day 20) for both verbal [F=51.372, df = (1.908, 99.206), hence P<0.001] as well as spatial memory scores [F=21.670, df = (1.812, 94.230), hence P<0.001]. The between-subjects factor i.e., groups (*Bramha-muhurtha* and Control) and the interaction between the assessments and groups were not significantly different. The post hoc analysis with Bonferroni adjustment for *Brahma-muhurtha* group showed significant increase in verbal memory scores on day 10 (P<0.01) and on day 20 (P<0.001) compared to day 1 values. Similarly, spatial memory scores showed an increase on day 10 (P<0.01) and on day 20 (P<0.01) compared to day 1 values. In control group there was a significant increase in verbal memory scores on day 20 (P<0.001) compared to day 1 values. Whereas, spatial memory scores increased on day 10 (P<0.05) and day 20 (P<0.01) compared to day 1 values.

DISCUSSION

Rising early in the morning (during *Brahma-muhurtha*) for twenty days as a routine has improved the performance in a task requiring attention & concentration. Also, there was a significant improvement in the performance related to verbal and spatial memory task. The control group (which got up after sunrise) showed no change in the digit-letter substitution task, while the ability to recall has improved.

It is evident from the earlier studies that circadian rhythm has a direct influence on the performance of an individual across the day (1). Rising early in the morning though has been a conventional practice over generations, earlier studies suggested diverse effects. While individuals who woke up early in the morning as an inevitable option (due to job requirements) demonstrated adverse effects in their performance (6), two separate studies mentioned below demonstrated enhanced performance in a memory task.

A recent study in an elderly population showed better performance in a memory task in the morning hours (9). Similar results were observed in healthy adults in an earlier study (15). The results of the present study are in line with the observations made in the above mentioned studies, suggesting an improvement in both verbal and spatial memory task in both groups. Hence, it is evident from the present study that irrespective of the time of waking (before or after sunrise), early mornings have been shown to improve an individual's ability to recall. The changes observed (improvement /better performance) in the morning can be attributed to (i) reduced distractibility, (ii) process of memory consolidation following overnight sleep and ready for registering new information and (iii) enhanced ability to recall. As the day progresses combination of factors have been shown to reduce an individual's performance in tasks requiring memory (15).

While the performance in memory improved in both groups, the performance in a task requiring attention improved only in the group which got up before sunrise. Since attentional processes involve different components such as phasic alertness, selective attention and vigilance (sustained attention, concentration), attempts were made to understand the influence of circadian rhythm on these processes. An earlier study in female undergraduate students reported a clear influence of time of the day (morning till night) on different performance oriented tasks requiring attention. The performance was best in the morning and the same deteriorated as the day progressed (14).

The digit-letter substitution task used in the present study involved (i) focused attention (ability to respond discretely to specific stimuli), (ii) sustained attention (ability to maintain a consistent behavioral response during continuous and repetitive activity) and (iii) selective attention (ability to maintain a cognitive set in the face of a distracting or competing stimuli). Hence, changes seen in the net scores in the *Brahma-muhurtha* group can be attributed to complex interplay of physiological mechanisms related to circadian rhythms. While a positive relationship between sympathetic tone and the attentional processes is well understood, (06) another study reported heightened sympathetic tone early in the morning (17). It can be speculated that along with a suitable external environment (of the early morning) for enhancing attentional activities, physiological mechanisms as well might have contributed favorably to produce the positive results seen in the present study.

The group which got up during *Brahma-muhurtha* had done so volitionally as their routine was anyway going to change as the students had just joined a residential school, where they were expected to follow a routine including rising before sunrise. Whereas the group which got up after sunrise continued their regular timing of rising (7 am) which they were used to at their homes before joining the residential school. Hence, the results of the present study indicate the positive influence of early morning awakening as a routine, volitionally.

The two major benefits demonstrated in the present study included an improved attention and aspects of memory. Since memory and attention span plays a major role in academic performance, it will be beneficial to apply the concept of early morning awakening in a student population. It is also speculated that slow learners and children with attention deficit hyperactive disorder can get benefited from such an intervention. In general, early morning awakening has shown to influence higher brain functions, hence it would be a good discipline and a lifestyle modification applicable to larger population including different age groups and gender. However, involving male subjects alone has been a limitation of the present study. It would be useful to conduct further research involving females and individuals belonging to different age groups. Perhaps, a cross sectional study in individuals who habitually get up early in the morning (long term) versus those who get up late would add additional value. Also, understanding the therapeutic benefits of such an intervention would be of great application.

Further studies are required to understand the underlying mechanisms as well as its reproducibility not only in individuals who are early risers, but also in the late owls.

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