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## Effect of examination stress on working memory in first year medical students

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### Abstract

**Background:** Working memory is important for cognitive function and its impairment is related to decrement academic performance of students. Examination stress is a potential stressor of medical students and excess stress may affect cognition. So this study aims to determine the working memory capacity owing to examination stress in medical students.

**Material and Method:** This study was conceived recruiting 72 MBBS students. All subjects were apparently healthy. They were subjected to record the heart rate (HR) and digit span. HR was calculated by examining radial pulse. Digit span included forward digit span (FDS) and backward digit span (BDS). All recordings were estimated in two settings i.e. first just before going to oral examination to see the effect of stress and second after one month of examination they were not having any kind of stress.

**Result:** During the period of stress majority of students working memory capacity was below 7 digits both in FDS and BDS. The mean HR was high during stress than stress free period. The mean digit span during stress was less than the stress free period both in FDS and BDS.

**Conclusion:** Our study suggested that examination stress has negative impact on working memory capacity of MBBS students. Low working memory capacity is related to poor academic performance and impairment of cognition.

**Keywords:** Stress, working memory, digit span, heart rate

### Introduction

Research on working memory in recent era enlightens its importance in academic, professional and social life of everyone<sup>[1]</sup>. Working memory has considered having limited capacity. Measuring of working-memory capacity are strongly related to performance in cognitive tasks like reading comprehension, problem solving etc.<sup>[2]</sup>. Memorizing a phone number, names, hotel room number are examples of working memory. Working memory is necessary to stay focused on a task, blocking out distractions and keeping one updated and aware of things that are going on in the environment<sup>[1]</sup>. Working memory is an ability of a person for storing short-term information, words and meanings<sup>[3]</sup>. Research on working memory measures a student's capacity to acquire knowledge rather than measuring what the student has already learned<sup>[4]</sup>. Acute and chronic stress can impaired working memory was first studied in animal<sup>[5]</sup>. They showed that stress-induced catecholamine release in prefrontal cortex (PFC) rapidly decreases its neuronal firing and impairs working memory performance through feed forward, intracellular signaling pathways<sup>[6]</sup>. Exposure to chronic stress leads to more profound working memory deficits and additional architectural changes in PFC, including dendritic atrophy and spine loss<sup>[7]</sup>. FMRI research has opened the door for working memory research to humans and confirms that reduced working memory caused by acute stress links to reduced activation of the PFC, and stress induced increase levels of catecholamine<sup>[8]</sup>. Imaging studies of medical students undergoing stressful examination have also shown weakened PFC functional connectivity, consistent with the animal studies<sup>[9]</sup>. The more stress in one's life, the lower is efficiency of working memory in performing simple cognitive tasks. Medical students are facing varieties of stress situations and one of the most consistent events examination stress. Medical curriculum is so vast that the cognitive function of brain should be at optimal level to achieve curricular and extracurricular activities at par. Therefore this study was conceived to determine the effect of stress on working memory so that proper advice can be suggested to them develop coping skill as a result their cognitive functions work at optimum.

### Correspondence

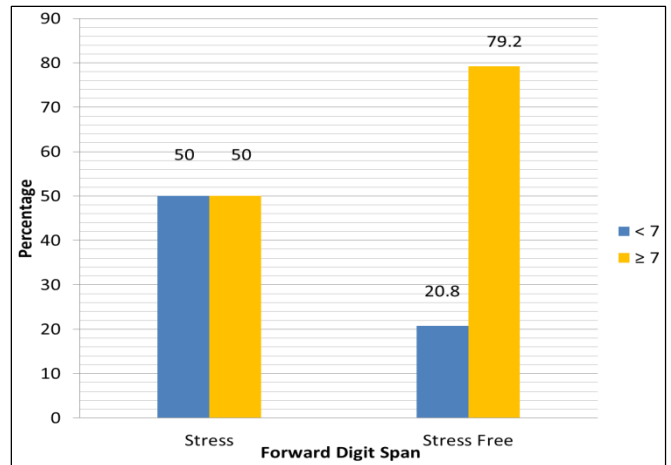
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**Material and Method**

This descriptive cross sectional study was conducted in department of Physiology in collaboration with Neurology in an educational health institute of eastern India. It was accomplished between Jan to March 2019. This study was approved by IEC of the institution. For this study 72 male MBBS students of age 18-20 years were selected. All subjects were apparently healthy, living with regular routine life. Students suffering from any chronic disease or history of taking drugs were excluded from the study. The assessment of working memory was done in room temperature by the tool Digit Span. Digit span is a subset of Wechsler Adult Intelligence Scale–Fourth Edition (WAIS-IV; Wechsler, 2008a) was administered to assess the working memory [10]. Digit span consists of two varieties of tests i.e. forward digit span (FDS) and backward digit span (BDS). To assess digit span, series of digits presented in front of subjects of minimum 2 digits up to 9 digits for FDS and up to 8 digits for BDS. Subjects were instructed to repeat the series of digits both in forward and backward direction i.e. for example the digits presented were 7382 and the forward repeat by the subject in correct form will be 7382 and backward repeat will be 2837. For each subject two trials were done and the highest digits counted were selected for scoring. Scoring was done according to Wechsler manual. Simultaneously the heart rate (HR) of each subject was calculated to correlate because increase HR is an established indicator of acute stress. Radial pulse rate was measured to record the HR of subject. Before recording HR subjects were asked to take rest for 5 min then radial pulse was recorded in sitting position in right hand. As such each subject was assessed in two settings i.e. just before examination which was at Departmental level to observe the effect of stress and in another sitting when there was no examination and one month after examination when the subjects were free from stress. For statistical analysis subjects were classified into Stress (just before examination) and Non stress (Stress free period) group. Statistical analysis was done by statistical software SPSS 16. Statistical test used was paired t test. P value <0.05 was considered to be significant.

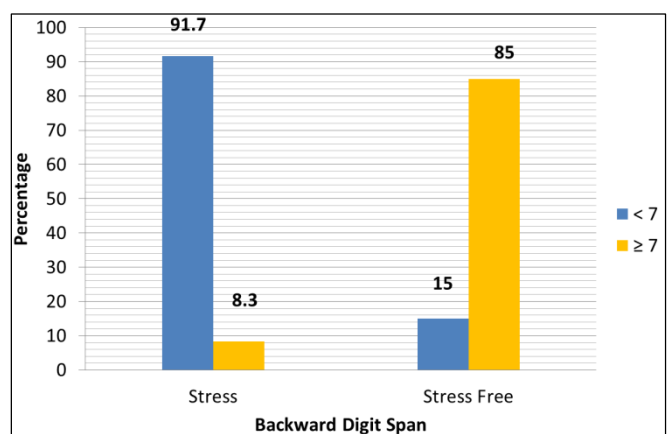
**Result**

This study was carried out among 72 healthy male MBBS students to determine the effect of examination stress on working memory. Fig: 1 depicts the frequency distribution of subjects in forward digit span. During stress 50% of subjects' digit span was less than 7 but when there was no stress only 15% of subjects digit span was less than 7. Fig 2: depicts the frequency distribution of subjects in backward digit span. During stress 91.7% of subjects digit span was less than 7 but when there was no stress 20.8% of subjects digit span was less than 7. Table 1 depicts the mean and standard deviation of HR, forward digit span and backward digit span. In stress condition the HR was 91±3.6 per minute but when there was no stress the HR was 74±6.5 per minute. The forward digit span in stress condition was 6.5±1.1 but when there was no stress it was 7.3±1.1. The backward digit span in stress was 5.7±0.6 but when there was no stress it was 7±0.7.



**Fig 1:** Percentage of Subjects

Percentage of subjects forward digit span with respect to magic number 7



**Fig 2:** Percentage of subjects

Percentage of subjects forward digit span with respect to magic number 7

**Table 1:** Comparison of variables in stress and stress free period

Variable	Stress Mean ± SD	Stress Free Mean ± SD	P
HR	91 ± 3.6	74 ± 6.5	0.000
FDS	6.5 ± 1.1	7.3 ± 1.1	0.018
BDS	5.7 ± 0.6	7 ± 0.7	0.000

HR- Heart Rate, FDS- Forward Digit Span, BDS- Backward Digit Span, SD-Standard Deviation, p<0.05 was considered to be significant

**Discussion**

Examination plays crucial role in the life of a student. Medical student's curriculum is such vast that it's difficult to achieve target [11]. So examination in medical students put a lot of stress on them. A lot of studies have suggested that examination is a potent stress factor for students and so to medical students. At the time of examination, all medical students perceive lot of stress due to course burden as well as they have to perform up to mark in examination [11]. The capacity of working memory has certain limit as suggested

by researchers. In 1956 Princeton cognitive psychologist Dr. George A. Miller suggested that information processing capacity of young adults brain is seven plus minus two despite the elements are digits, letters, words or other. Thus he suggested the magic number seven of working memory capacity<sup>[12]</sup>.

In this study the comparison of HR suggested that during examination the HR is higher than the period when there was no examination. So the HR confirmed that there was stress due to examination. Previous studies suggested that rise in HR is an indicator of stress. During stress the sympathetic nervous system is activated more so that catecholamine release is high leading to elevated HR<sup>[13, 14]</sup>. Our study observed that the minimum and maximum digit in FDS was 5 and 9 respectively. Likely the minimum and maximum digit in BDS was 5 and 8 respectively. The frequency distribution of subjects suggested that during stress the no of subjects whose digit span less than 7 were more in number both in forward and backward direction. The mean digit span in stress condition was low than non-stress condition. So our study suggested that there is definitely effect of examination stress on working memory. The stress decreases the capacity of working memory. Richard S.L. *et al.* in their research of examination stress suggested that forward digit span was not affected but backward digit span was increased<sup>[15]</sup>. Our study contradicted to their study i.e. both forward and backward digit span was decreased due to examination stress. Similar result was suggested by the study Klein and Boals in which working memory capacity was decreased owing to stress<sup>[16]</sup>. Other researchers Vedhara *et al.* and Kuhlmann *et al.* in separate studies reported that there was no change in working memory owing to stress<sup>[17, 18]</sup>. Another researchers Elzinga & Roelofs in their study suggested that the FDS was low owing to stress<sup>[19]</sup>. Study suggested that stress-induced catecholamine release in prefrontal cortex (PFC) rapidly decreases its neuronal firing and impairs working memory performance through feed forward, intracellular signaling pathways<sup>[6]</sup>. In stress the cortisol secretion increases. Slight increase in cortisol may be associated with facilitation of working memory capacity but higher level of cortisol may be associated with decreasing the capacity of working memory<sup>[15]</sup>.

Evidence based data suggested that working memory capacity links to the neural ability to focus attention on task relevant information and to ignore distractions<sup>[20]</sup>. Increasing in task related focused attention is helpful in practice related improvement in working memory<sup>[21]</sup>. Study suggested that working memory capacity is associated with controlling the orientation to different types of stimuli in the environment facing every day<sup>[22]</sup>. Various studies have suggested that one in ten students in class room study have deficit of working memory. Academic performance of majority of them is very poor independent of their IQ status<sup>[23]</sup>. Working memory links to cognition aspect of brain. Thus working memory deficit or impairment is associated with low academic achievements for students<sup>[24]</sup>.

### Conclusion

Examination is an acute stressor which can impair working memory. Working memory assessment suggests the cognition status of a person. This study suggested that during examination the working memory may impaired

which may have negative impact on academic achievement of students. Therefore stress management techniques may be suggested for better coping skill of MBBS students.

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