Original Article

www.ijrhs.com
ISSN (o):2321–7251

Effect of exam stress on reaction time in medical students

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Submission Date: 24-11-2014 Acceptance Date: 01-12-2014

How to cite this article:
Vancouver/ICMJE Style
Wadikar SS, Muley PA, Muley PP. Effect of exam stress on reaction time in medical students. Int J Res Health Sci [Internet]. 2015;3(1):24-8. Available from http://www.ijrhs.com/issues.php?val=Volume3&iss=Issue1
Harvard style
Wadikar, S.S., Muley, P.A., Muley, P.P. Effect of exam stress on reaction time in medical students. *Int J Res Health Sci*. [Online] 3(1). p.24-8 Available from: http://www.ijrhs.com/issues.php?val=Volume3&iss=Issue1

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Abstract:

Introduction: Stress is an adaptive response of organism towards a noxious or threatening condition. Exam stress is a common condition faced by students and is quite predominant among medical students. Reaction time is an index of sensory- motor performance. The study was conducted to assess the impact of stress on reaction time in medical students prior to examination. Choice reaction time was used to evaluate the cognitive performance of students. Exam stress acts as an acute stressor and is known to affect the cognitive functions. **Materials and methods**: The study was conducted on 60 healthy second MBBS students between the age group of 18 and 20 years, at Topiwala National Medical College. In this study, digital reaction time apparatus, manufactured by Bio-Tech., with the maximum time resolution of 0.0001 seconds, was used. Randomly occurring visual and auditory choice reaction time tasks were presented to the students. After adequate training, three sets of recordings were taken. First set during stress free period, and the second & third sets were taken 20 minutes before the first terminal and second terminal practical examination respectively. **Results**: - The readings were analysed by paired student "t" test and results showed that the exam stress prolonged both visual and auditory reaction time. **Conclusion**: - The study shows that exam stress affects the performance in medical students.

Key words: Choice Reaction Time, Cognitive, Medical Students, Prefrontal Cortex, Stress.

Introduction:

Stress primarily signifies condition of disturbed normal functioning due to imbalance between individual's interactions with the environment. Stress is an adaptive response to noxious stimulus causing imbalance or disturbance in normal functioning. Stress is a structured series of physiological, neurohormonal and psychological efforts of adaptation towards any real and anticipated situations that threatens or disturbs homeostatic balance of the body and that require some kind of adjustments [1, 2].

Academic stress is an inevitable feature of students' life where periodic exams become an acute stressful experience for them. During exams, students

are exposed not only to the real stress of exam itself but also to the perceived stress of the fear of failure or low scores due to high level of competition. Exam stress can literally paralyze a student from performing during an exam.

Exam stress is quite predominant among medical students. Various studies conducted among medical students have reported prevalence of stress ranging from 27-73% [3, 4]. The medical students probably face a major stress especially during practical examination especially when they have to present a case in front of the examiners. This study was conducted on second year M.B.B.S students, when they get exposed to clinical training on patients for the first time in their career. This transition from pre-clinical to clinical training has been identified as a crucial stage of medical school regarding student stress [3]. In addition to that inordinate hours, sleep deprivation, excessive workload, helplessness, increased psychological pressure, mental tension, inadequate support from allied health professionals adds to the stress of medical students. Furthermore, stress in medical students can affect the physical and psychological well-being of medical students and break the stability (homeostasis) of the student's health and move students from being healthy to being sick.

Reaction time is an index of sensory motor performance. It is an indicator of biological efficiency of central nervous system. Reaction time is the interval between the application of the stimulus and appearance of voluntary response. The study was conducted to assess the impact of exam stress on choice reaction time in medical students.

Materials and Methods

Study population:

The study was conducted on 60 healthy second MBBS students (boys & girls) between the age group of 18 and 20 years, selected randomly by simple random sampling technique, at Topiwala National Medical College, Mumbai. The subjects who were suffering from color blindness, hearing impairedness and sensory-motor disability were excluded from the study. Informed consent was taken from all the subjects. The study was approved by Institutional Ethics Committee of Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai

Material:

Digital reaction time apparatus manufactured by Bio-Tech (INDIA), Mumbai, which has got maximum resolution time of 0.0001 seconds was used in this study.

Methods:

In this study a choice reaction time in the form of visual (red and green lights) and auditory signals (high & low frequency sounds) were used. The examiner sat with master (primary) controls and subject sat on other side with secondary controls. The two were separated with the help of opaque partition in order to avoid seeing which switch the examiner pressed.

Once the unit was switched on, the examiner presented either visual (red or green lights) or auditory signals (high & low frequency sounds) to the subject at random. The subject immediately responded by pressing the corresponding switch on his side. The time duration between the application of stimulus by examiner and the response from the subject was the reaction time, which was recorded on reaction time apparatus in seconds. Four such test recordings were done after two to three practice sessions. The averages of these recordings were taken as final record for each subject. First set of recordings was taken in 'stress free' condition that is during the exam free period two months before the first terminal examination and the second & third sets of recordings were taken 20 minutes before the first terminal and second terminal practical examination respectively. Statistical analysis was done with the help of paired "t" test.

Table 1: Effect of exam stress on reaction time during 1st terminal exam

	STRESS FREE PERIOD	IST TERMINAL EXAM	T-TEST
VRT RED SIGNAL	0.2632 ± 0.062	0.3321 ± 0.098	***
VRT GREEN SIGNAL	0.2493 ± 0.059	0.3118 ± 0.113	**
ART HIGH FREQUENCY SOUND	0.3695 ± 0.066	0.4712 ± 0.102	***
ART LOW FREQUENCY SOUND	0.3708 ± 0.074	0.5206 ± 0.109	***

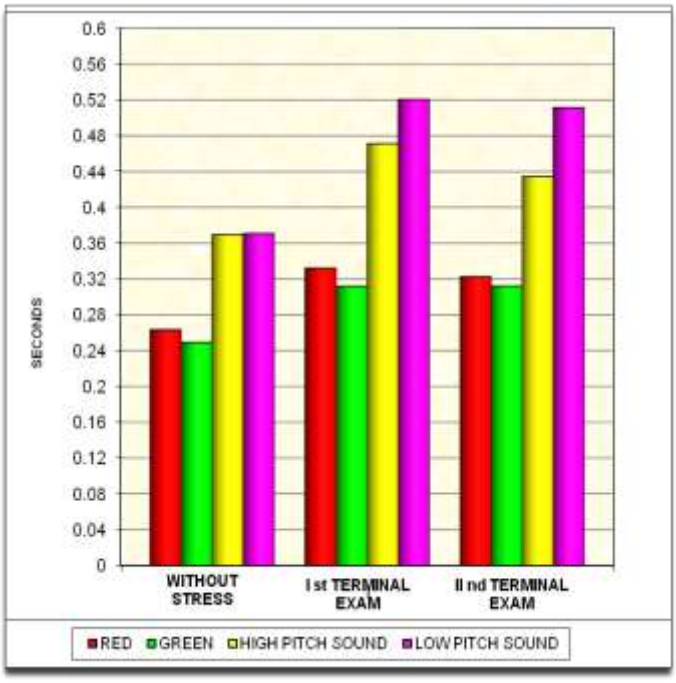
Table 2: Effect of exam stress on reaction time during 2nd terminal exam

	STRESS FREE PERIOD	II ND TEMINAL EXAM	T-TEST
VRT RED SIGNAL	0.2632 ± 0.062	0.3226 ± 0.077	***
VRT GREEN SIGNAL	0.2493 ± 0.059	0.3121 ± 0.086	***
ART HIGH FREQUENCY SOUND	0.3695 ± 0.066	0.4343 ± 0.095	**
ART LOW FREQUENCY SOUND	0.3708 ± 0.074	0.5115 ± 0.149	***

Values are given with ± standard deviation (SD)
** Significant at 0.01, *** Significant at 0.001

VRT: Visual reaction time; ART: Auditory reaction time. Reaction time given in table is in seconds.

Figure 1: Effect of exam stress on reaction time (visual & auditory)



Results

The table (Table no 1 and 2) shows that visual (Red & green) and auditory (high & low frequency sound) reaction time were significantly prolonged when the students were exposed to examination stress (Ist Terminal and IInd terminal examination) as compared to stress free condition. The difference in the readings during stress free & exam stress condition were statistically significant.

Discussion:

The aim of the present study was to observe the effect of exam stress on choice reaction time in medical students. It was observed that choice reaction time increased significantly when the students were exposed to exam stress as compared to stress free condition.

Reaction time is defined as an interval of time between presentation of stimulus and appearance of appropriate voluntary response in a subject [5].

Luce & Welford described reaction time as [5-8]:

Simple reaction time: In simple reaction time tasks only one stimulus is presented which commands a single response [9].

Choice reaction time: In choice reaction time tasks, several stimuli are presented at random and the subject is required to respond correspondingly to the presented stimulus; the response being specific to the particular stimulus e.g. Pressing a key in response to the appearance of a particular light on screen. In choice reaction tasks the subject has to discriminate between various stimuli and make a choice amongst responses [9].In this study we have used the choice reaction time (CRT), where we presented either with visual (red or green lights) or auditory signals (high or low frequency sounds) to the subject at random. Now, the subject immediately responds by pressing the corresponding switch on his side.

The time to react in a situation in which any one of several signals may occur, (Choice reaction time) include following processes:

Mental Processing time: time required by subject to perceive stimulus, identify, analyze and decide proper motor response. It consists of:

a) Reception of the signal by a sense organ and conveyance of data by afferent nerves to the brain;
b) Identification of the signal;
c) Choice of the corresponding response;

Movement Time: time required to perform the movement after selection of response.

d) Initiation of the action that constitutes the response [5, 8].

Thus, CRT is a complicated process which involves recognition, discrimination, and analysis of stimulus and decision making for appropriate response selection. Reaction time (RT) performance is widely used in cognitive neuroscience research as a measure of information processing speed [10]. Cognitive function refers to an individual's ability to think and reason in terms of temporal and spatial relationships and in symbols such as words and number. Simple Reaction Time test is usually considered a psychomotor test which refers to an individual's ability to co-ordinate timely and appropriately respond to a stimulus but if the stimuli are complex and require decisions about how to respond (CRT) then the test becomes more cognitive [9].

The five essential cognitive functions of the human brain are attention, perception, memory, intelligence, and language. Pre-frontal Cortex (PFC) is involved in analysis and processing of information, planning, decision making, and executive attention. The executive functions of the prefrontal cortex are components or combinations of those five cognitive functions to serve the goal-directed action .Working memory and preparatory set are the critical components of executive attention in PFC [11]. Working memory (WM) plays an important role in higher cognitive processes including reasoning, planning and problem solving [12].Working memory (WM) may be defined as the retention and/or manipulation of to-be-remembered information over brief time intervals [12]. Preparatory set is the priming of sensory and motor neural structures for the performance of an act contingent on a prior event [11]. Studies indicate that the PFC is a vital neural substrate for WM functions [12,13]. During preparatory states, the PFC is important for biasing higher order brain regions that are going to be engaged in the upcoming task. Thus, the role of the PFC is to coordinate cognitive functions and neural structures in the formation of coherent behavioral sequences toward the attainment of goals [11].

The exam stress is a known acute stressor. Various studies show that, acute stress selectively and reversibly disrupts human PFC functioning [12] & can modify cognitive functions in humans [14], including PFC based WM systems [15,16].

Medical education renders significant amount of stress to the students. Medical students go through not only the stress due to medical education but also routine everyday life stressor which explains the level of severe stress noted among medical students [3]. In our study, exam factor acts as an acute stressor to the students. The results of our study shows that the reaction time (both visual RT and auditory RT) increased significantly when students were exposed to exam stress as compared to that of stress free condition. The results show that exam stress affects the cognitive functions of students.

Stress causes excitation of the hypothalamic–pituitary–adrenal (HPA) axis and secretes cortisol which exerts a profound influence over PFC structure and functioning. The high level of cortisol also appears to disinhibit HPA activation thus increasing sympathetic nervous system activity. Excessive PFC glucocorticoid and catecholamines may lead to a "hyperdopaminergic" response [12,17]. These neurochemical changes impairs PFC signaling and neurotransmission during periods of stress and may compromise PFC functions, thus affecting cognition and behavior [12,18].

Thus, the exam stress affects the cognitive functions which resulted in prolonged reaction time during exam period. This necessitates intervention measures that need to be introduced, so that students can learn to cope with the pressure induced by medical education. Interaction and counseling between students and faculties should be encouraged so that the signs of stress can be detected and addressed at the earliest. Recreation facilities should be provided within the campus for the students and also leisure activities help reduce stress among students. Relaxing exercises, yoga and meditation can be advised to relieve exam stress among medical students.

Conclusion

- Exam stress acts as a naturalistic acute stressor, which affects cognitive performance of the students.
- In this study, exam stress prolongs both visual & auditory reaction time as compared to stress free condition.
- Counseling and relaxation therapy like yoga can be advised to counter exam stress.

Source of Funding: Nil
Conflicts of Interest: Nil

Acknowledgement:

We are thankful to the staff of Department of Physiology of Topiwala National Medical College & B.Y.L.Nair Ch.Hospital for helping us in conducting this study smoothly.

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors/editors/publishers

of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

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Abbreviations:

ART- Auditory Reaction time
CRT- Choice Reaction time
HPA axis- hypothalamic–pituitary–adrenal axis
PFC – Prefrontal Cortex
RT – Reaction time
VRT- Visual Reaction time
WM – Working memory