

Evaluation of Auditory and Visual Reaction Time during Examination Stress in Medical Students

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Abstract

Background: Medical students always face examination stress due to vast syllabus and newer research knowledge which they have to gain. Stress affects the body systems in many ways, causing various systemic effects including processing in central nervous system (CNS). Evaluation of cognitive functioning which requires higher CNS processing is unavoidable part of any professional exam. Thus exam stress might be also affecting cognitive functioning of the students. **Aims and Objective:** Present study was carried out to find effect of examination stress on cognitive functioning by measuring auditory reaction time (ART) and visual reaction time (VRT) in first year medical students. **Materials and Methods:** Study included 199 healthy male and female first year medical students. ART and VRT were recorded just after their admission (Stress free condition) and before their terminal and preliminary exam (Under exam stress condition). These two exams were taken at the interval of four months each after their admission. Test was done with portable, electrically driven and latest model of Research Reaction Timer with two response choices. **Statistical analysis:** Data was analyzed by applying Friedman repeated ANOVA test. The outcomes were presented as a mean (SD) and mean difference of less than 0.05 was considered as significant. **Results:** Study found significant improvement (decrease) in ART and VRT when compared between stress free and under stress condition before terminal exam. Significant improvement was also seen before prelim exam and between the terminal and prelim exam. **Conclusion:** Exam stress affects the ART and VRT. Decrease in both the reaction times in our study suggests that the exam stress improves cognitive functioning of first year medical students measured by ART and VRT. It could be due to stress induced changes in endocrine system and CNS processing. More elaborative study is required to find out endocrine and neurological mechanisms behind it. **Key words:** Medical students, Examination stress, Cognitive function, Reaction time, Endocrine system, Nervous system processing

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I. Introduction:-

“Stress” is the most common companion in our day to day activity. Stress is a word used to describe experiences that are challenging emotionally, physiologically as it arouses anxiety and fear. Anxiety can be defined as an emotion characterized by feelings of anticipated dangers, tension, and distress by tendencies to avoid or escape.^[1] People try to avoid the stress but it is not always possible for example student cannot achieve their educational goal without facing examination stress. In professional colleges, student especially medical students face many forms of stresses as per their age and stages of academic years,^[2,3] that may be one of reason for including activities for stress handling in new medical curriculum by national medical commission. The first year medical students face a major academic challenge and mental stress due to dramatic change in syllabus and teaching methods as compared to their school education years.^[4,5] Students react to the new situation in a variety of ways, for some students stress is due to emotional factors but majority of them faces stress due to vast syllabus, fear of future and examinations which means majority of stressful factors are related to medical training rather than to personal problems.^[4,5,6] Sometimes these stressors can lead to decrease self-esteem and concentration, errors in judgments, increase anxiety which may lead to depression and suicidal tendencies in severe cases.^[7]

In situations where we cannot avoid the stress, we learn techniques to cope with it. According to Stanford psychologist embracing stress is more important than reducing stress and their research showed that the stress make us smarter, stronger and happier if we learn how to open our minds to it.^[8] Medical experts also stated that occasional stress can help us to keep focused and improve our recall, which can be a plus point when

cramming for a test or preparing for an important presentation at work.^[9] Some experts believe that the stress is necessary for learning.^[10] All these studies showed that the stress is not always a notorious response.

Reaction time is the time interval between application of a sensory stimulus and appearance of appropriate voluntary response thus the auditory reaction time (ART) and visual reaction time (VRT) is time interval between applications of respective stimuli and obtaining the appropriate voluntary response as quickly as possible in a subject.^[11] The response being voluntary in nature, primarily governed by ability to concentrate, sensory pathways and motor pathways.^[11, 12] Research has shown that reaction time study can be used as tool to identify central nervous system involvement in hypothyroidism.^[13] Simple non invasive technique of measuring ART and VRT can be used to evaluate functioning of sensory motor association and its speed of processing.^[11, 12]

Research has shown the relation between reaction time (RT) and some form of stress. ART and VRT were significantly increased in hypothyroidism.^[13, 14] Simple chanting of mantra reduces ART, VRT and biomarkers of stress.^[15] RT was found to be shorter in students with high performance in their academic career.^[16] In females prolongation of ART and VRT was observed in physiological situations such as premenstrual phase and luteal phase of menstrual cycle.^[17, 18] Even physiological stress such as pregnancy tends to alter the VRT.^[19]

In our search we found very few studies regarding the effect of examination stress on RT in medical students. Hence the present study was planned to evaluate ART and VRT in first year medical students during examination stress. The study will evaluate the central and peripheral processing of nervous system in these students. Study will be also helpful for students and policy makers of medical colleges to decide the plans of actions in future curriculum.

II. Materials And Methods:

Present study was conducted in one of the biggest medical institute's Physiology department in Mumbai. Study was approved by the institutional ethical committee and written informed consent of participants was taken. Our study was consisted of 200 first year medical volunteer students of age 17 to 20 years. Out of 200 participants, 137 were males and 63 were females. Detail history, general and systemic examination of each participant was done so as to select them as study subjects. One male student left the course hence study was completed with 199 participants (136 males and 63 females). Fortunately throughout our study duration, all the participants were healthy and without any central or peripheral nervous system disorder which may interfere with study. This was confirmed by taking detail history along with general and systemic examination of participants at each stage of study duration. Special attention was given for to history and examination of auditory system, visual system and cognitive functioning of the subjects.

Instrument used for study was portable, electrically driven and latest model of Research Reaction Timer with two response choices manufactured by Anand Agencies Pune. It was suitable for measuring visual reaction time (VRT) and auditory reaction time (ART). Subjects were asked to report for recording the readings after having enough prior night sleep and light breakfast in morning. Participants were properly instructed for doing tests and readings were taken in strictly quite environment with subject and examiner sitting in comfortable position on two sides of the instrument.

Auditory and Visual reaction time: -

Once unit was switched on, examiner presented either with visual (red or green light) or auditory signals (high or low pitch sound) to the subject at random. The subject was asked to immediately respond by pressing corresponding switch on his side. Time duration between application of stimulus by examiner and response from subject was recorded in secondson apparatus. Readings were taken as ART or VRT as per the type of stimulus. Average of three readings was taken as final reading of each subject after two to three practice sessions.^[11]

Readings of ART and VRT were taken three times in a academic year during our study. First readings of the participants were taken just few days after their admission in medical college. These first readings were considered as basal or exam stress free readings. Second and third sets of readings were taken before their terminal and preliminary examinations. Subject's terminal examination was conducted after four months of their admission and preliminary examination was conducted after four months of their terminal exam. Second and third sets of readings were taken four days prior to exam so as to get maximum co-operation from our study subjects. These sets of readings were considered as readings under the exam stress.

STATISTICAL ANALYSIS:

Data analysis was done by using SPSS version 16.0 (SPSS Inc. Chicago, USA) software. Friedman repeated ANOVA test was applied to compare ART and VRT readings of study subjects taken during exam

stress free condition and two exam stress conditions. The outcome of analysis was presented as a mean (SD). The mean difference of less than 0.05 was considered as significant.

III. Results:

Table No 1 shows the descriptive statistical analysis of auditory reaction time (ART) and visual reaction time (VRT) taken just after admission (Exam stress free condition) and just before terminal and preliminary examination (Under exam stress conditions). Analysis was expressed in term of mean value and std. Deviation.

TABLE 1: Descriptive statistic of ART and VRT just after admission, before terminal and before preliminary examination

Test	When taken	Mean	Std. Deviation	N
ART	1. Just after Admission	0.17095	0.17095	199
	2. Just before Terminal exam	0.15529	0.15529	199
	3. Just before Preliminary exam	0.14202	0.14202	199
VRT	1. Just after Admission	0.19853	0.19853	199
	2. Just before Terminal exam	0.17985	0.17985	199
	3. Just before Preliminary exam	0.16654	0.16654	199

Table shows decreasing mean values of the test results when compared between just after admission to just before terminal and prelim exam for both the ART and VRT readings.

Table No 2 shows the statistical analysis for pair wise comparison of ART and VRT readings taken just after admission (1), just before terminal (2) and just before preliminary (3) exam. Analysis was expressed in terms of mean difference, std. Error and significance.

TABLE 2: Statistical analysis showing pair wise comparison of ART and VRT

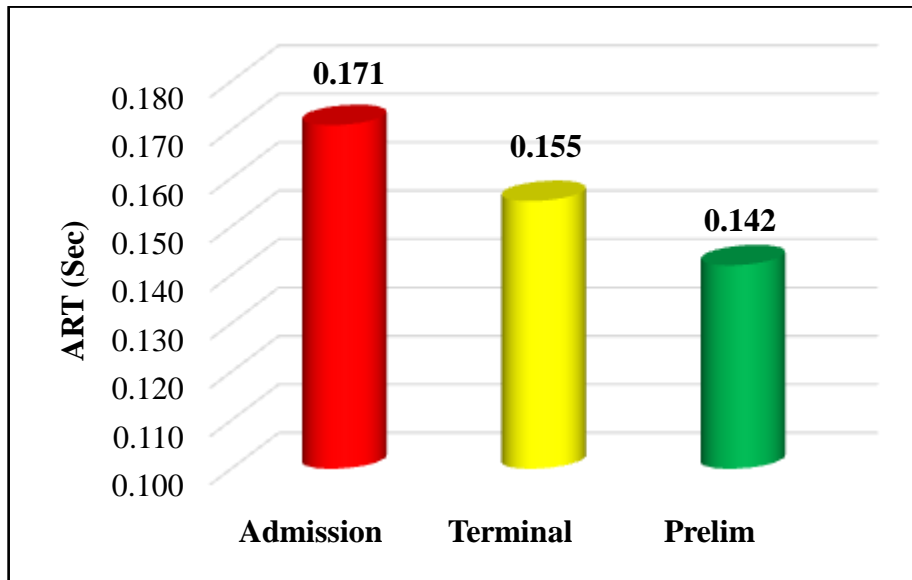
Measure			Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
ART	1	2	.016*	0.002	0.000	0.011	0.020
		3	.029*	0.002	0.000	0.024	0.034
	2	1	-.016*	0.002	0.000	-0.020	-0.011
		3	.013*	0.002	0.000	0.009	0.018
	3	1	-.029*	0.002	0.000	-0.034	-0.024
		2	-.013*	0.002	0.000	-0.018	-0.009
VRT	1	2	.019*	0.002	0.000	0.015	0.023
		3	.032*	0.002	0.000	0.028	0.036
	2	1	-.019*	0.002	0.000	-0.023	-0.015
		3	.013*	0.002	0.000	0.009	0.017
	3	1	-.032*	0.002	0.000	-0.036	-0.028
		2	-.013*	0.002	0.000	-0.017	-0.009

* The mean difference is significant at the 0.05 level

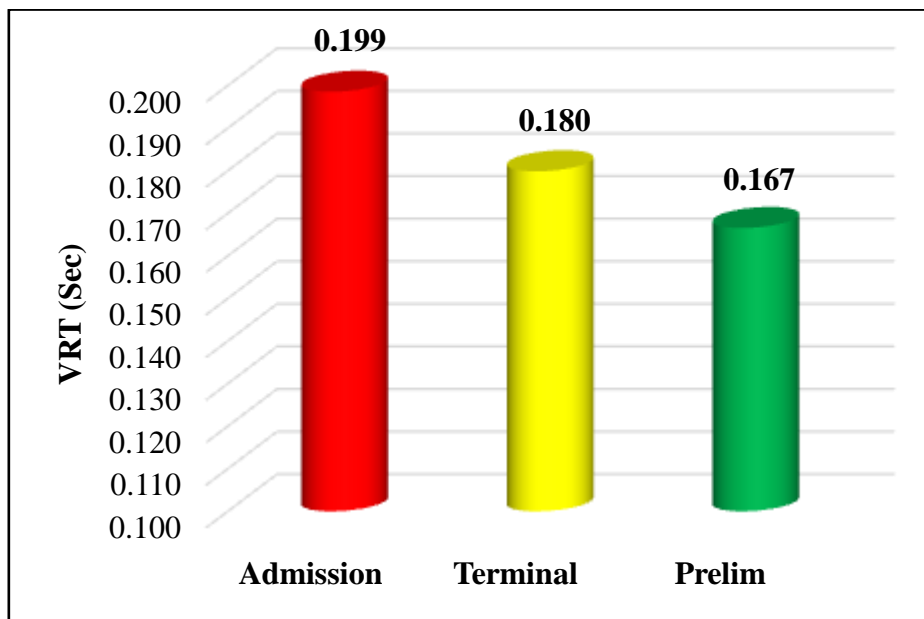
Table shows the statistically significant difference between values of ART and VRT taken during three times as per study protocol. It means both the reaction times (ART and VRT) were improved. Perhaps both the ART and VRT were more improved before prelim than terminal exam as compared to admission readings.

Graph No. 1 and 2 shows mean ART and VRT values respectively taken at the time, just after admission, before terminal and before preliminary examination.

Graph No. 1: Comparison of mean ART at admission, terminal and preliminary exam



Graph No. 2: Comparison of mean VRT at admission, terminal and preliminary exam



IV. Discussion:-

Present study was undertaken to evaluate the effect of examination stress on auditory reaction time (ART) and visual reaction time (VRT) in first year medical students. Study was initiated on the fact that various forms of stresses [13, 14, 16, 17, 18, 19] and decreasing the stress [15] alters ART and VRT. Our study examines the effect of examination stress on these reaction times in first year medical students. Vast syllabus and requirement of knowledge updates keep medical students under stress throughout their professional college life.^[1, 2, 3] Studies have shown the evidence that academic assessment is associated with psychological distress among students of medical education.^[20, 21] We select the first year medical students as a study population who are exposed to medical exam stress for the first time after their school days. This population of students enables us to compare their reaction time before and after exposed to medical examination stress. We have also compared ART and VRT readings during two different examinations in the period of their first year so as to see the effect of examination stress on these reaction times.

Information processing tested in the form of various reaction times is negatively associated with weight, body mass index or adiposity of young healthy adults.^[22, 23] Therefore we have not divided our population on the basis of anthropometry. More intelligent people have slight tendency to show the faster reaction time^[24] and showed more speed for tests requiring more complex responses.^[25] Being in one of the topmost institutes in state, there was a very little difference in intelligence in terms of their entrance exam score among our study population. Good level of emotional intelligence has been observed in males and females of the medical colleges.^[26] Exploratory study on emotional intelligence of medical students has shown that aggregated emotional intelligence scores remains stable during medical training.^[27] Hence emotional intelligence is also not a confounding factor for the study.

A cognitive process includes sensation, perception, decision-making, attention, memory and the use of sensory information to control movement.^[28] Large scale cognitive information is processed by functional units (tripartite synapses) connected by gap junctions that link distributed astrocytes.^[29] Cognition is one of the important domains of learning; structure of cognitive process dimension of the revised taxonomy included many added features.^[30, 31] Evaluation of cognitive skill of students is integral part of their examination process.^[30] Reaction time provides assessments of motor and mental response speeds, as well as measures of movement time, reaction time, response accuracy and impulsivity.^[32] Studies have shown that the measurement of reaction time can reflect or predict more accurately the cognitive functioning of subjects.^[13, 33, 34] Thus we decided to measure ART and VRT as a study tool to measure cognitive functioning of first year medical students and to evaluate effect of examination stress on it.

Our study shows statistically significant decrease in ART and VRT when compared between values recorded just after their admissions and values before terminal and preliminary examination. Significant decrease was also observed between the readings taken before the terminal and before the prelim exams. This particular finding suggests that improvement in reaction times occurs as students are exposed to next successive examination. Measuring ART and VRT is one the assessment tool for measuring cognitive function in subjects so in turn study findings also suggest the positive role of examination stress for increasing cognitive functioning of first year medical students.

Exact causes for our study results are difficult to explain but many studies have shown the improvement of performance in stress due to some endocrine and / or neurological mechanisms. Hypothalamic-pituitary-adrenocortical (HPA) axis activates sympathetic system when psychological stress increases release of glucocorticoid and this leads to changes in cardio respiratory parameters and reaction time positively.^[35] Enhanced dual task under psychosocial stress was said to be due to increased processing efficiency via modulatory effects of stress (glucocorticoids) on dopamine neurotransmission.^[36] In central stress responses corticosteroids exerts non-genomic effects on the excitability and activation of neurons in the hypothalamus, hippocampus, amygdala and prefrontal cortex.^[37] Psycho-neurological study has shown that the mild stress improves motor action execution and hence the responses speed of a selective attention task.^[38] Animal study in rats has suggested the involvement of substance corticotropin releasing factor (CRF) for enhance attention in moderate stress.^[39] Stress, within a limit facilitates positive feedback to central nervous system processing of information and decreases the reaction time.^[40] Levels of anxiety and salivary cortisol were significantly correlated with levels of stress but no significant effect of stress was seen on performance.^[41] Stress is necessary sometime to make the students smarter and stronger.^[8, 9]

Cognitive function of first year medical students gets hampered by exam as a stressor, so counseling of students should be initiated to decrease stress.^[42] Changes in the vital parameters of medical students due to powerful stressors like academics and examinations affect their performance.^[43] Mental stress adversely affects the cognitive function and hence the reaction time.^[44] All these studies have shown the adverse effect of examination stress on response time and hence counseling and stress relaxation methods should be implemented to improve the performance. Simple chanting of mantras has shown the improvement in autonomic and cognitive functioning.^[15] Being one of the biggest medical institute we have adequate and co-operative staff, enough space, best administrative and curriculum managing body. With the help of all these resources we routinely include stress relaxation sessions, extracurricular activities and counseling program like mentoring in our yearly plans. This might have gave better stress handling capacity to our study subjects and reflected as improved ART and VRT (Cognitive function) during exam stress as our study results.

While our study we have not analyzed other tests for knowing the cognitive function of students such as Mini-Mental Status Exam or Montreal Cognitive Assessment etc. We have also not analyzed the role of other stress inducing factors or effect of levels of stress, comparing reaction times in male and female subjects, comparing their academic output with reaction time and so on, but this information poses some questions for future research in evaluating the effect of stress on cognitive function. Other limitation of the present study was in its design; this was a small group study which was carried out in single institute. A larger sample size from multiple institutes and a longitudinal study will definitely be of a great value in predicting the effect of stress on cognitive functioning assessed by measuring reaction time.

V. Conclusion:-

Present study is based on premise that exam stress affects the ART and VRT and thus cognitive functioning in medical students. This study find significant decrease in both the ART and VRT when compared between readings taken at just after the admission (exam stress free condition) and before the first terminal exam (First exam stress condition). Significant decrease is also noted when compared between exam stress free condition and before the preliminary examinations (Second exam stress condition) and when compared between first and second exam stress condition. Our study results conclude that the continuous exam stress improves the reaction time (ART and VRT) in first year medical students which is indicator of improved cognitive functioning. Exact causes for the results are difficult to explore but there is possible role of glucocorticoids secreted during stress which improves processing in central nervous system. Non genomic action of glucocorticoids and suggested role of CRF may be also responsible for the results of study. Lastly the counseling and stress relaxation techniques may also be having the role in improvement of central processing. Present study concludes that examination stress improves the auditory and visual reaction time in first year medical students. More elaborative study is needed to evaluate the effect of stress on cognitive functioning of medical students and endocrine / neurological mechanisms behind it.

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