



EFFECT OF EXAM STRESS ON 4-CHOICE VISUAL REACTION TIME AMONG SECOND-YEAR MEDICAL STUDENTS.

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ABSTRACT

Background: Reaction time (RT) is the interval between presentation of a stimulus and initiation of the response. In simple reaction time, a single response to a single stimulus is obtained, whereas in choice reaction time, there are multiple stimuli and multiple responses. Several factors have been shown to affect reaction time, such as age, gender, physical fitness or stress. The present study aims to evaluate the effect of examination stress. **Aim:** To study the effect of exam stress on 4-choice visual reaction time among second-year medical students. **Methodology:** The study was conducted on 15 Second-year male MBBS students aged 18 - 22 years. The reaction time tests were done using Deary Liewald Reaction Time Software version 310. After a practice trial, three test recordings of visual reaction time were noted, and best of 3 was taken for statistical analysis. Two sets of recordings were taken –

1. 2 hours before terminal practical examination
2. During a stress-free period

Results: The readings were analysed using Wilcoxon signed-rank test. The results show that exam stress prolongs choice visual reaction time.

Conclusion: The study shows that exam stress affects the psychomotor performance of medical students.

KEYWORDS : Exam Stress, Reaction Time, Choice Visual Reaction Time.

INTRODUCTION

A reaction is a voluntary response to an external stimulus. There is a specific time interval between the presentation of the stimulus and the onset of the motor response.^[1] Reaction time is the interval between the presentation of a stimulus and the initiation of the response^[2]. It is considered an index of psychomotor performance and is expressed in milliseconds.

Many factors that have been shown to affect reaction time. Some of them are age, gender, physical fitness, distraction, level of fatigue and stress.^[3] Reaction time is also affected by whether the stimulus is auditory or visual, as different sensory modalities are processed at different speeds in the brain.^[4] With practice, reaction time decreases and responses become faster, likely as a result of learning and memory processes that enhance efficiency.^[5] Prolonged reaction time indicates decreased performance. Three fundamental reaction time experiments have been identified – simple, recognition and choice reaction time experiments^[6,7].

In simple reaction time experiments, a single stimulus is presented at a time, and the participant is required to make one predetermined response. Examples include pressing a button when a light appears or releasing a key when a sound is heard. These tasks are designed to measure the speed of responding to a single stimulus.

In recognition reaction time experiments, participants are presented with a series of stimuli that include both target stimuli (the memory set) and non-target stimuli (the distractor set). They are required to respond only when a target stimulus appears and withhold their response to distractors, resulting in a single correct response. Examples include pressing a button only when the letter "X" appears among other letters, responding only to a green light while ignoring red and yellow lights, or pressing a key when a specific shape (e.g., a circle) appears among squares and triangles.

In choice reaction time (CRT) experiments, participants are presented with multiple stimuli, each requiring a different response. They must first identify the stimulus and then select the appropriate response. For example, participants may press the left button when a red circle appears, the right button when a green square appears, or press different keys corresponding to different arrows (←, →, ↑, ↓) displayed on a screen. In a pure choice reaction time task, the stimuli are presented in a random sequence, preventing participants from predicting the next stimulus and ensuring that each response requires stimulus identification and response selection.^[6,7,8]

Studies have shown that reaction time is influenced by stress. Stress can be broadly defined as the actual or anticipated disruption of homeostasis resulting from physical and/or psychological events, commonly referred to as stressors.^[9]

Medical training is widely regarded as one of the most stressful educational programs. Factors such as the transition to a rigorous professional curriculum, adaptation to a new learning environment, academic and peer-related pressures, extended study hours, and separation from family due to relocation can collectively contribute to high levels of stress among medical students.^[10] Medical students experience multiple stressors, including examination stress, sleep deprivation, heavy academic workload, psychological pressure, and particularly practical viva voce examinations, which are often more stressful than theory examinations because they require direct interaction with examiners and immediate responses to questions.^[11,12] Previous studies suggest that examination stress adversely affects psychomotor performance, and reaction time has been widely used as an index to evaluate these effects.

Several studies have investigated the impact of examination stress on choice reaction time and have consistently demonstrated a detrimental effect on reaction time.^[13] The present study aims to evaluate the effect of examination stress on 4-choice visual reaction time (CRT).

Aim

To study the effect of exam stress on 4-choice visual reaction time among second-year medical students.

MATERIAL AND METHODS

Study Population

The study was conducted on 15 healthy second-year male medical student volunteers between the age group of 18 and 22 years who were randomly selected at Topiwala National Medical College, Mumbai. Female students and those with a history of visual disorders, chronic illnesses, sensorimotor disabilities, or use of medications affecting cognitive performance were excluded from the study.

Female students were excluded from the study because reaction time may vary across different phases of the menstrual cycle, potentially influencing the study outcomes.^[14]

All participants were tested at the same time of day to minimise the influence of circadian rhythm on reaction time.^[11]

Participation of students was purely on a voluntary basis. Informed consent was taken from all the participants. The study was approved by the Institutional Ethics Committee.

Study Duration

The study was conducted for a period of 6 weeks from the date of approval of the protocol.

Equipment Needed

Reaction time was assessed using the Deary-Liewald Reaction Time Software (Version 310) installed on a laptop.^[15]

Material and Methods

The study procedures were carried out in the Department of Physiology in 2 sittings – one sitting 2 hours before the Terminal Practical Exam held by the College and the other sitting 7 days after the exam. The experiment was conducted in the Physiology Lab in the morning session. Informed consents were taken. Subjects were given time to relax before starting the tests. The tests were done using Deary Liewald Reaction Time software version 310. It is a free, user-friendly, computer-based program that assesses simple and four-choice reaction time and demonstrates excellent internal consistency, with a Cronbach's alpha value of 0.97 for correct responses in choice reaction time (CRT).^[15]

Choice Visual Reaction Time (CRT):

During a four-choice reaction time test, four boxes were displayed on the screen, and a cross appeared randomly in one of the boxes (Fig. 1). Participants were instructed to press the corresponding key as quickly as possible based on the location of the cross. All participants were familiarised with the procedure, and a practice trial was provided before the actual test.

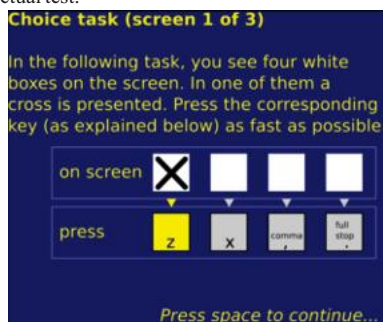


Fig. 1: Choice Reaction Time Instructions Screen 1

The key configuration was CRT Key Box 1 – 'Z', CRT Key Box 2 – 'X', CRT Key Box 3 – ',', and CRT Key Box 4 – '.', as shown in Fig. 2.^[16]

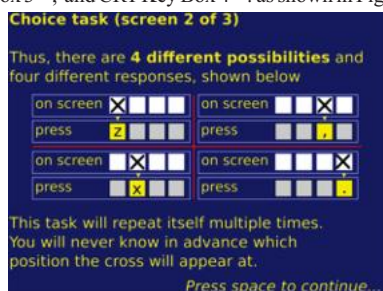


Fig. 2: Choice Reaction Time Instructions Screen 2

The fingers used to select the keys are shown in Fig. 3.



Fig. 3: Choice Reaction Time Instructions Screen 3

Each participant underwent three experimental trials. Following each trial, the choice visual reaction times were displayed on the screen in milliseconds (ms) and recorded. The fastest reaction time among the three trials was considered for statistical analysis.

Statistical Analysis:

The collected data were presented using tables, graphs, and diagrams. Statistical analysis was performed using IBM SPSS Statistics Version 21. The Wilcoxon signed-rank test, a non-parametric test, was used to compare choice visual reaction time between the pre-exam (stressful period) and stress-free period. A p-value ≤ 0.05 was considered statistically significant.

RESULTS:

A total of 15 healthy second-year male MBBS students participated in the study. Choice visual reaction time (CRT) was assessed during the stressful pre-examination period and again during the stress-free post-examination period.

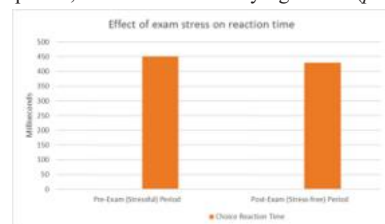
Comparison of Choice Visual Reaction Time During Stressful and Stress-free Periods:

The pre-examination and post-examination Choice Visual Reaction Time parameters of the study participants are presented in Table 1 and graphically represented in Graph 1.

Table 1. Comparison of Choice Visual Reaction Time

Reaction Time (ms)	Pre-exam (Stressful) Period (Mean $\pm$ SD)	Post-exam (Stress-free) Period (Mean $\pm$ SD)	p value
Choice Visual Reaction Time	450.27 $\pm$ 47.16	429.33 $\pm$ 41.88	<0.05

Choice visual reaction time was significantly prolonged during the stressful pre-examination period compared with the stress-free post-examination period, and it was statistically significant ($p < 0.05$).



Graph 1: Comparison of Choice Visual Reaction Time During Stressful and Stress-free Periods

DISCUSSION

The present study was conducted to assess the effect of exam stress on choice visual reaction time among second-year medical students. Reaction time serves as a key indicator of psychomotor performance, and prior research has demonstrated that stress — particularly examination-related stress — can significantly affect it.

In the present study, choice visual reaction time was found to be increased during the pre-examination (stressful) period compared to the post-examination (stress-free) period. The increase in reaction time was statistically significant ($p < 0.05$). These findings suggest that examination stress has a negative effect on psychomotor performance.

The prolongation of choice visual reaction time during the stressful period indicates that exam stress affects mental processing involved in stimulus identification, response selection, and execution. These observations are consistent with previous studies, which have reported that examination stress adversely affects reaction time and psychomotor performance^[17], but evaluation of the effect of examination stress was not done using a computerised four-choice visual reaction time task. Cariappa and Mohanraj demonstrated that examination stress significantly increased choice reaction time among first-year medical students, but the methodology employed was different; instead of a 4-choice, they used a colour choice reaction time task.^[11]

Choice reaction time includes additional cognitive processes such as stimulus discrimination and response selection, whereas simple reaction time mainly reflects sensory detection and motor execution.^[17]

Acute examination stress activates the HPA axis, elevating cortisol and catecholamine levels, which modulate both the prefrontal and parietal

cortices.^[17,18] The prefrontal cortex is responsible for attention, working memory, and response selection, while the parietal cortex plays a critical role in integrating sensory information and supporting visuospatial working memory.^[17,18] In a four-choice task, the participant must detect which of the four spatial locations contains the stimulus, requiring visuospatial attention mediated by the posterior parietal cortex. The participant also requires executive processing by the prefrontal cortex for maintaining stimulus-response associations, response selection, and inhibition of competing responses.^[19]

Examination stress may impair these prefrontal-dependent functions through neuroendocrine stress responses affecting executive control and response selection and also alter posterior parietal cortex activity, which may reduce visuospatial attention and stimulus localisation, resulting in delayed reaction time.^[20,21]

However, as the present study did not assess stress hormones or cognitive function directly, this explanation remains hypothetical. To better elucidate the underlying mechanisms, future research should employ larger sample sizes and incorporate neurophysiological and biochemical markers.

Clinical Implications

The present study has important clinical implications in the assessment of psychomotor function among medical students and its association with exam-related stress using reaction time tests. These tests are cost-effective, easy to administer, and reproducible, making them useful tools for evaluating psychomotor performance during stressful academic situations. They may serve as screening tools to identify alterations in cognitive-motor performance among students during examination periods, enabling educators to implement appropriate stress-management strategies and supportive interventions to improve students' coping mechanisms and overall academic performance.

List of Abbreviations:

CRT - Choice Visual Reaction Time

HPA - Hypothalamic-Pituitary-Adrenal

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Ethical Approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study.

Data Availability Statement

The data generated and analysed during the current study are not publicly available due to privacy and ethical restrictions concerning the study participants, but on reasonable request, may be available from the corresponding author, subject to approval from the institutional ethics committee.

Funding Information

No specific funding was received for this study.

Conflict of Interest

The authors declare no conflicts of interest.

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