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Foreign First-Year Female Medical Students Do Experience Acute Stress in the New Environment as Evidenced in a Virtual Model

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Abstract

Students in foreign countries face challenges when adjusting to a new socio-economic and cultural environment. Our aim was to study the stress experienced by first-year foreign (F) medical students in a new educational environment. We used sensorimotor reaction times (SMRT) as a tool to assess their adaptation to stress. The study included 14 F and 10 local (L) first-year healthy female medical students. They were exposed to two simulated virtual visual tasks: simple (S) and choice (C) SMRT (SSMRT/CSMRT) in random order. We calculated the means (M), standard deviations (SD), and residual standard deviations (RSD) for both groups during SSMRT and CSMRT. For statistical check, we calculated the accuracy index (AI) and some derivative parameters of RT histograms: coefficient of variation (CV), and reaction sustainability (RS). Our results showed no significant differences in the M, SD, and RSD during SSMRT and CSMRT between the two groups, indicating almost equal and high mental abilities in both groups. However, higher CV for L students compared to the F students were found during CSMRT, indicating less concentration of attention in the L students. Significant differences between the means of RS in F and L students during CSMRT were also revealed, indicating more reaction stability in the L students. On the contrary, the F students showed lower accuracy, especially during SSMRT, implying faster and more impulsive error responses as they familiarized themselves with the new environment. The mental chronometry parameters in F and L first-year female medical students are the same. Some neuroticism in F-students can be explained by the presence of certain stress related to the difficulty adapting to a new environment. However, F-students showed better concentration than L-students in choice tasks, indicating a "focus on achievement coping strategies" of F-students.

Keywords

First-Year Female Medical Students Stress, Mental Chronometry, Sensorimotor Reaction Time Tasks

1. Introduction

The prevention of stress-related issues is a crucial goal of the educational system. Normally, younger students live with their parents, who provide support and supervision to ensure their well-being and prevent stress. Globalization has led to educational migration motivated by various factors, such as open borders, safe and affordable living, friendly people, access to globally recognized educational programs, and better career prospects.

However, it's important to note some challenges students in foreign countries face when adjusting to a new socio-economic and cultural environment. The acculturative stress that foreign (F) students experience can be caused by various factors, such as immersion in a new culture, an unfamiliar educational environment, language barriers, and the loss of direct contact with family and friends. Sometimes, they also suffer discrimination. These can lead to psychological changes in students (González, Mesanza, & Mariel, 2011: pp. 413-430; Smith & Khawaja, 2011: pp. 699-713).

Moreover, the demands of rigorous learning and training, particularly in medical universities, can have a detrimental impact on the physical and mental health of junior students. Research has indicated that they may suffer from depression, anxiety, stress, and even mental illness as a result, which can have a negative effect on their academic performance and overall quality of life. This can manifest in various ways, including loss of interest, low self-esteem, disrupted sleep and appetite, and difficulty with concentration, among other symptoms (Sullivan & Kashubeck-West, 2015: pp. 1-11; Dyrbye, Thomas, & Shanafelt, 2005: pp. 1613-1622; Guthrie et al., 1997: pp. 179-184; Kulsoom & Afsar, 2015: pp. 1713-1722; Damiano et al., 2021: pp. 35-42).

Good adaptation enables students to function better in a new environment and improve their ability to study, academic performance, and well-being. The process of adapting involves assessing life changes cognitively and adopting appropriate coping strategies that involve a conscious problem-solving approach (Machul et al., 2020).

The World Health Organization (WHO) recently conducted a study across 8 countries called "World Mental Health International College Student Project" to investigate the prevalence and basic sociodemographic correlates of common mental disorders among first-year college students. The initial results of this project indicate the high level of need for mental health services, representing a major challenge to institutions of higher education and governments (Auerbach et al., 2018: pp. 623-638).

Mental chronometry is a valuable method for evaluating an individual's situational attention, working memory, instant decision-making, and ability to adapt to stress. It helps to objectively understand how a person perceives the environment

based on their observations.

In simple sensory-motor tasks, the reaction time (RT) is measured by the time when the stimuli appear and an individual's response occurs. In complex RT tasks, the RT includes the times when the sensory organs receive the features of the stimuli and transmit them to the brain, identifying and processing the signal and making the decision to perform an appropriate motor response (Riemann & Lephart, 2002: pp. 71-79). The sensor and motor periods are mainly reflexive, and a cognitive component is related to the decision-making period. RT increases at the expense of the cognitive processing of information. The difference between the means of choice sensorimotor RT (CSMRT) and the simple sensorimotor RT (SSMRT) indicates the speed of mental processes in the central nervous system (Hick, 1952: pp. 11-26). Considering the interaction of RT can refine a person's teaching methods to adapt to daily life more effectively (Goldstein, 2011). Studying the relationship between SSMRT and CSMRT can be used as an indirect indicator of neuronal efficiency, demonstrating the effectiveness of neural apparatus interactions and information processing. Students need to maintain their cognitive abilities for extended periods during their studies (Wetherell, 1997: pp. 495-503). This analysis can aid in understanding the mechanisms of cognitive processes and abilities (Sanders, 1998; Hockley, 1984: pp. 598-615).

Research has shown that standard deviation (SD) is more strongly associated with mental ability scores than the RT mean (RTM). Individuals with higher cognitive abilities tend to have fewer variable responses or standard deviations, indicating a more balanced nervous system (van Ravenzwaaij, Donkin, & Vandekerckhove, 2011: pp. 381-393). This is related to the decisional, but not perceptual, stage of information processing (Willoughby, Kim, Lee, & DeYoung, 2023). A large-scale study of people of different ages found correlations between psychometric intelligence and simple RT (Deary, Der, & Ford, 2001: pp. 389-399). According to the studies, males had a faster RT compared to females for both auditory and visual stimuli (Shelton & Kumar, 2010: pp. 30-32). These results were confirmed by a study of 100 first-year medical students, including 50 male and 50 female students (Prabhavathi et al., 2017: pp. 371-374).

On the other hand, it has been found that faster responses are more closely linked to high levels of extraversion rather than intelligence (DeYoung, 2020: pp. 1011-1047). Moreover, faster error responses and a higher frequency of multiple responses are significantly associated with neuroticism (Crow, 2019: pp. 623-638). This study was performed on 18 to 24-year-old healthy adults of both sexes and investigated relationships between Five Factor Model personality traits and indices of response inhibition, sustained attention, and response variability on a continuous performance test. The present findings indicate that neuroticism is associated with error-prone behavioral performance, suggesting that a propensity to experience negative emotions may manifest as impulsivity and hyperactivity on performance-based measures of executive functions. A meta-analysis of functional neuroimaging studies has shown that neuroticism is linked to increased activation in brain areas

involved in emotion processing, e.g., ACC (anterior cingulate cortex), mPFC (medial prefrontal cortex), amygdala, and hippocampus that are responsible for fear learning, anticipating unpleasant stimuli, processing and regulating emotions (Servaas et al., 2013: pp. 1518-1529). ACC and mPFC are currently considered primary generators of physiological or behavioral responses representing regulatory roles for these regions, such as in the top-down modulation of limbic and endocrine systems for emotion regulation (Etkin, Egner, & Kalisch, 2010: pp. 85-93; Craig, 2009: pp. 59-70; Schiller & Delgado, 2010: pp. 268-276). In addition, neuroticism is associated with more pronounced and less well-regulated emotional responses to stressful events using maladaptive coping strategies (Lahey, 2009: pp. 241-256).

According to research, effective teaching requires students' attention to be focused. To measure students' accuracy during performances, a modified version of Whipple's index (index of concentration), known as the Accuracy Index, is used.

In demographic statistics, the concentration index summarizes information from the concentration curve and evaluates inequality at different points in the distribution, assessing the tendency of individuals to inaccurately report their actual age or birth date (Spoorenberg, 2007: pp. 847-859). In RT measurements, the Accuracy Index (AI) is calculated based on the number of correct and incorrect answers of test subjects in response to stimuli. The lower this indicator, the higher the degree of accuracy in completing tasks. A comparison of the calculated average errors of anticipation or delay gives an idea of the relationship between the processes of excitation and inhibition in the central nervous system. AI reflects the stability of attention, which is influenced by the strength and balance of nervous processes (Psychophysiological Methods, Method "Simple Visual-Motor Reaction", 2024). Equation (1) represents this index

$$\mathrm{AI} = (\mathrm{N} - \mathrm{C})/(\mathrm{N} + \mathrm{E}) \tag{1}$$

where: N—presented signals, C—number of correct answers, E—number of errors.

Based on the above, the objective of our study was to examine F and local (L) first-year medical students using an experimental virtual model for stress recognition based on the SSMRT, CSMRT, and AI, detection/assessment of acute cognitive stress effects and possibly inadequate adaptations of students due to the new environment, with the goal of preventing stress-related problems.

2. Materials and Methods

Our study followed the standards of the International (the Helsinki Declaration) and the University Ethics Commission (Protocol No. # 5/2019) regarding data protection, written consent was obtained from all participants. In our previous research (Janashia et al., 2023: pp. 1258-1268), we focused on first-year male medical students, while the current study targets first-year female medical students. We collected a brief medical history, including basic physical parameters and objective test data for each participant. In this study, we utilized a block and between-subjects design. There were two groups: group 1 (n = 14) comprised mainly of Indian students, and group 2 (n = 10) consisted of Georgian students. Considering

that RT can vary due to several factors such as age, health, daily activities, and the physical and mental well-being of an individual, as well as environmental conditions (Woods et al., 2015), in our study, we included physically healthy, right-handed students aged 17 to 18 who had no visual impairments or the need for glasses. Additionally, participants did not have a history of head trauma, self-reported muscular or neurological diseases, and had not consumed alcohol, coffee, or any medication in the two days prior to the study. The testing was conducted after lectures, in the afternoon, when all students were feeling fatigued due to their learning schedules. To prevent any impact from previous experiments, the test subjects were placed in a room only once. Before testing, subjects were given detailed instructions about the test and were required to respond to stimuli as quickly and accurately as possible by clicking the mouse during the test period.

Our staff has developed computer software for a virtual model of acute stress recognition based on Python language and valid cognitive tests (http://pebl.sourceforge.net/). The software operates in a specially designed experimental room that is shielded from light and sound. It has been specifically designed to conduct laboratory experiments that last for 25 minutes. These experiments are divided into five stages, consisting of a 5-minute baseline period followed by a 5-minute stress condition; another 5-minute stress condition is preceded by a 5-minute relaxation period and ends with a 5-minute recovery period. During the stress conditions, participants were exposed to two randomly ordered simulated tasks measuring simple and complex RT to stimulus-response pairs administered sequentially. Acute stress was induced using an image of light Landolt's broken rings with different numbers of gaps in the central position of the dark computer monitor. For a detailed description and further information regarding the model and tests, please consult our previous articles (Janashia et al., 2022: pp. 305-317; Janashia et al., 2023: pp. 1258-1268). **Figure 1(a)-(b)** shows the process of the experiments. The participants were given the instructions to press the left button if they saw an odd number of rings and the right button for even numbers. The program is designed to calculate various parameters using the RT histograms, such as the RT during simple and choice sensorimotor reactions, the total number of answers, the number of correct answers, and the percentage of correct answers (CA %). Some function derivatives are calculated using RT histograms (Bobrova, 2015; Tsarev, 2006). This includes the reaction sustainability index, which evaluates the stability of the central nervous system by analyzing the distribution of a person's reaction times to a stimulus across various functional states. Equation (2) represents the reaction sustainability index:

$$\mathrm{RS} = \ln P_{\max} / \Delta T 0.5(C^{-1}) \tag{2}$$

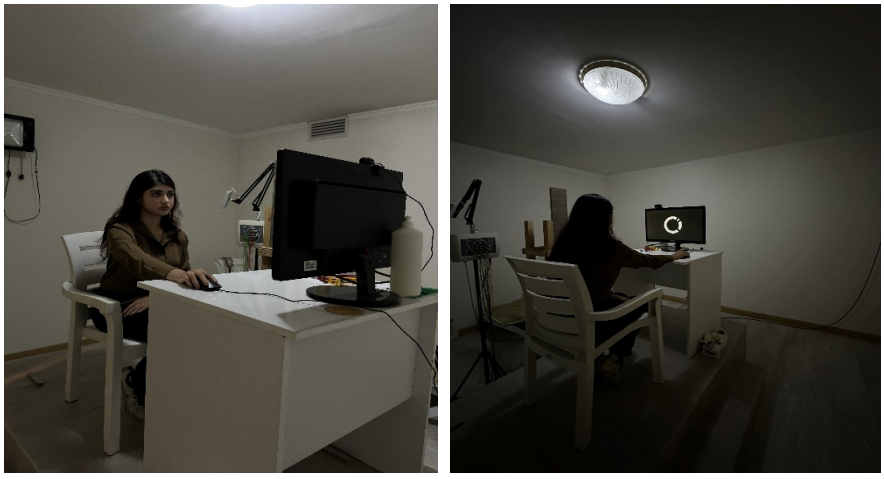
where: $P_{\max}$ is the number of most frequently repeated reactions—amplitude of mode; $\Delta T 0.5$—The range of the most frequently repeated reactions at the level of 0.5 $P_{\max}$.

We utilized version 7 of the "Primer of Biostatistics" software by Stanton A. Glantz and employed the t-distribution to analyze the acquired data. The significant

level was taken as 0.05. We calculated both groups' means, standard deviations (SD), and residual standard deviations (RSD) during SSMRT and CSMRT. To perform statistical checks, we calculated the coefficient of variation. The higher the coefficient of variation, the greater the level of dispersion around the mean. In Ratcliff's diffusion model of RT distributions (Ratcliff, 2002: pp. 278-291), when task difficulty increases, RT mean and RT standard deviation increase at the same rate, indicating linearity between them. The coefficient of variation measures whether the relation between the RT mean and RT standard deviation is linear (Wagenmakers, Grasman, & Molenaar, 2005: pp. 195-204; Wagenmakers & Brown, 2007: pp. 830-841). Equation (3) defines this coefficient

$$CV = SD/Mean \tag{3}$$

In addition, we calculated CA% and AI for both groups.



(a) (b)

Figure 1. The process of the experiments ((a), (b)).

3. Results

In the current study, we tested the null hypothesis that F female medical students might experience stress due to the new educational environment compared to L students and consequently show worse performance during specific tasks. We processed the abovementioned parameters of mental chronometry and compared the parameters of F and L junior students to reveal their processing speed and mental states in each case.

In **Table 1**, The means (in seconds), standard deviations, and residual standard deviations of SSMRT (T1) and CSMRT (T2) in the two subgroups (n), coefficient of variations (CV) and t and p-values are shown, the asterisk indicates statistically significant difference.

As shown in **Table 1**, there are no statistically significant differences between the means of SSMRT and CSMRT for L junior female students in groups F and. Also, there are no statistically significant differences between the SD and RSD values in F and L students, indicating no differences between the values measured in

different individuals. Furthermore, the low SD rates suggest almost equal and high mental abilities of female students in each group, as currently, SD is considered a useful index of mental noise (Robinson, Wilkowski, & Meier, 2006: pp. 311-344; Tamir & Robinson, 2005: pp. 107-114).

Table 1. The means, SDs, and coefficient of variations of the different tests in the two subgroups.

Groups	n	MT1	SDT1	RSDT1	CVT1
F	14	0.3445	0.1073	0.02867	0.311465893
L	10	0.3212	0.1105	0.03496	0.344022416
t		0.519			
p		0.609			
F	14	MT2	SDT2	RSDT2	CVT2
L	10	0.7254	0.1543	0.04123	0.212710229
t		0.6373	0.1867	0.05903	0.292954652*
p		1.265			
F		0.219			

As a statistical check, we calculated the coefficient of variation, which revealed a small level of dispersion around the mean during SSMRT tasks, indicating a cognitively same mode of processing speed in F and L junior female students. However, the results revealed higher CV CSMRT for L students compared to the F students during choice tasks, suggesting that L students had less concentration of attention (Rabbitt, Osman, Moore, & Stollery, 2001: pp. 981-1003).

Then we calculated the RS, CA%, and AI, indicating a person's accuracy during tasks, abilities of attention, and stability of the central nervous system.

In Table 2, the means and standard deviations of RS and CA% during SSMRT (T1) and CSMRT (T2) in the two subgroups, and t and p-values are shown:

Table 2. The means and standard deviations of RS, CA%, and AI during SSMRT (T1) in the two subgroups.

Groups	n	MRST1	SDRST1	MCAT1	SDCAT1
F	14	5.4	0.7	86.2	10.33
L	10	5.7	1	89.9	6.48
t		−0.686		−0.994	
p		0.5		0.331	
F	14	MRST2	SDRST2	MCAT2	SDCAT2
L	10	4.2	0.4	49.8	7
t		5	0.8	54.5	4.5
p		−3.285		−1.822	
F		0.003*		0.082	

As shown in Table 2, there are no statistically significant differences in the means and standard deviations of RS in female junior students from F and L during SSMRT. However, significant differences were observed in the means of RS in F and L students during CSMRT. This indicates that L students showed more stability of reaction during choice tasks, suggesting a more balanced nervous system in L students.

The various means for CA% did not show any statistically significant differences. However, the SD for SSMRT in F students was higher than in L students, suggesting hyperactive responses during performances in F students. This means that individuals in the F group are less effective in regulating their behavior over time (Robinson, Wilkowski, & Meier, 2006: pp. 311-344).

For statistical checks, we calculated AI (see above). In Table 3, the means of the number of presented signals (MN), correct answers (MC), errors (ME), and AI are presented during SSMRT and CSMRT.

Table 3. The means of N, C, E, and AI during SSMRT and CSMRT in the two subgroups.

Groups	MNT1	MCT1	MET1	AIT1
F	164.71	141.86	22.857	0.1218
L	164.5	147.9	16.6	0.0917
	MNT2	MCT2	MET2	AIT2
F	164.79	83.786	81	0.3296
L	164.2	89.3	74.9	0.3133

As seen from Table 3, F students showed fewer correct answers and more errors than the L students, particularly during SSMRT, presenting worse AI than L students. This can be explained by some neuroticism experienced by foreign students as they adjust to a new environment, which can lead to impulsive and hyperactive responses during performances (Crow, 2019: pp. 623-638).

4. Discussion

As seen from our study, first-year F and L students had almost equal and high mental abilities when they started studying at medical universities. Our study found less concentration of attention in the L students during choice tasks. This can be related to some fatigue experienced by students since they conducted performances after lectures; however, the passive responses may be explained by the less motivation of L students in the presence of a stable and balanced nervous system. It seems that local students are less likely to show their best qualities.

On the contrary, F students are shown hyperactive and impulsive responses when performances start. As we noted above, faster and impulsive responses are linked to high levels of extraversion (Crow, 2019: pp. 623-638). Such traits include assertiveness and focus on achievement coping strategies. Such efforts also indicate some neuroticism (Servaas et al., 2013: pp. 1518-1529; Chen, 2016: pp. 377-387) and negative emotions using maladaptive coping strategies (Lahey, 2009: pp.

241-256). Performances related to accuracy and speed of cognitive responses can be impaired by stress, leading to decreased productivity and a tendency to make mistakes during performances (see above). In this case, we can say that first-year healthy female F students experience some alertness to acute visual stress in the stress recognition virtual model and have difficulty in problem-solving. It seems there is a problem of less adapting to a new environment.

Researchers described three different types of coping styles: problem-focused coping, emotion-focused coping, and avoidance coping. A problem-focused coping style is a task-oriented coping that attempts to manage or alter stressful situations with active efforts to solve the problem that is causing the experience of stress or reduce its negative impact (Chen, 2016: pp. 377-387). Seems that, using this pattern of behavior, F students attempt to develop appropriate coping styles to immerse in the new educational environment.

The threats from the new environment engage physiological, behavioral, and cognitive-emotional preparatory mechanisms to respond adaptively and consequently minimize exposure to the source of the threat (Folkman & Moskowitz, 2004: pp. 745-774). Neurotic individuals have shown a tendency to appraise life events as more threatening (Wood, Ver Hoef, & Knight, 2012: pp. 787-799).

Currently, neuroticism is considered a general risk factor for various psychopathologies, including internalizing disorders such as major depressive disorder, generalized anxiety disorder, and social phobia as well as personality disorders, such as schizophrenia, eating disorders, somatoform disorders, etc. (Suls & Martin, 2005: pp. 1485-1510; Kotov, Gamez, Schmid, & Watson, 2010: pp. 768-821). Neuroticism has been related to an increased risk for suicide and general health problems, such as cardiovascular diseases and disrupted immune functioning (Ormel et al., 2013: pp. 686-697).

The present study indicates that foreign female students presented a higher level of perceived stress than local students. Our results correspond with the results of other authors who proved that foreign students were prone to more stress, anxiety, and depression (Lahey, 2009: pp. 241-256; Chen, Su, Ren, & Huo, 2019). According to one such study (Fritz et al., 2008: pp. 244-259), optimism and mental health are closely related, and cultural adaptability significantly affects the effect of self-efficacy in regulating depression and life satisfaction.

Our results coincided with the results of a large study, we cited in the section introduction, performed on 575 medical students in a multiethnic setting across 5 years and that revealed that the female sex predicted higher levels of "baseline" depression, anxiety, or stress (Kulsoom & Afsar, 2015: pp. 1713-1722). Although recent studies found that the most important stressors related to academic performance and the learning environment (Nowreen & Ahad, 2019: pp. 440-442; Damiano et al., 2021: pp. 35-42).

As seen from the results of our research, the problem of less adapting to a new environment is more related to the person's sex. Our results coincided with other research indicating that despite performing equally to their male peers, female medical students report decreased self-confidence and increased anxiety, particularly

over issues related to their competence (Blanch, Hall, Roter, & Frankel, 2008: pp. 374-381). The same result was reported in another large study conducted among 761 Brazilian medical students, identifying that the female gender is associated with stress, anxiety, and depression (Moutinho et al., 2017: pp. 21-28).

Generally, our results confirm the results of previous studies, including our studies, indicate that females are shown worse performances in RT tasks compared to males. Seems males have a more balanced nervous system (Shelton & Kumar, 2010: pp. 30-32; Prabhavathi et al., 2017: pp. 371-374; Janashia et al., 2022: pp. 305-317), and consequently, males do not have the problem of difficulty adapting to a new environment (Janashia et al., 2023: pp. 1258-1268).

Adaptive coping strategies typically involve a conscious and direct approach to problems. Close cooperation of universities worldwide can increase the quality of education, allowing for the exchange of information between different cultures and countries. Students in a foreign country can gain this information and enhance their cooperation with local people. Consequently, their adaptation to the new environment can be improved. Better adaptation can also be achieved by developing university-based programs targeting problem-solving by familiarizing foreign students with the local cultural and socio-economic norms, involving students in a creative and healthy lifestyle, organizing different intellectual and sports competitions between local and foreign students, etc.

5. Conclusion

The results of our study are as follows:

1) The mental chronometry parameters in first-year female medical students, both foreign and local, are the same, indicating high mental abilities in both groups.

2) The presence of neuroticism in foreign female students can be attributed to the stress of adapting to a new environment.

3) Foreign female students tend to employ achievement-focused coping strategies.

Our findings provide valuable insights into stress related to the educational process and may assist in developing university strategies to support first-year foreign students in adapting to a new educational environment. Recommended coping strategies include improved time management, adopting a healthy and optimistic lifestyle, relaxation, and good sleep habits. Additionally, emotional support and access to psychological counseling are beneficial for female junior medical students when needed.

The current study has some limitations due to the small number of subjects in each group, which may restrict the statistical power of the findings. We recommend conducting further studies that collect and analyze more data to draw more definitive and generalized conclusions. Additionally, we suggest using various stress scales to better assess the specific relationship between physiological and psychological stress patterns among foreign and local medical students.

Data Availability Statement

The detailed datasets used for analysis during the current study are available by the reasoned request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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