

Visuo-motor response of students living in areas of military threat

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Abstract

Background and Study Aim

In the modern fast-changing world, university students face a range of complex situations and challenges that require quick and accurate decision-making. In this context, the motor responses of students are crucial for successful adaptation to contemporary challenges. This is particularly important when students live in areas of military conflict. Therefore, the aim of this study is to assess the choice reaction and reaction time to visual stimuli through an online simulation test in university students.

Material and Methods

The study involved students from three Ukrainian universities (physical culture faculties). A total of 86 students participated (men – n=38; women – n=48). An online simulation test was used to assess the visuo-motor reaction to visual stimuli. Information about the participants was collected through Google Form. For statistical analysis, the PyCharm CE development environment and various Python programming language libraries were used.

Results

Differences in average visuo-motor reaction metrics were established among students from three universities. According to the test results, 9 men (27 clicks in 30 seconds) and 12 women (about 25 clicks in 30 seconds) were assigned to the first quartile. The best result was shown by students from university 2 (0.737 ± 0.19 s). The best results by universities: men – university 3 (0.73 ± 0.106 s); women – university 2 (0.785 ± 0.208 s). It was determined that variations in time intervals between clicks decrease towards the end of the test.

Conclusions

The impact of the conflict in Ukraine goes beyond direct physical threats, infiltrating the everyday existence of those in the impacted regions, encompassing college students. In such scenarios, prompt physical responses are vital for effectively adjusting to current challenges.

Keywords: health, physical activity, quality life, young people, Ukraine

Introduction

The impact of the military conflict in Ukraine extends beyond immediate physical dangers and permeates the daily lives of residents in affected areas, including university students. In this context, motor reactions in situations where every second counts are crucial for successful adaptation to contemporary challenges. It should be added that two years of students living under COVID-19 pandemic conditions and the subsequent nearly two years of military conflict in Ukraine have significantly affected the level of physical preparedness of students.

The emergence of the COVID-19 pandemic in 2020 led to significant lifestyle changes in students, affecting their physical health and activity level [1, 2, 3]. The transition to online learning became a necessary response to the pandemic [4, 5]. This inadvertently led to a decrease in the effectiveness of practical training, crucial for physical education teacher students. The decline in physical preparedness of university students was highlighted in the studies by Nopembri et al.

[6] and Franks et al. [7]. The authors emphasize the importance of teacher education programs in the context of students' physical readiness to face various emergency situations. The higher the level of students' physical preparedness, the more physically equipped they are to face disasters.

Moreover, military conflicts in the areas where students live have created additional difficulties they face [8, 9, 10]. The war not only disrupted their physical daily routines but also required significant adjustments in their educational and professional training. As noted by Orlov [11], such a situation necessitated the transformation of educational methodologies, emphasizing the need to maintain a high level of education while ensuring the safety of students.

Research on the impact of military conflicts on education systems is detailed in the study by Muthanna et al. [12]. The authors demonstrated how the war in Yemen had a strong negative impact on education. Another study [13] showed the impact of war on schools and students in the Eastern Tigray zone. A similar situation is evident in the war in Ukraine, which began in February 2022 and has been ongoing for almost 2 years [14]. The author

notes that education is closely linked to other social institutions of society and experiences significant influence from global trends, challenges, and risks.

Evaluating the effects of the COVID-19 pandemic, military conflicts, and the shift to online education on university students' rapid adaptability to dynamic environments is essential. This is supported by multiple research findings. Scrimin et al. [15] explored the impact of emotional states on student learning and educational practices. Sorout et al. [16] analyzed the relationship between academic stress and both physical activity and cognitive function among freshman medical students. They deduced that stress, when balanced with sufficient physical activity, can actually boost cognitive functions.

In addressing these issues, it's crucial to adopt effective problem-solving strategies. Jasmin [17] suggests conducting diverse health and physical activity surveys. Awada et al. [18] introduced a technique to enhance cognitive abilities in youth, focusing on attention span, work precision and speed, alongside fostering creativity and alleviating stress.

These research findings emphasize the importance of developing strategies to enhance students' visual-motor responses. It's also clear that there's a critical need for effective techniques to oversee students' health.

Various research [19, 20, 21] has outlined methods to enhance motor responses and quicken decision-making. Thus, Romanenko et al. [22] explored sensorimotor response traits in taekwondo practitioners, using tablet-based programs to assess their reaction levels, which are crucial for combatants.

Johne [23] examined and compared the quick response and action times of fencers from different ranks using the Vienna test system. Parallel studies by Ramon Suarez et al. [24] and Piatysotska et al. [25] also investigated these metrics, employing tests to gauge reaction and choice times.

Khatri et al. [26] involved measuring hearing and sight reaction speeds with the Anand Agency-Pune tool. Adolescent physical activity was gauged using the PAQ-A. The outcome revealed that teens engaging in more physical activities had shorter reaction durations than those less active.

In summary, these research analyses highlight the strong connection between sensorimotor responses and factors like physical activity, health status, and the environment for tracking students' motor function metrics.

Also, of significant importance is finding better and more practical ways to assess visual-motor reactions. Recent developments in this regard include:

- Enhanced balance and quicker visual-motor responses post mixed reality gaming [27].
- Methods to evaluate visual-motor reflexes and response quality in rugby-7 athletes post-

neurocognitive training [28].

- Reduced visual-motor response times in selecting movements among young female basketball players [29].
- Analysis of rest periods and visual-motor fatigue in Turkey's deaf national basketball players [30].

Various research works offer detailed insights into how reaction speed and decision-making are influenced by factors such as anxiety levels [31, 32], gender differences [3, 21, 33], the extent of physical activity [34], and the rigor of physical training [35]. Different types of equipment [22, 36, 37, 38], digital platforms [22], and practical objects [39] are used for testing. Additionally, the importance of confirming the consistency and authenticity of reaction time tests is highlighted [36, 40, 41].

These research findings illustrate different strategies for improving sensorimotor responses. There's an obvious necessity to explore the connection between vital health elements, namely visuo-motor reaction and body mass index. Bhat et al. [42] reveal the connection between students' body mass index and their straightforward visual reaction speed. Additionally, several studies [33, 43, 44, 45] examine the relationship between BMI and visual-motor responses.

Together, these research works underscore the significance of assessments in grasping and lessening the effects of war and pandemic situations on university students' health and physical responses. The aim of the study is to assess the choice reaction and reaction time to visual stimuli through an online simulation test in university students.

Materials and Methods

Participants

The participants were students from three universities of Ukraine, specializing in physical culture: two in the east (Kharkiv, a region of ongoing conflict) and one in the west (Ivano-Frankivsk, frequently at risk of bombardment) area of Ukraine. The study included 86 participants (38 males and 48 females). They were guided to comply with safety measures if air raids were announced and to utilize the 'AirAlert' mobile app for missile threat notifications.

Conditions and setting for student life

The entire length of e-learning, initially a result of the pandemic and later extended by the conflict, was [3 years and 6 months] at the research's commencement. In Kharkiv's two higher education institutions (1, 2), near battle zones, there was an obligatory shift to virtual learning due to safety concerns amid frequent shellings and air raids. In the western Ukrainian city of Ivano-Frankivsk, the educational institution implemented a dual-mode educational system (conventional and online learning), with an option for a full transition to online

classes during increased military confrontations or emergency scenarios.

Research Design

The ‘Visual-Motor Reaction Test’ online simulator mimics 12 circular protruding buttons

(Fig. 1). Participants are required to configure the test initially: the default settings are 30 seconds for the test duration and 12 buttons. These settings should ideally remain unchanged. To start, click on ‘Generate Circles’ to display 12 buttons. These

Visual-Motor Reaction Test

Choose the test version that corresponds to your device:

Version for computers and tablets | Version for mobile phones

If your tablet does not support the first version, please use the second one

During the test, you need to press the illuminated button as quickly as possible

Your reaction and speed will be recorded to assess your reaction time

Visual-Motor Reaction Test

Goal: Assess reaction speed and the ability to make quick decisions

Method: Press illuminated circles

Short Instructions:

1. Click "Generate Circles" to set up the test
2. Measure the distance between the circles
3. Enter the value in centimeters in the appropriate field
4. Click "Start" to begin the test.
5. Press the illuminated circles as quickly as possible
6. After the test, click "Copy Results" and paste them into the Google form

For detailed instructions [click here](#)

Good luck!

Enter the width occupied by the circles in the first row (in centimeters): 18

Set the test time limit (in seconds): 30

Number of circles: 12 **Generate Circles**

Start **Clear Results**

RESULTS

Time: 0 seconds

Number of presses: 0

Date	Time between presses (ms)	Total number of presses	Time limit (s)	Number of circles	Display width (cm)	Average reaction time (s)
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Results in CSV format

Export to CSV **View chart** **Copy results** **Return to Google Form**

Figure 1. Interface of the ‘Visual-Motor Reaction Test’ online simulator

should be organized into rows of 4 by adjusting the screen's position or size (either portrait or landscape mode). The width of a row with 4 buttons should be measured and entered into the provided field.

Upon beginning, a button will be marked with a colored ring. Participants should click on it promptly. Subsequently, a different button will light up, requiring a swift press. This cycle continues for 30 seconds, and the outcomes are shown on the same webpage. Participants can select actions like 'Export to CSV', 'View Chart', 'Copy Results', or 'Return to Google Form'.

It's advised to 'Copy Results' and then 'Return to Google Form', promptly pasting the results into the initial data field. Subsequently, complete the other fields (nickname, gender, height, weight, course, major, university) and submit. Participants can later revisit the test page to save their results, view the chart, and save it for analysis.

Statistical Analysis

The analysis of the experiment's data was conducted using the PyCharm CE platform and several Python libraries (including the Shapiro-Wilk and Mann-Whitney tests). Average values and variability were computed, with a significance threshold established at 0.05.

Results

Table 1 displays the participants' descriptive

Table 1. Participant information from the experiment

Gender	Count	Age Mean, year	Age StdDev	Height Mean, cm	Height StdDev	Weight Mean, kg	Weight StdDev
Male	38	20.37	4.08	178.87	6.32	72.03	17.66
Female	48	19.33	4.44	165.0	6.45	59.5	9.39

Table 2. Findings from the Mann-Whitney U-test regarding BMI and VMR measurements in males and females

Gender	University Comparison	Statistical Difference	Mann-Whitney Statistic	P-value
VMR, s				
male	1 and 2	False	29.0	0.7848
male	1 and 3	False	36.5	1.0
male	2 and 3	False	118.0	0.9840
female	1 and 2	False	73.5	0.3383
female	1 and 3	False	61.5	0.5142
female	2 and 3	True	231.0	0.0177
BMI, kg/m²				
male	1 and 2	False	29.0	0.78487
male	1 and 3	False	36.5	1.0
male	2 and 3	False	118.0	0.9840
female	1 and 2	False	73.5	0.33830
female	1 and 3	False	61.5	0.51426
female	2 and 3	True	231.0	0.01777

Note. 'False' means the results are not statistically significant, while 'True' means there is a statistically significant finding

Table 3. Visual-motor reaction metrics for male and female students across universities

University	Mean Score, s	Median	Std Dev	Minimum Value	Maximum Value	Student Count	Student Count male	Student Count female
1	0.729	0.66	0.301	0.47	1.67	14	4	10
2	0.737	0.69	0.19	0.45	1.25	38	13	25
3	0.721	0.7	0.1	0.5	1.05	34	21	13
University 1 + 2	0.734	0.69	0.222	0.45	1.67	52	17	35

Table 4. Aggregated data on mean VMR and BMI metrics across gender

University	Gender	Mean Score	Median	Standard Deviation	Minimum Value	Maximum Value	Student Count
VMR, s							
1	Male	0.63	0.61	0.183	0.47	0.83	4
2	Male	0.643	0.67	0.098	0.49	0.8	13
3	Male	0.73	0.71	0.106	0.61	1.05	21
1	Female	0.768	0.66	0.338	0.51	1.67	10
2	Female	0.785	0.74	0.208	0.45	1.25	25
3	Female	0.708	0.69	0.093	0.5	0.83	13
University 1 + 2	Male	0.64	0.67	0.116	0.47	0.83	17
University 1 + 2	Female	0.78	0.71	0.247	0.45	1.67	35
BMI, kg/m²							
1	Male	24.298	22.21	5.362	20.52	32.25	4
2	Male	23.409	22.21	3.471	19.84	30.06	13
3	Male	23.437	22.84	3.375	19.37	30.79	18
1	Female	21.669	20.445	3.488	17.99	28.73	8
2	Female	22.152	22.105	2.449	17.31	27.43	24
3	Female	20.375	20.2	1.655	18.42	23.94	13
University 1 + 2	Male	23.618	22.21	3.818	19.84	32.25	17
University 1 + 2	Female	22.032	21.965	2.691	17.31	28.73	32

Table 5. Breakdown of 30-second click counts among participants, segregated by sex

Gender	Quartile	Timelimit, s	Participants
Male	25 %	27.0	9
Female	25 %	24.75	12
Male	50 %	29.0	9
Female	50 %	28.0	12
Male	75 %	31.0	9
Female	75 %	31.0	12
Male	Mean	29.89	38
Female	Mean	27.94	48

disparities in standard deviation, median values, and student counts, reflecting the variability and size of the data samples. From the table's data, we can deduce that men at University 1 have a higher mean BMI compared to those at University 3, while women at University 3 have a lower mean BMI than those at Universities 1 and 2. Notably, the standard deviation in BMI across these groups varies, suggesting different levels of data variability. Additionally, the median BMI values are distinct, which is crucial for interpreting average measures, especially considering the influence of extreme values.

The click-rate analysis over a 30-second period is detailed in Table 5. It's evident from the table

that men, on average, register more clicks than women in the same duration (a higher number of clicks in 30 seconds signifies a lower performance level). This disparity is also reflected in the quartile measurements, pointing to a higher VMR proficiency among men in this assessment.

Figure 2 displays the VMR level variation among students. On this histogram, individual bars represent specific value intervals ('High Level', 'Medium Level', 'Low Level'), and each bar shows how many students (on the 'Frequency' axis) have VMR scores in that interval (on the 'Clicks in 30 sec' axis).

Figure 3 depicts the mean durations between

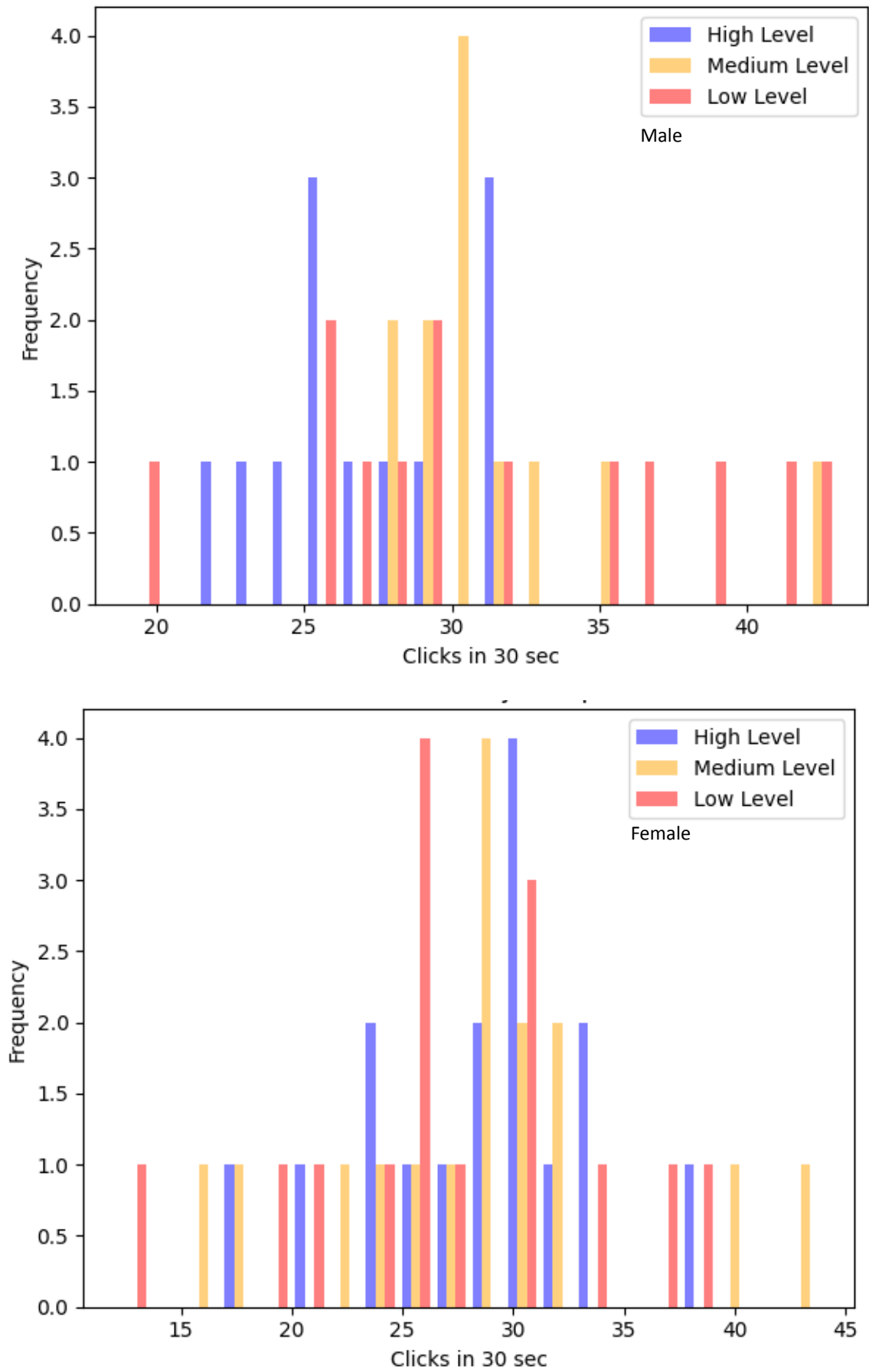


Figure 2. Breakdown of study participants' response levels by click count over 30 seconds, segregated by gender

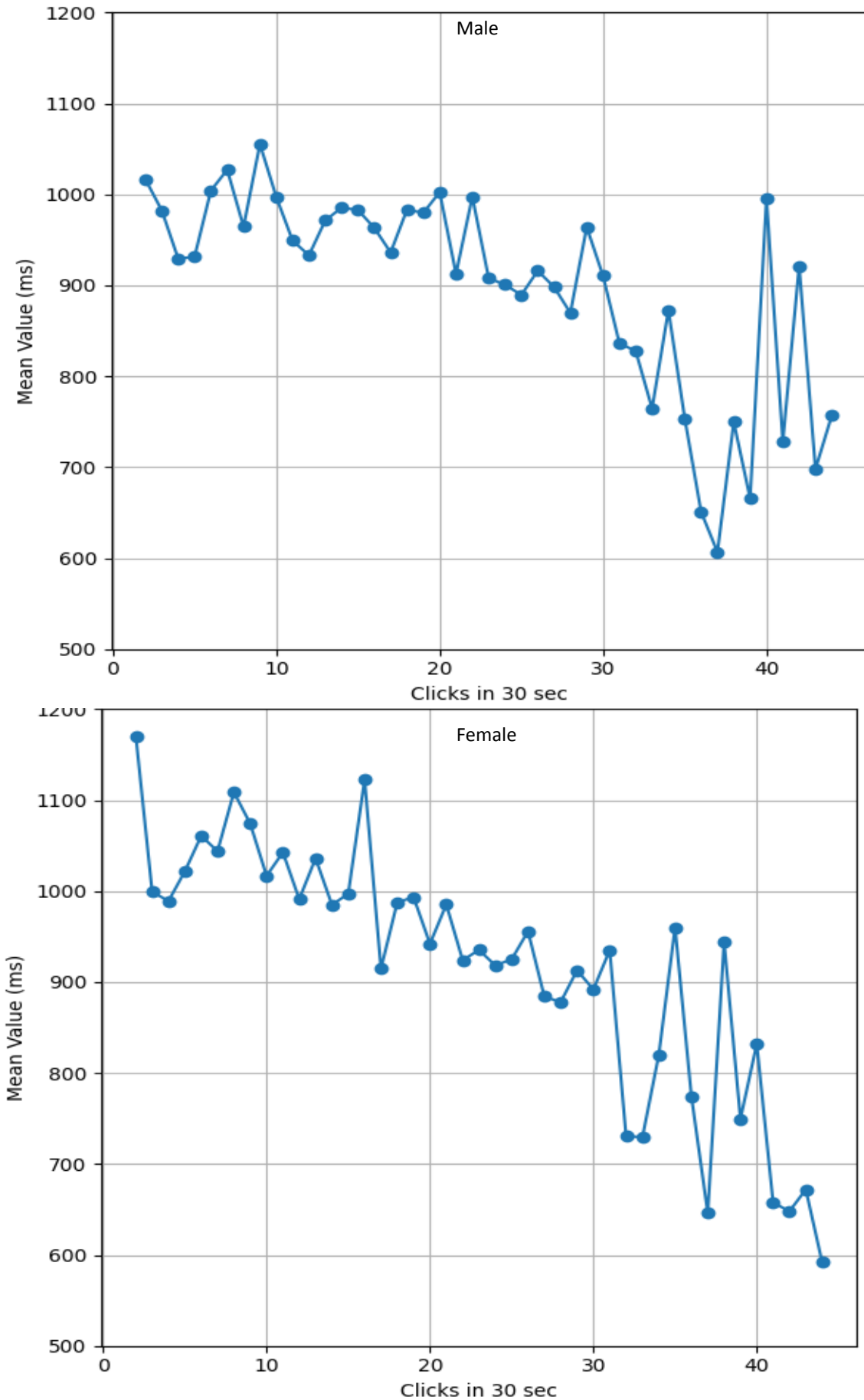


Figure 3. Mean durations between clicks during a 30-second span

clicks throughout a 30-second period. The graph's examination reveals that participants initially exhibit fluctuating click intervals, especially in the first 15 seconds, suggesting less uniformity in their responses. As the test progresses, these time gaps tend to stabilize, implying an increase in concentration and steadiness in participant actions. The chart shows that men's shortest reaction time is 0.69s and women's is 0.76s, implying rapid responses from both genders. The range of reaction times is broader for women (1169.43 ms) than for men (1054.65 ms), suggesting women have more varied responses. The overall time interval analysis reveals gender differences in click tasks, with women displaying wider variations and higher mean values.

Discussion

The aim of the study is to assess the choice reaction and reaction time to visual stimuli through an online simulation test in university students. In this regard, our study's results are valuable for comparing with those from another research in this field. Our study's participants are students who have experienced life in a conflict zone for more than two years.

Our analysis of student outcomes across various risk areas revealed that solely female students exhibited enhanced visual-motor responses. This underscores the need to factor in the prolonged stress effects on students' lives and mental-physical well-being, particularly amid military tensions. These elements might be explored in future studies, given the detrimental effects of warfare on students' educational experiences and mental health [12, 13, 22].

Variations in VMR metrics have been the subject of multiple studies. Statsenko et al. [46] and Dickerson et al. [47] verified disparities in visual-

motor processing speeds across genders. Aditya Jain et al. [33] and Dickerson et al. [47] shed light on the reaction time variances due to gender and physical activity levels, mirroring the findings of our investigation.

Our research investigated the link between VMR and BMI. Studies by Raza et al. [43], Mocanu et al. [44], Parekh et al. [45], and Bhat et al. [42] have also examined the association between body mass index and visual-motor responses. Mocanu et al. [44] highlighted that individual with excess weight showed lower average performance than those with normal or low weight. Bhat et al. [42] identified a slight positive relationship between BMI and basic visual reaction speed ($r=0.17$). Our findings, however, did not reveal a similar correlation between BMI and VMR.

Consequently, these study findings offer supplementary insights for our evaluation and highlight the need for more in-depth research in this field to better comprehend the determinants affecting students' visual-motor responses.

Conclusions

The findings demonstrate that students exhibit increased stability and uniformity in their behavior as they approach the test's conclusion, possibly reflecting heightened concentration. This method could be advantageous for assessing students' visual-motor responses in scenarios demanding rapid and precise decisions.

The impact of the conflict in Ukraine goes beyond direct physical threats, infiltrating the everyday existence of those in the impacted regions, encompassing college students. In such scenarios, prompt physical responses are vital for effectively adjusting to current challenges.

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