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CASE REPORT

Çevrimiçi rekabetçi bir video oyuncusunda kısa süreli sıcak uygulamanın ince motor beceriler üzerine etkisi: bir olgu sunumu

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Rekabetçi video oyunları -veya daha profesyonel ve ticari bir tanımla; e-spor, iyi finanse edilen ve hızla büyüyen bir alandır. Ancak oyuncular arasında sıcak uygulama yaygın olarak kullanılmasına rağmen bu oyuncuların sıcak uygulama öncesi/sonrası performansları hakkında detaylı bir bilgi bulunmamaktadır. Sıcak uygulamanın ince motor beceriler üzerindeki etkilerini değerlendirmek için 21 yaşında bir erkek video oyunu oyuncusu bu çalışmaya dahil edildi. Sıcak uygulama Zippo HeatBank® 6 cihazı ile 5 dakika boyunca olgunun bu cihazı her iki elinde aynı anda tutması ile yapıldı. İnce motor beceriler (reaksiyon süresi, genel fare kontrolü, tekrarlı tuşa basma), "PEBL: The Psychology Experiment Building Language" adlı yazılım kullanılarak sıcak uygulaması öncesi ve sonrasında değerlendirildi. Kısa süreli sıcak uygulamanın özellikle fare eli üzerinde olumlu etkilerinin olabileceği ancak klavye eli sonuçlarının tartışmalı olduğu kaydedildi.
Anahtar kelimeler: Video oyunları, Motor beceriler, Reaksiyon zamanı.

Effect of short-term heat application on fine motor skills in an online competitive video gamer: a case report

Competitive video gaming -or in a more professional and commercial definition; e-sports- is a well-funded and rapidly growing field. However, there is no detailed information about the performance of these gamers related to heating even though heat application is commonly used among players. A 21-year-old male gamer was included in this report to assess the effects of heat application on fine motor skills. The heat was applied via Zippo HeatBank® 6 for 5 minutes by holding the devices in the palms of each hand at the same time. Fine motor skills (reaction time, overall mouse control, repeated keypress) were assessed before and after heat application by "PEBL: The Psychology Experiment Building Language" software. It was noted that the short-term heat application may have positive effects, especially in the mouse hand however the results of the keyboard hand were controversial.
Keywords: Video games, Motor skills, Reaction time.

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Competitive video gaming -or in a more professional and commercial definition; e-sports- is a well-funded and rapidly growing field.[1] As an example due to the pandemic, most of the official football/basketball leagues/matches were indefinitely postponed or canceled. The fans were craving competition and the teams were craving for a source of income. Thus the already-known "online" competitive leagues were introduced to the "traditional" sports fans. With this most of the football/basketball teams formed their "online" team from the wide range of gamer rosters.[2] The fans realized that "online video games" can be as intense as a "regular" football or basketball match/game.

Competitive gaming or e-sports are mainly popular and supported in Asian countries.[3] However, nowadays, professional gaming is considered a full-time job in most parts of the world. As a professional gamer, an individual needs to attend practice sessions, complete game-related tasks, and maintain his/her both physical and cognitive fitness in order to stay competitive.[4] As it was mentioned in the literature, the training session of a professional e-sports player may last approximately 5.28 hours/day.[5] Of these 5.28 hours, 1.08 hours are comprised of exercises related to maintaining physical fitness.[5]

In "traditional" sports, athletes use some regulated and/or legal chemicals or applications prior to matches/performances to reach their top level. This may be in the form of some drinks, or a wide range of applications (heat, cold, electrical stimulation, etc.).[6,7] In the field of "e-sports", it is pretty much the same. Competitive video gamers and professional e-sports players popularly use heat packs prior to games in order to enhance their fine motor skills.[8] Even though the literature contains a vast amount of information related to the positive effects of heat on blood circulation and the number of recruited motor units on specific types of muscle contraction, there is no consensus about both the method and the effectiveness of such applications in professional e-sports players.[9,10] Despite the lack of scientific information, most of the players are still using heat gel bags as a form of heat application during the preparation phase of the games. This case report aims to share the effects of the short-term heat application on fine motor skills in an online competitive video gamer.

CASE

A 21-year-old, male, right-hand (which he also prefers as his mouse-using hand) dominant individual with 28,08 kg/m^2 body mass index and 15 h/wk gaming time was included in the study. The case was informed about the aims of the study and the assessment process in detail before participation. The written informed consent form was signed by and obtained from the case. The case was asked about his gaming habits, including gaming duration of a session in a week, and average daily sleep duration. This information was gathered from the case's gaming software and the smartwatch application. The case mentioned he used to have longer single gaming sessions (more than 4 hours) and weekly gaming time (more than 25 hours/week) in the last year. The decision of tracking this information was started by the case himself after realizing his gaming habit may shift into "Gaming Disorder" as defined by World Health Organization (WHO) in a report he read.[11] However, the case mentioned that due to his workload in the last 6 months, he needed to reduce both the duration of gaming sessions and weekly gaming time. Additionally, the case emphasized that 2 years prior to the study, he had won the 2nd place award during a gaming festival in a competitive video game tournament.

The case had no chronic systemic problems, however, he mentioned that his father was diagnosed with Type II Diabetes.

Assessments and Measurements

All of the assessments and measurements were performed in a soundproof and isolated room with a constant temperature of 24°C. The reaction time and mouse dexterity assessment were performed on a laptop computer with high-end hardware (Monster Abra A7 V 13.2 17.3"). The case was asked to bring his usual gaming equipment (mouse and keyboard) for the testing procedure. The tests were performed on a monitor with a resolution of 1920x1080 pixels and a 60 Hz refresh rate. With a diagonal length of 17.3 inches and the aforementioned resolution, the pixel density (pixels per inch-PPI or dots per inch-dpi) of the monitor was

calculated to be 127 pixels/inch. With a dpi value of 127 pixels/inch, 1 pixel is equal to 0.02 centimeters. Thus to provide a better understanding to readers all data which were collected as pixels by the testing software were converted into centimeters. However, for more precise and comparable results we strongly suggest using pixels instead of centimeters as a unit since in the video gaming field pixels are a more common measurement unit.

During the whole assessment procedure, only the case and one researcher were in the room. After the collection of demographics and gaming/daily sleep-related information, the researcher only gave the required explanations and directions prior to the testing, out loud, other than these both the case and the researcher remained silent.

Collection of Demographics and Gaming Habits

Demographics of the case were recorded by an interview prior to the assessment session. The interview was conducted and the data were recorded by one researcher. Information related to the gaming habits of the case was gathered from the smartwatch application (Mi Fitness) and gaming application (Steam) which recorded every gaming and sleep session in the last year. This information was presented in Table 1.

Skin Temperature Measurement

After the collection of demographics and habitual information was gathered, the case was asked to sit on a chair with no handles. The skin temperature was measured in 3 conditions bilaterally. The skin temperature was measured by an infrared contactless thermometer (Proviss) The first measurement was before the initial assessment, the second one was after heat application and the third one was after all the assessments were complete. The measurement was performed 3 times from the center of the palmar side of the hands and the average of 3 measurements was recorded.

Fine Motor Skills Assessment

Reaction Time and Mouse Dexterity Assessment

Reaction time and mouse dexterity values were measured by using The Psychology Experiment Building Language (PEBL) software. PEBL is an open-source software to which all researchers can contribute.[12] There are numerous tests/tasks created by the original author and many more added later by the contributors.[12] Even though this software is mainly used in the field of psychology and psychiatry, it can also be used as a valid tool for assessing fine motor skills while using a keyboard and mouse with the help of measuring reaction time, vigilance, dexterity, etc.[12] The validity and reliability of these tests/tasks are updated regularly by both contributors and other researchers.[12,13]

From the scope of this paper, the tests used for assessing Fine Motor Skills were:

Mouse Dexterity Task, was performed with the default settings for the test. The case was asked to position both the equipment and himself according to the most comfortable and preferred gaming position. Then he was informed about the task he needed to complete with the command: "Please move the mouse cursor to the middle point (bullseye) of the circular target as quickly as possible". According to the default settings, the assessment was performed at 7 different perturbation levels between 1-19. The perturbation levels defined according to the software were 1, 4, 7, 10, 13, 16, and 19. Every perturbation level was tested in a random order provided by the software. The case completed 10 repetitions (moving the cursor to the target) for each perturbation level with a preferred resting period –no more than 30 seconds- between each repetition. The data were presented as average values of 10 repetitions for each perturbation level calculated by the software. This test assesses the ability of overall mouse control in terms of mouse movement speed and mouse movement speed/movement ratio.[12]

Tapping Task was performed with the default settings for the test. The case was asked to position both the equipment and himself according to the most comfortable and preferred gaming position. Then he was informed about the task he needed to complete with the command: "Please press the "A" key on the keyboard with your left ring finger as fast as you can. Please start pressing the "A" key after seeing the "GO" cue". According to the default settings, the test duration was 10 seconds for each repetition. The case was asked to perform this task 8 times with a preferred resting period –no more than 30 seconds- between each repetition. The data were presented as the number of key presses and reaction time. This test assesses the repeated keypress ability of the

case which also measures the initial reaction time to start the test and the number of key presses in 10 seconds.[12,14]

Compensatory Tracker Test was performed with the default settings for the test. The case was asked to position both the equipment and himself according to the most comfortable and preferred gaming position. Then he was informed about the task he needed to complete with the command: "Please hold the mouse cursor during testing, which will last 20 seconds, in the center of the circular target". According to the default settings, the data were recorded by the software and are presented as deviation from the center of the target and mouse cursor velocity. This test assesses the ability to keep the mouse cursor in the center of a static target as long as possible during random mouse cursor perturbations from software are present (overall mouse control). This measures both the deviation from the target and the overall control of mouse movements with mouse movement speed.[12,15]

Hick's Law Demonstration was performed with the default software settings on a laptop computer with the specifications mentioned before. The case was asked to position both the equipment and himself according to the most comfortable and preferred gaming position. Then he was informed about the task he needed to complete with the command: "Please place your fingers as follows: Your pinky finger on the "1" button, your ring finger is on the "2" button your middle finger is on the "3" button and your index finger on the "4" button. When the red light appears behind the number key on the screen press that key as quickly as possible. You will start with only 1 button but the number of choices will increase by 1 after each set is completed up to 4". According to the default settings, the data were recorded by the software and presented as accuracy, mean, and median reaction time. This test assesses the reaction time during gradually increasing choice options.[12,16]

Heat Application Protocol

After the initial assessments and measurements were completed, the case was asked to lean back to the chair, hold an electronic hand warmer in each hand and relax. The electronic hand warmers used in this report were "Zippo HeatBank® 6". This device can provide temperatures up to 50°C and is used by professional e-sports players and competitive gamers. The heat was applied for 5 minutes by asking the case to hold one heating device in each hand while fully grasping the device in a relaxed sitting position, considering the average time a professional/competitive gamer pauses for the preparation phase prior to each match/session reported according to the tournament rules for the main game of the case.[17] The heat was applied with the first heat level (below 44°C) of the device to prevent any uncomfortable effect according to the literature.[18] During the heat application, the case was asked not to let go of the hand warmers and/or contact any other surface to prevent any heat loss or gain.

RESULTS

After the 5-minute heat application, the temperature of the palmar side of both hands was increased by 2 °C. Additionally, the temperature of the palmar side was approximately 1 °C higher compared to the initial measurement. The case reported that he relieved and performed given tasks more comfortably after heat application.

Mouse speed during the "Manual Dexterity Test" was almost doubled in perturbation levels of 4,7,13 and 16. In the easiest perturbation level, it remained almost the same before and after heat application (2.69 cm/sec and 2.68 cm/sec respectively). On the other hand, in level 19 (hardest) it was almost halved (Table 2).

In the "Compensatory Tracker Test" median deviation and mean mouse velocity values were the same but mean deviation values were decreased from 0.31 cm to 0.29 cm after heat application (Table 3).

In the "Hick's Law Demonstration" the accuracy was 100, 88, 94, and 96 percent before heat application whereas 100, 86, 92, and 92 percent after heat application for 1, 2, 3, and 4 choices respectively (Table 4). Mean reaction time was faster in all choice conditions except 2 choices but median values were better (lower) in all conditions after heat application (Table 4).

In the "Tapping Task," keypresses in 10 seconds were 56 and 57, and reaction time values were 180 ms and 176 ms respectively before and after heat application.

Table 1. Demographics, gaming habits, and daily sleep duration of the case.

Age	21
Gender	Male
Body Mass Index	28.08 kg/cm^2
Mouse hand	Right
Preferred gaming platforms	PC
The average duration of a gaming session	2 h/session
Average weekly gaming time	15 h/week
The average duration of a PC gaming session	2 h/session
Average weekly PC gaming time	15 h/week
Average daily sleep duration	7 h/week

Table 2. Comparison of mouse speed and speed/move ratio of right (mouse) hand with variable targets between before and after heat application (Mouse Dexterity Task).

	Mouse Speed (cm/sec)		Speed/Move Ratio (cm/sec per move)	
Noise Condition (Intensity)	Before Heat Application	After Heat Application	Before Heat Application	After Heat Application
1	2.69	2.68	0.03	0.04
4	2.91	5.71	0.05	0.13
7	1.67	2.95	0.01	0.04
10	2.68	3.14	0.04	0.05
13	2.71	4.78	0.03	0.09
16	2.30	5.64	0.02	0.12
19	4.34	2.08	0.07	0.03

Table 3. Comparison of overall control and mouse dexterity of right (mouse) hand with a static target between before and after heat application (Compensatory Tracker Task).

	Mean Deviation From the Target (cm)		Median Deviation From the Target (cm)		Mean Mouse Velocity (cm/ms)	
Number of trials	Before Heat Application	After Heat Application	Before Heat Application	After Heat Application	Before Heat Application	After Heat Application
1	0.42	0.30	0.25	0.26	0.12	0.09
2	0.25	0.24	0.21	0.22	0.09	0.08
3	0.28	0.34	0.24	0.24	0.08	0.10
4	0.27	0.26	0.24	0.24	0.08	0.09
Average of 4 Trials	0.31	0.29	0.24	0.24	0.09	0.09

Table 4. Comparison of reaction time of left (keyboard) hand with increased choices before and after heat application (Hick's Law Demonstration).

Number of choices	Button Choices (a)	Accuracy (%)		Mean Reaction Time (ms)		Median Reaction Time (ms)	
		Before Heat Application	After Heat Application	Before Heat Application	After Heat Application	Before Heat Application	After Heat Application
1	2	100	100	248	175	263	202
2	2 and 3	88	86	318	322	319	313
3	1, 2 and 3	94	92	507	376	426	362
4	1, 2, 3 and 4	96	92	475	419	463	389

(a): Button label on the keyboard. Accuracy was calculated out of 50 button presses, %100 accuracy means 50 out of 50 correct key presses.

DISCUSSION

The short-term (5 minutes) heat application by using a commercially available electronic device indicated improvements in fine motor skills of the dominant (mouse) hand. However, on the non-dominant (keyboard) hand the results were observed to be controversial.

According to the results of the "Mouse Dexterity Test" mouse speed and mouse speed/move, the ratio was increased after short-term heat application in 5 of 7 different perturbation levels (Table 2). Furthermore, the values of 4 of these 5 different perturbation levels were almost doubled (Table 2). However, in the easiest level mouse speed was almost the same and at the hardest level, it was almost halved after short-term heat application. These results indicate that some improvements may be acquired with a short-term heat application in gamers. However, we were not sure about the mechanism of this since the literature reported that heat may also have a positive effect on cognitive performance. Yet we believe that the performance increase, in this case, might be mainly due to muscle-related features since such a short-term and local heat application may not be enough to induce and/or enhance cognitive performance.

"Compensatory Tracking Test" results indicated exactly the same results before and after heat application except for mean deviation from the target. We believe that this may be due to the type of the task. Considering the action and the need for quick decision-making and acting in competitive gaming, this task may be perceived as easy to complete. The case is considered to be a hardcore gamer according to his gaming time thus his mouse control is expected to be above average and this task is static compared to the "Mouse Dexterity Test". Thus his performance might be already at the peak level for this test and that's why the results were exactly the same.

Contrary to the results of the mouse hand, the results of the keyboard hand were controversial. The results of one test were somewhat similar before and after heat application. On the other hand, the second keyboard hand test indicated interesting results. Depending on the results of the "Tapping Test" the overall performance of the case remained almost similar before and after heat application. When 8 trials were examined separately the data were also do not present any explainable difference. However, the results of the "Hick's Law Demonstration" test were exhilarating. The case indicated decreased accuracy values apart from heat application as expected according to Hick's Law, where performance decreases parabolically related to the number of choices.[16] However, the accuracy was lower after short-term heat application. The exhilarating aspect of these results was that even though the decreased accuracy, both mean and median reaction time values (except one) were decreased. This means that after heat application the case was reacting faster. We believe these data were not enough and should be considered with decreased accuracy in mind. Further studies may find a relation or an optimal ratio for increased reaction time/accuracy value. In competitive gaming where both the accuracy and the reaction time

are important, the coaches and the players may choose to sacrifice some of their accuracies for shorter reaction times.

We believed that using a commercially available electronic device for heating enabled us to perform heat application in a methodological way. The device can be acquired easily and the temperature ranges are definite as opposed to gel packs used by some players. As a not, we humbly suggest using digital units (ex. pixels, milliseconds, etc.) for further studies since the difference may be easier to detect.

We would like to suggest readers carefully evaluate the results since the validity and reliability of the specific PEBL tests were not properly conducted due to copyrighting the tests.[12] Thus especially for newer tests within the PEBL further studies may need to identify validity and reliability for specific settings and setups.

Conclusion

Even though the positive effects are notable in the mouse hand (reduced reaction time, mouse movement speed, and better overall control of mouse movements), the performance of the keyboard hand (reduced reaction time but reduced accuracy in repeated keystrokes) is questionable. Short-term (5 minutes) heat application reduced reaction time and increases the overall mouse movement speed in the mouse hand, however, in the keyboard hand, reduced reaction time is acquired with the cost of accuracy.

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