Proceeding

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Effects of gaming glasses on the autonomic nervous system while playing e-Sports

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ABSTRACT

[Purpose]Eyestrain associated with playing e-Sports has been identified as a problem. Several types of glasses for use during play have been developed to address this, but the studies to prove their efficacy are scarce. This research aims to examine what influence the wearing of gaming glasses has on the autonomic nervous system when playing e-sports. [Method] 60 students were divided into 3 groups, with two of these using gaming glasses and one group using demonstration lenses. Each group got Standard Deviation of Normal to Normal (SDNN), Physiological Stress Index (PSI), Total Power (LF/HF/VLF), Sympathetic Nerve Activity (LnLF), Parasympathetic activity (LnHF), as well as Sympathetic and Parasympathetic Balance (Ln (LF/HF)) Autonomic Nervous System measurements (6 in total) before and after playing one videogame for three hours. [Results and remarks] Blue and Gray lenses were compared against demonstration lenses with the results of the SDNN, showing a higher and healthier heartbeat variability, stronger resistance to stress and improved concentration after playing. Furthermore, the results of the Ln (LF/HF) showed the use blue lenses remarkably improved Sympathetic and Parasympathetic Balance, both working actively and in good form. These results suggest the wearing of gaming glasses during play have a real effect on players.

Keywords: e-Sports; Autonomic nervous system; Eyes; Gaming glasses.

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INTRODUCTION

e-sports is an abbreviation of "*Electronic Sports*", a term used broadly to refer to some forms of entertainment, competitions and sports done through the use of electronic devices, and particularly to when PC and console videogames are played as a form of sports competition. These e-sports have expanded around the world in recent years at a very fast pace. Especially, since the development of professional e-sports leagues, it has shown a remarkable ability to attract viewers as a spectator sport, raising its profitability and securing an important position in the sports industry (Wagner, 2006).

On the other hand, scientific research related to e-sports has been insufficient. Particularly, studies related to e-sports and health hazards associated with the playing of videogames, as well as the development and assessment of preventive measures are not seemed to receive the required attention (Keyi et al., 2020). It can then be said that research pertaining the health of players is in need. For example, it has been reported that in order to become a professional e-sports player for a team in the Netherlands, they need to spend some 50 hours every week, with teams in South Korea requiring 12 to 14 hours of daily training (Jacobs, H. 2015; Sky and Jenifer, 2016). It is thought players suffer from eyestrain as they need to keep looking at screen displays for long periods of time.

Until now, eye fatigue has been studied in environments where eye-straining activities are common, such as when using computers at work or when looking at phone screens for extended periods of time, with several terms such as *VDT Syndrome* (Computer Vision Syndrome) or *Technostress* used to describe symptoms caused by the use of video screens of IT devices (Takahashi, 2005). Furthermore, with the pervasiveness of video screens another term known as *digital eye strain* has been pointed out (Ioanna et al., 2020). Another term for this is *Computer vision syndrome* (Mark, 2016). Is has been noted that one of the main causes for these problems comes from the blue light emanating from electronic devices.

Within the range of visible light and of a small wavelength there is what is known as *blue light*, which ranges from 380 to 500 nanometres and is the type found in LED displays used in computers and smartphones. Overexposure to this light is known to have several bad effects on the eyes (Ozawa and Ide, 2015). Blue light scatters easily due to its short wavelength, causing flickering and glare and making it difficult for the brain to adjust eyesight properly. Also, since blue light uses more energy than other types of light, it strains the muscles around the eyes as they try to contract repeatedly. This effect is also one of the causes of eyestrain, retinitis pigmentosa, age-related macular degeneration, dry eyes and the like. Besides the damage to the eyes mentioned before, there are other known effects such as sleep disorders, obesity, cancer and mental condition due to the confusion of the circadian rhythm (Wada, 2018; Blue Light Society, 2016).

In order to avoid the effects of blue light, measures such as limiting the time spent in front of the display, adjusting the brightness and contrast, as well as the use of filters or glasses that cut blue light, etc. have been proposed (Blue Light Society, 2016). Since reducing time in front of a screen causes difficulty for e-sports players who need to train for long hours, they wore blue-light cutting glasses for the purpose of this study.

More specifically, we decided to study the effects on the autonomic nerve system when using gaming glasses developed by G-SQUARE for use in e-sports. G-SQUARE applied multiple coatings and original colouring technologies on the lenses to cut 30 to 40% of blue light. Also, not only cutting blue light, but also by applying a glare-reducing coating, they were able to reduce the burden on the eyes caused by long hours of game-play. Moreover, since this coating also suppresses the flickering caused the reflection of light commonly

found in common blue-light blocking glasses, players were able to focus more on their game. It was for the reasons above mentioned that we decided to use G-SQUARE's glasses.

Even though we studied the reactions of the autonomic nerve system to the use of gaming glasses, perceiving these is actually a difficult subject, since it is continuously working to keep normal mind and body functions, with both sympathetic and parasympathetic nerves automatically reacting to both internal and external stimuli in order to adjust the functions of internal organs and keep their balance. There are also cases where the Central autonomic nerves in the brain and spinal cord can cause autonomic ataxia (unbalance) due to several types of stress or fatigue (Nishida et al., 2012). It this therefore that by looking at the reactions between the sympathetic and parasympathetic nerves of the autonomic system that we can assess the effects on the brain and the body (Motoyama et al.,2017).

From the above, we decided to set out as our purpose to study the effects of the use of gaming glasses on the autonomic nervous system while playing e-sports.

METHODS

Duration of the study

We carried out this study on six occasions during an e-sports class at a vocational school from August 17th to September 16th of 2020.

Study subjects

60 students aiming to become programmers at the department of e-sports at a vocational school. Their average age was 19.1 years old, 59 of them male and 1 female.

As for the numbers of subjects with eyesight correction, 28 people wore glasses, 9 wore contact lenses and 23 people didn't need any. The average sleeping time was 6 hours and 58 minutes, with daily videogame playtime between 6 to 9 hours being the most common with 35 people, followed by 15 people playing between 3 to 5 hours and 8 people between 10 to 12 hours. (Figure 1).

The study was carried out after thoroughly explaining the subjects about the dangers related with the content and measurements, obtaining their verbal consent and taking the necessary precautions.

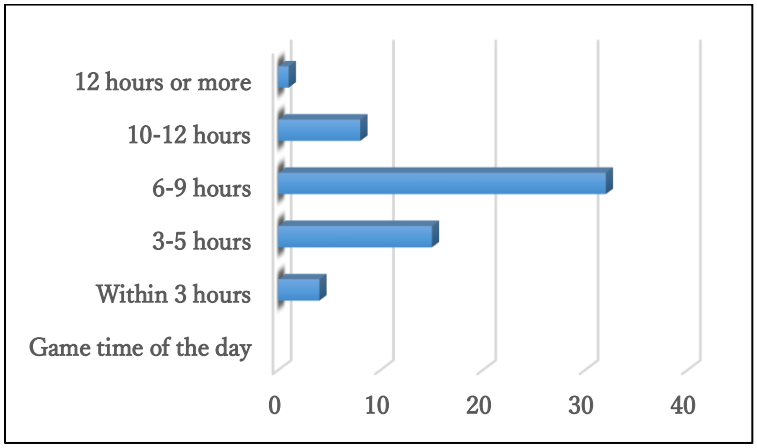

Figure 1. Daily play time average.

Gaming glasses used

Gaming glasses from G-SQUARE Lenses (NIDEK Co., Ltd) were used. Unlike common work in front of a PC, the amount of light emitted from screens used in the gaming scene is quite higher, becoming one of the causes of eyestrain. G-SQUARE Lenses were developed to reduce the burden on the eyes caused by long hours of playing videogames. Multiple coatings and original colouring technologies were applied on these lenses in order to cut 30 to 40% of blue light, also limiting the amount of flicker caused by light reflection. Glare-reducing coating (hexagonal coating called "*Lequa-Mesh*") is also used. Though coloured lenses optimized for each genre were provided, only gray lenses for FPS games and blue lenses for overall gaming were used for the purposed of this study. Since the number of glass-wearing players was high, fit over glasses were also used (Figure 2).

Figure 2. Fit-over frames that can be used with normal glasses.

Used videogames: FPS

The type of videogames used for this study are known as FPS (First-person shooter) games (Rainbow Six Siege, Overwatch, League of Legends, PUPG, etc.) FPS is a type of shooting videogame played from the point of view of the character itself (first-person). The characters can move around the game's world/space, using weapons and sometimes bare-hands to battle against other opponents.

Autonomic Nerve System Measurements

We used a device called TAS9 in order to carry out the measurements of the autonomic nerve system. TAS9 is a medical device that uses pulse waves to capture changes in the capacity of peripheral blood vessels, extracting the pulsations from the intervals of the pulse wave's heights, then using this data to analyse the balance of the autonomic nerve system.

We used TAS9 to measure 1) Standard Deviation of Normal to Normal (SDNN), 2) Physiological stress index (PSI), 3) Total Power (LF/HF/VLF), 4) Symphatetic Nerve Activity (LnLF), 5) Parasymphatetic Nerve Activity (LnHF), and 6) Symphatetic and Parasymphatetic Nerve Balance (Ln(LF/HF)).

Experiment Procedure

The experiment was carried out during e-sports classes, with the approval of the teacher in charge and with the cooperation of related teaching staff. The distribution and positioning of lighting and game consoles was the same in all cases. The 60 subjects were divided into 3 groups according to the type of lenses used. 21 people were in the gray-lenses group, 21 in the blue-lenses and 18 people in the control group who wore

demonstration lenses. All subjects participated in the groups during the six sessions. The procedures for each experiment were the same as mentioned below (Figure 4).

Figure 3. TAS9 System.

1) All subjects received an explanation about the contents of the experiment and their consent was requested 2) Autonomic Nerve System values were measured using TAS9 during 2 minutes and 30 seconds. 3) 3 hours of e-sports play wearing each different type of glasses, 4) Autonomic Nerve System values were measured using TAS9 during 2 minutes and 30 seconds, 5) Collecting of impressions about the feelings when wearing each glass, 6) End of the experiment session.

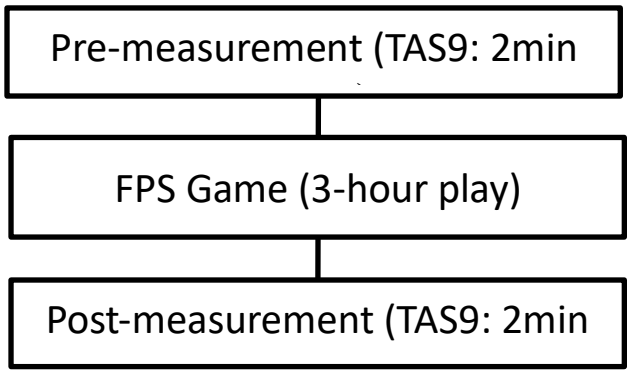

Figure 4. Measurement procedure.

RESULTS AND DISCUSSION

In order to evaluate Autonomic Nervous System functions, we used TAS9 to perform the following 6 data measurements, before and after e-sports gaming sessions: 1) Standard Deviation of Normal to Normal (SDNN), 2) Physiological stress index (PSI), 3) 3) Total Power (LF/HF/VLF), 4) Sympathetic Nerve Activity (LnLF), 5) Parasympathetic Nerve Activity (LnHF), and 6) Sympathetic and Parasympathetic Nerve Balance (Ln(LF/HF). For each measured value, we performed variance analysis for each type of lenses (gray, blue, demonstration) before and after each gaming session. The results are as follows:

Standard Deviation of Normal to Normal (SDNN)
It shows heart-rate fluctuations. Higher fluctuation values indicate a healthier condition, and an increase in fatigue causes a drop in fluctuations and lower values shown.

Compared with the small -.18 change when using demonstration lenses, gray lenses showed a 5.19 rise, and blue lenses a 5.05 rise in values ($p < .10$), indicating a good health condition after play (Figure 5).

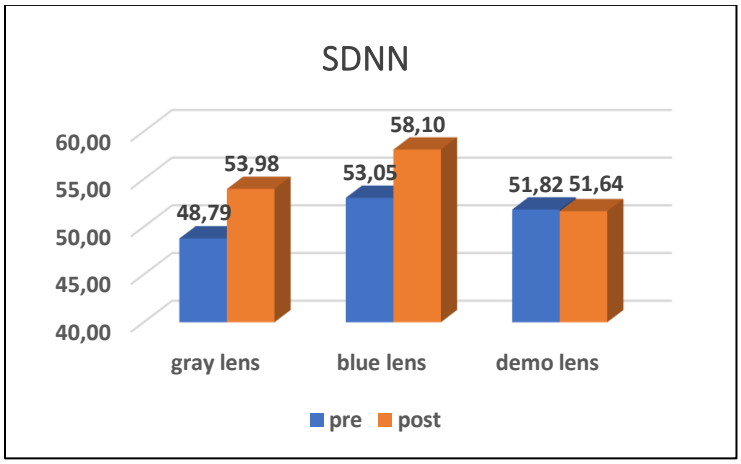

Figure 5. Pre/Post play SDNN compared values for each 3 groups.

Physiological stress index (PSI)
PSI shows the conditions of accumulated physical fatigue. No significant differences were observed, with demonstration lenses showing a small .11 increase, while gray lenses showed -.22 and blue lenses -.05 decreases (Figure 6).

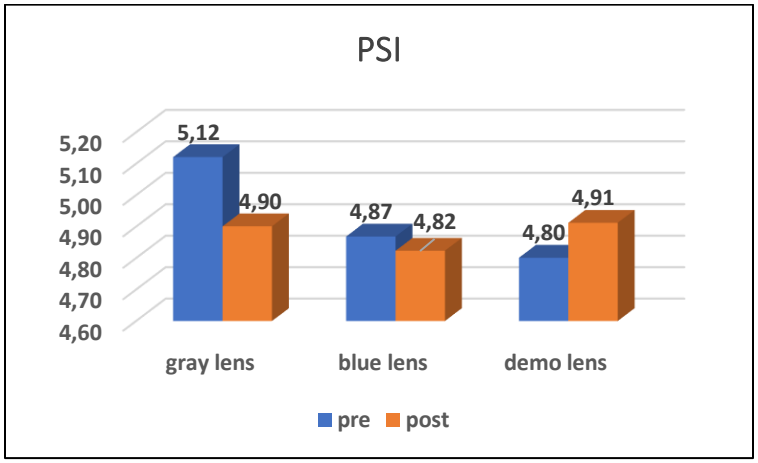

Figure 6. Pre/Post play PSI compared values for each 3 groups.

Total Power (LnTP)
Total Power indicate greater tolerance levels to higher levels of stress. Demonstration lenses showed a -.16 decrease, against a significant .24 increase trend ($p < .10$) with gray lenses and .09 with blue lenses, indicating greater tolerance to stress after gaming sessions (Figure 7).

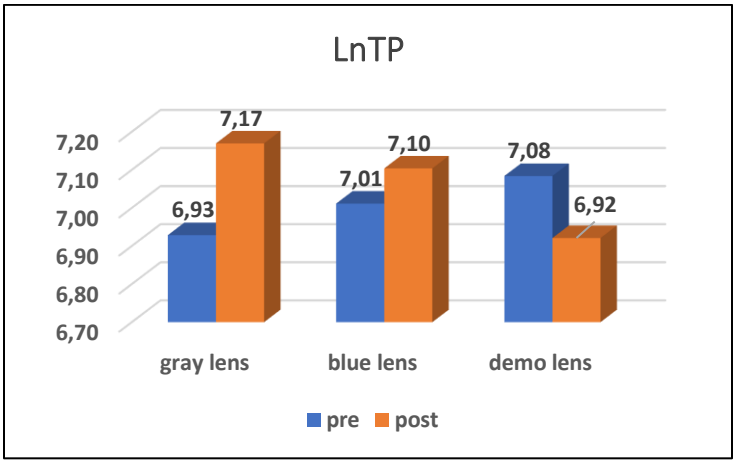

Figure 7. Pre/Post play LnTP compared values for each 3 groups.

Sympathetic Nerve Activity (LnLF)

The autonomic nerve system is divided into sympathetic and parasympathetic nerves, with both controlling the homeostasis of each of the body's organs. Sympathetic nerves are more active during situations of excitement, concentration and stress. While demonstration lenses showed a -.32 decrease in values, gray lenses showed a .29 increase and blue lenses .19, indicating that while values increased with a higher excitement after playing, the difference was not significant (Figure 8).

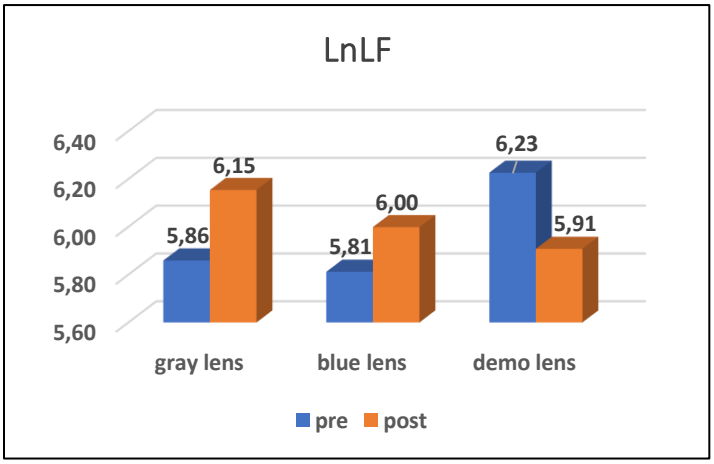

Figure 8. Pre/Post play LnLF compared values for each 3 groups.

Parasympathetic Nerve Activity (LnHF)

Parasympathetic nerves are more active during times of relax and rest. Demonstration lenses showed a -.14 decrease, with blue lenses showing a -.28 decrease in values. On the other hand, gray lenses presented a significant .22 increase in value ($p < .05$), clearly indicating greater relaxation levels after play (Figure 9).

Sympathetic and Parasympathetic Nerve Balance (Ln(LF/HF))

Higher activity values indicate better balance between sympathetic and parasympathetic nerves. Blue lenses showed a significant .10 increase ($p < .05$), while gray lenses showed a small .03 increase, and demonstration lenses a -.03 reduction (Figure 10).

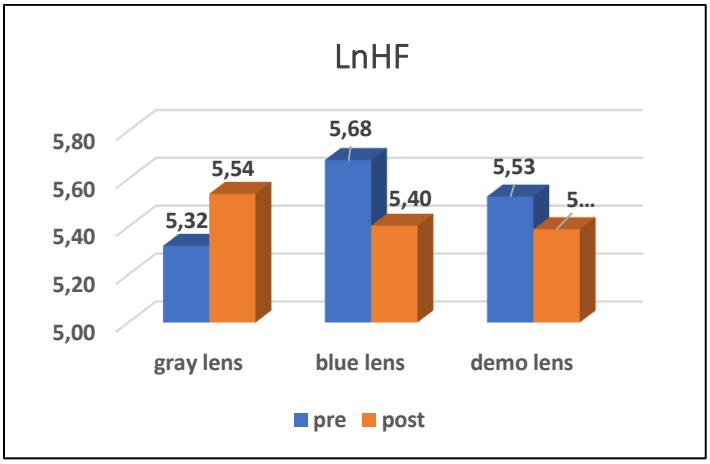

Figure 9. Pre/Post play LnHF compared values for each 3 groups.

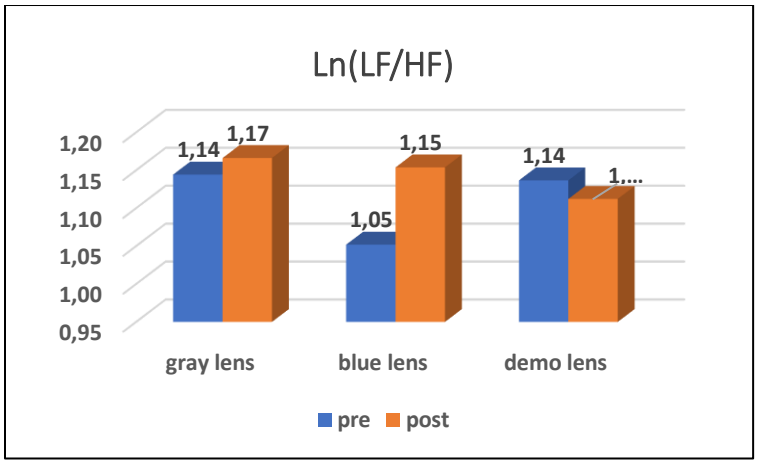

Figure 10. Pre/Post play Ln(LF/HF) compared values for each 3 groups.

When considering the 6 measurement results related to autonomic nerve system in a comprehensive manner, it can be said that when comparing the use of G-SQUARE's blue and gray lenses that cut 30 to 40% of blue light with the use of demonstration glasses, there was a larger heart-rate fluctuation after playing, indicative of a healthier condition, as well as improved resistance to stress and higher concentration. Blue lenses also demonstrated a prominently better balance between sympathetic and parasympathetic nerves after playing, a clear indication of mind and body in good condition with both nerves working actively (Nishida et al., 2012).

As stated above, compared with the use of demonstration lenses, blue and gray lenses showed better results regarding fatigue and autonomic nerve system performance, suggesting the effectiveness of wearing blue light-cutting glasses such as those from G-SQUARE while playing e-sports. Due to the time limitations during experiments for this study, we consider necessary to carry out further testing under longer-hour play conditions and for extended periods of time in order to analyse the effectiveness of gaming-glass use. Health hazards derived from playing e-sports, as well as their preventive measures are subjects that have already been pointed out (Keyi et al., 2020). We therefore consider necessary to carry out more research related to eye-fatigue and e-sports in the future.

CONCLUSIONS

In order to investigate how to prevent eye-fatigue related to e-sports, we decided to set out as our objective to carry out the present study on the use of gaming glasses when playing e-sports and their effects on the autonomic nerve system. With 60 students from the e-sports course at a vocational school as subjects, we assigned them 3 kinds of glasses, 2 of these being gaming glasses (gray lenses and blue lenses), as well as demonstration lenses. The subjects were then asked to play FPS videogames for 3 hours, measuring 6 items related to autonomic nerve system functions before and after each play session. Many of these measurements indicated a good influence on mind and body conditions after playing when gaming glasses were used. This suggests the effectiveness of wearing gaming glasses when playing e-sports.

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