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COMPARATIVE ANALYSIS OF THE COMPUTER VISION SYNDROME BETWEEN THE DEVELOPED EU COUNTRIES AND REPUBLIC OF SERBIA

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Abstract: It is hard to envisage any business activity nowadays without the use of computers. The users who in their work utilize computers or some other displays for viewing electronic contents are exposed to the computer vision syndrome effects. This paper defines the computer vision syndrome and explains occurrences of the syndrome, setting out also its consequences. Analysis has been made of the viewpoints of users from the developed EU countries regarding the computer vision syndrome. Comparison has been made of the obtained data with the data showing viewpoints of the users in the Republic of Serbia. The aim of this analysis is to form a comprehensive picture of the computer vision syndrome issues. At the end of the paper, solutions are depicted for reducing the consequences and preventing the computer vision syndrome occurrences.

Keywords: computer display, eye aids, computer vision syndrome – CVS, engineering work, eye morphology

1. Introduction

New technologies have been changing the ways in which people communicate. They enable constant education and information for the users. Owing to their widespread reach, it is necessary, in addition to their positive aspects, to analyze also the negative features of the new technologies, i.e. the risks posed by using of contemporary electronic devices (mobile phones, computer screens, game consoles and similar) (González-Pérez et al., 2018; Fabricio Ccami-Bernal et al., 2024). This paper analyzes one of the problems occurring as the consequence of intensive usage of electronic devices – the Computer Vision Syndrome (CVS) (Vate-U-Lan, 2015). The CVS is a complex eyesight syndrome resulting from protracted watching the display of a computer or some other electronic device. (Marwa et al., 2021) This syndrome implies

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headaches, blurred vision, tired and dry eyes, neck and shoulder pains, sleep disorders (Ahmed et al., 2016; Zovkic et al., 2011; Dimitrijević et al., 2023; Altlhi et al., 2020) for which it is presumed to occur in 70% (from 64% to 90%) of computer users (Charpe & Kaushik, 2009; Selvaraj et al., 2021). These symptoms take place when the visual demands exceed visual abilities of an individual to perform the task (Zainuddin & Mohd Isa, 2014). The main reasons for existence of this syndrome can be poor lighting of the room, glare on the screen, improper viewing distance of the user, poor seating posture (American Optometric Association, 2019) or combination of any of these causes (Mowatt et al., 2017).

This syndrome is manifested through eye anomalies or superficial accommodative spasms or extra of the eye (ergonomic). All these problems occur with the individuals who do not have sufficient visual capacities to comfortably perform the computer task (Viduka et al., 2017).

Although use of computers enables fast and efficient performing of tasks, its excessive use significantly affects the users' health. Use of a computer for several hours (more than three hours) brings about the professional risk of developing the Occupational Overuse Syndrome (OOS), Computer Vision Syndrome (CVS) and psychosocial stress (Ahmed et al., 2018). Other authors have also agreed regarding the causes of subsistence of these undesirable effects, like (Toama et al., 2012). According to American Optometric Association – (AOA), as much as 70-75% of users working on computers have experienced numerous vision problems which have been collectively encircled under the name Computer Vision Syndrome – CVS) (Viduka et al., 2017; Žunjić, 2014).

If these problems are neglected, there is a great probability of their recurrence or even worsening in future. Although it has not been proven that the tasks performed on computers can cause permanent damage to the eye, there is a great probability that they will cause temporary discomfort that can bring about lowering of employees' performance causing work time losses, as well as diminishing of the employees' work satisfaction. This syndrome affects 90% of the employees (Rosenfield, 2011) who use computers in their work for more than three hours every day. Surveys reveal that this syndrome can reduce employees' performance in certain tasks even up to 40% (Zainuddin & Mohd Isa, 2014). Owing to great technological advances and to the drop in hardware prices, the use of computers is rising in performing the ever-larger number of tasks. The tasks requiring long time computer work, i.e. the work longer that eight hours a day, actually refer to the engineering work where the computer is used as the basic tool of the trade.

The problems related to computer vision syndrome mainly come about due to the fact that human eyes have basically been conceived for remote vision. However, nowadays we have evaluated from the primeval hunters to computer users who in everyday work spend most of their time looking at screens of electronic devices. These new work conditions in the novel visual environments are named in literature as the disease of the millennium (Logaraj et al., 2014).

2. Preceding studies

The condition of health is an essential aspect of life which should be looked after all the time. Existing health issues can have negative effects on both business and private aspects of life. Research studies on this subject have been going on in the last 30 years. Most of these papers were created at the very beginning, i.e. at the time when the problem was determined and defined as the CVS we know today. The trend can be observed of the increasing number of such papers, mainly coming from universities worldwide. This, however, is still a poorly covered topic, considering the number of people affected by this problem. This topic is rarely mentioned in expert circles, except in case of medical workers. However, the occurrence of

health issues can be observed also through the prism of economic factors such as loss of employees' productivity, increase in sick leave days, diminished satisfaction of employees and employers, etc. If observed from this angle, the very topical subject for further research studies comes into focus.

Although the CVS is named the millennial disease, there is a small number of researchers dealing with this topic. In recent years, however, a move forward has been observed in this field. Some of the research studies analyze the computer vision syndrome with students, some with medical staff or with administrative workers, but with engineers also. The researcher Seshadhri with associates analyzed in 2014 the link between number of hours spent on computer work and the occurrence of computer vision syndrome. This research study came to the conclusion that there were no connections between the total number of hours of computer use and occurrence of the syndrome.

The study conducted in 2014 by Logarel et al. at Chennai University on engineers and medical staff showed that prevention among engineers was 81.9%, and 78.6% among medical students. This study also proved that the students who used computers for four to six hours daily had a higher risk of developing the symptom. Contrary to the previously mentioned study, this study showed there was a correlation between the number of hours spent at work on computers and the CVS symptoms occurrence.

The results of the research conducted in Malaysia on IT students, medical and administrative staff shows that 55% respondents have experienced tingling in the eyes, 61% have had headaches, 46% redness of eyes while 87% of respondents have felt tiredness of eyes and eye lids after six hours spent in front of a computer screen.

Furthermore, in 2013, a research study was conducted by Reddi SC and associates on Malaysia University students. The aim of the study was to determine the visual symptoms, related factors and the knowhow and practice in computer use (Thilakarathne et al., 2014).

One of the studies has dealt with researching the average time the users spend using the mobile phone. The results have shown that in 2011, the mobile phone was used 98 minutes per day, while it rose to 195 minutes in 2013. This study demonstrated the increase in time of mobile phone use and the amount of time people spent watching the screens. The mobile phone screens are rather small, thus requiring additional strain of the eye and bringing about rapid eye tiredness and some of the CVS related symptoms. One of the studies which analyzed the mobile phone (smart phone) blue light consequences has proven adverse effect of this type of light to the corneal epithelium cells in humans. Excessive exposure to the blue light has caused deterioration of the tear film and increase in the inflammatory markers of the eye surface (Choi et al., 2018). In 2014, a study was conducted in Serbia aimed at discovering how much the users know about computer vision syndrome and about the modes of its prevention (Viduka et al., 2017). Comparison was made within that study of the results obtained in Serbia which is in the process of EU accession, with the data from the EU member countries.

3. Job of the future

It is often stated that a job in the field of information-communication technologies is the job of the future. Many parents advise their children to take studies in that particular domain. However, choosing a job in this field should be observed by taking into consideration the computer vision syndrome and the difficulties it brings about (Hashemia et al., 2018). Namely, each educated engineer, and an IT engineer in particular (because the computer is basic tool of the trade in IT, and not just a work aid) is expected, after completing the education and when starting to work, to have a working life of 40 years. This requirement poses a heavy burden for the user's health, (Urbanova et al., 2023) as he/she spends the minimum of eight hours on

computer work (which is about 84,480 work hours in their work life) (Viduka et al., 2017). This job, as well as most of the jobs today, necessitates multiple hours of computer work, thus presenting a certain health hazard. One of the causes of health problems occurrence can be the work space strong light, which also can bring about development of the vision problems (Ahmed et al., 2016).

This paper gives its contribution to increasing the awareness of the health protection importance, (Zarina et al., 2022) with special emphasis on the people whose work implies continuous computer work. It is very important for engineers, as well as for other employees, to be informed about the risks involved in the use of computers as well as about the ways to decrease that risk and about the means of protection.

4. The situations in the countries where studies have been conducted

There are few research studies dealing with the computer vision syndrome status and the related protection modes in the European Union countries. This paper analyzes the points of view of users in the European Union (EU) developed countries regarding the computer vision syndrome. The obtained data are compared with the data showing viewpoints of the users in the Republic of Serbia (SRB), which were obtained in the previous study. The results of the previous study of the CVS issues in the Republic of Serbia, point to the existence of a large number of users with this syndrome. (Balaban et al., 2021) Despite that fact, the conducted study has shown that there is a small percentage of users who are familiar with the causes of this syndrome occurrence, its consequences as well as the possible protection means.

5. Research method

The research study conducted for the needs of this paper was realized by the use of an electronic questionnaire. The electronic questionnaire was put up on a certain Internet address, which the authors of the paper shared with social networks and expert forums gathering large number of computer users for their business and other purposes. The questionnaire was designed in such a way that the respondent first provides essential information such as gender, age and profession, which is followed by the questions related to the use of computers and the respondent's opinion about the topic of the research. This was the identical questionnaire to the one we had used for the research study in the Republic of Serbia, the only difference being that it was translated into the English language and limited to the users in the EU member countries. Users from the following EU member countries took part in our study: Croatia (75), Greece (42), Slovenia (30), Romania (27), Slovakia (21), France (15), Check Republic (15), Italy (15), Bulgaria (12), Germany (9), Spain (3), Sweden (3) and Austria (3). All the questions in the questionnaire were compulsory ones, and the condition for a successful forwarding of the filled-in questionnaire to this paper's authors' email was answering to all the questions posed. Captcha was used as the protection means intended to prevent computer robots to fill-in the questionnaire themselves, affecting in that way validity of the results obtained.

6. Research results

There were 270 respondents in the carried-out research coming from the countries within the EU, while, for comparison, the results were used of the study showing the situation in the Republic of Serbia, where there were 90 respondents. This is to say that we analyze in this paper the points of view of the total of 360 respondents from both the studies. Out of that number of respondents, there was a majority of 239 male respondents, where 147 of them came from the EU and 65 of them from Serbia. The youngest respondent was 18 and the oldest one was 67.

There was a large number of women (total of 121 of them), with 96 coming from the EU and 25 from Serbia. This ratio was the expected one, considering that there are still more men employed in the technical sector.

In addition to the actual number of respondents, another factor also added to the significance of the research, and it was the age span of the respondents. The respondents were divided into two categories, with one category comprising those younger than thirty and the other one the respondents older than thirty. This age limit was taken as the rough half of the life span and working life of people. Out of the total number of respondents, 215 of them are thirty or younger, with 177 of them coming from the EU, and only 38 from Serbia. The second category, comprising 145 people older than 30, was the smaller group with respect to the total number of respondents. Among this group, 93 people were from the EU and 52 from Serbia.

Besides the information on the respondents' profession and age, it was very important to us to learn how many respondents used some of the aids such as lenses, spectacles or artificial tears. Out of the total number of respondents, a large number of them, i.e. 209, did not use any aids, with 162 of them coming from the EU and 47 from Serbia. Lenses are used by 18 of the respondents (EU - 12 and SRB - 6), spectacles by 107 respondents (EU - 75 and SRB - 32) while artificial tears are used by 26 respondents (EU - 21 i SRB - 5). This was a good indicator, considering that majority of the respondents did not have any need for the aids. On the other hand, the number of those who use some of the aids is rather high, referring primarily to those using the spectacles as the traditional aid.

The last datum in Table 1 shows the number of hours spent on the computer within one day. The questions referring to the hours are divided into five categories. The first category consisted of users who spend from zero to two hours on the computer daily, where 58 respondents gave their confirmatory answers (EU - 42 and SRB - 16). The second category comprised users who spend from two to four hours a day and here 84 respondents gave their affirmative answer (EU - 66 and SRB - 18). In the third category are the users who use computers from four to six hours daily, and there are 66 of them in our study (EU - 51 and SRB - 15). The fourth category consists of users who use computers from six to eight hours a day, and 66 respondents marked this in our study (EU - 51 and SRB - 15). The last category refers to those who use the computer for more than eight hours a day and there were 86 of them (EU - 60 and SRB - 26). These parameters have shown to us the kind of the group of respondents in our study, indicating whether we have come across the target group of people using the computer to large extent within a day. All the above stated pieces of information are contained in Table 1.

Table 1. General research information

|		SRB	EU	Total
Respondents' gender	Male	65	174	239
	Female	25	96	121
Respondents' age	≤ 30	38	177	215
	> 30	52	93	145
Does the respondent use some of the eye aids?	No	47	162	209
	Lenses	6	12	18
	Artificial tears	5	21	26
	Spectacles	32	75	107
The average time spent by the respondent on the computer.	0 – 2h	16	42	58
	2 – 4h	18	66	84
	4 – 6h	15	51	66
	6 – 8h	15	51	66
	More than 8h	26	60	86

Source: Author's research

Interesting data have been obtained by analyzing the age of the users who have had some of the CVS symptoms, as depicted in Table 2. It is possible to discern that there are more respondents younger than 30 who have had some of the CVS related symptoms. It is especially worrying that in the age group up to 30 there are more respondents experiencing problems than those who do not. There are more respondents from the EU having these problems than those in Serbia.

Table 2. Ages of respondents who have experienced problems

Ages of respondents who have experienced problems (some of the symptoms)				
	≤ 30		> 30	
	Have	Don't have	Have	Don't have
EU	114	66	42	48
SRB	12	26	20	32

Source: Author's research

The ratio of the respondents with perceived CVS symptoms, according to the gender, is shown in Graph No. 1. The results reveal that there are more men experiencing these problems. However, the difference in the number of men with the perceived CVS symptoms is negligible with respect to the number of women with the same problem.
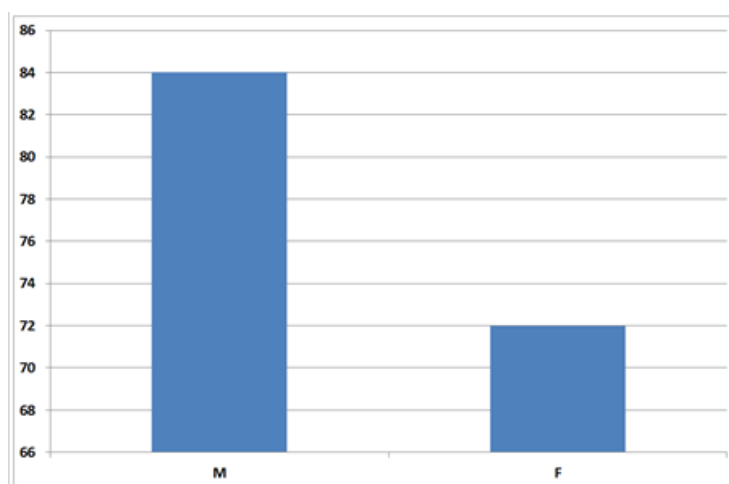

Graph 1. The ratio of the number of respondents with perceived CVS symptoms, according to gender
Source: Author's research

Further analyses of the data obtained in the study have provided other useful outcomes shown in Graphs 2, 3, 4, 5 and 6.

Total of 72 respondents have heard of the CVS, while as many as 198 respondents in the EU countries have never heard of this syndrome (Graph 2).

The results reveal very low awareness of the problem existence and low degree of knowledge about this topic. Intensive action is required towards informing the users about the health-related risks involved in using computers. In view of the obtained results, it would be desirable to introduce to technical faculties some lectures of informative character, where students could obtain more information regarding development of the computer vision syndrome, as well as about possible preventive measures.
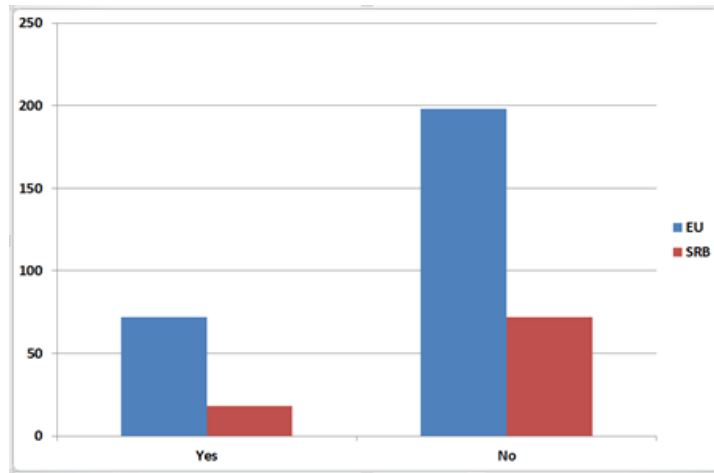
Graph 2. Number of respondents who have heard of the CVS
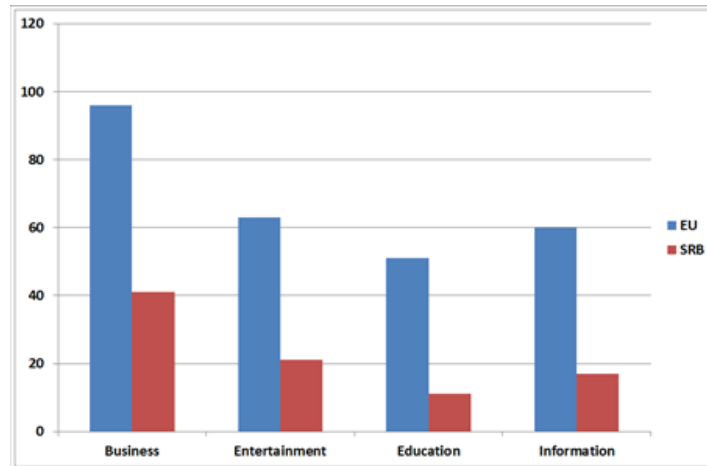Source: Author's research

Out of the total number of respondents who stated they have perceived existence of some of the computer vision syndrome problems, there are 108 of these who have used some eye aids. This number is considerably lower than the number of those who have not used any aids and there were 162 of them among the respondents from the EU countries. The results of this analysis (Graph 3) point to the need for education towards increasing the computer users' awareness about the consequences of protracted computer work, as well as about the importance of using various eye aids aimed at preventing occurrence of the computer vision syndrome symptoms.

Some other parameters, showing more information about the state in the EU countries, can be singled out of the study. One of the parameters refers to the answers to the question about the purpose of computer use.
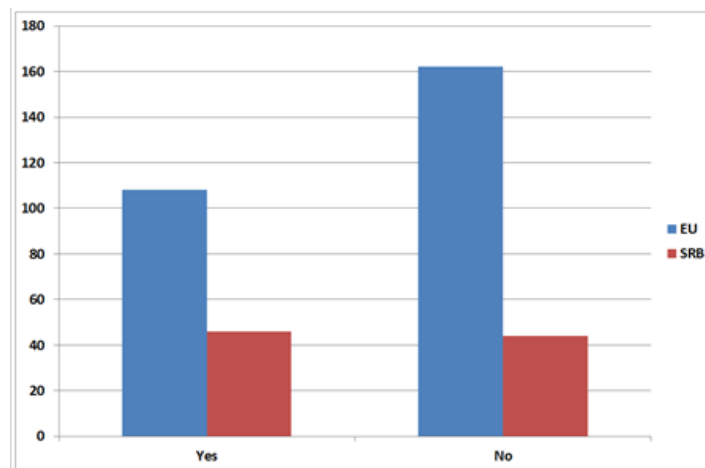
Graph 3. The ratio of the number of respondents with perceived DVS symptoms who use some of the aids, with respect to those who do not use any aids
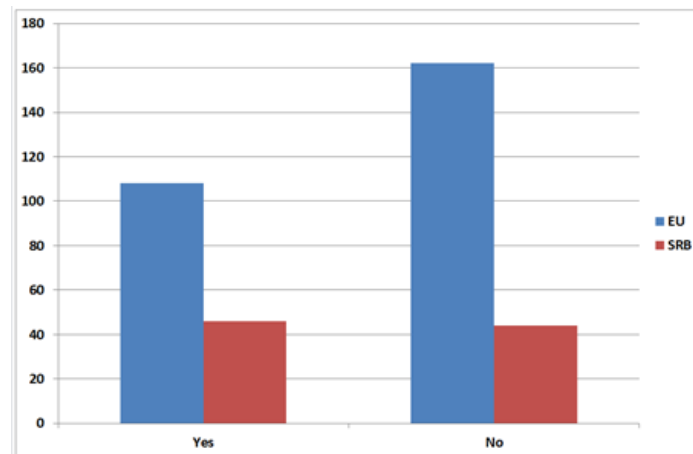Source: Author's research

We have offered a couple of answers, as we did in the previous study, which will be compared here so as to provide a realistic picture of this topic.

Graph 4. The purposes to which computer is used
Source: Author's research

The information about how many users believe that the work environment contributes to the CVS related difficulties at work, are depicted in Graph 5. The data about how much the respondents are interested in the advice from experts regarding protection of eyes, are shown in Graph 6.

Our study has shown that there are few users who have heard of the CVS and therefore it could be expected that most of the respondents have described their work environments as good. Although this might be true, the question still remains of how they know the environment is good if they have not been aware of the problems that can occur during protracted work in inadequate conditions.

Graph 5. Do you think that your work environment additionally provokes your eyesight difficulties?
Source: Author's research

This same question is also disputable in the results depicted in Graph 6 showing the number of respondents interested in the experts' advice for protection of eyes in case of prolonged work on computers. Considering the small number of respondents aware of the CVS problems, it is expected that they have had no need for information and advice from experts.
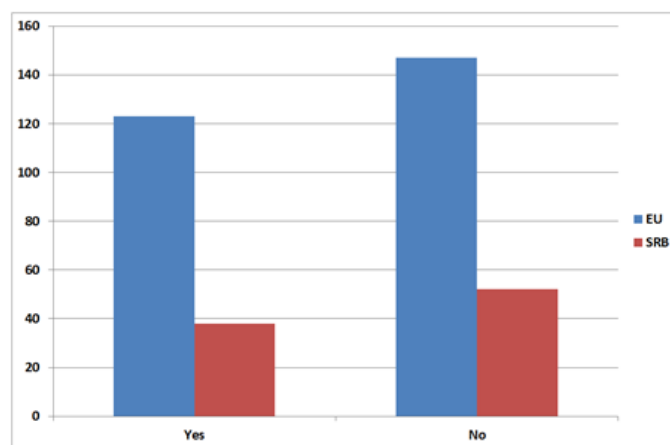
Graph 6. Are you interested in the advice of experts regarding protection of eyes?
Source: Author's research

7. Conclusion

The problems with eyes and eyesight are the frequent health problems found with engineers, but also with other people who spend a lot of time on computers. These problems can result in decreased productivity, increased frequency of errors and reduced satisfaction with work. The computer vision syndrome also implies problems with spine, but such problems have not been processed in this paper. The reason for this lies in the fact that there is a large number of users who are aware, i.e. who have some of the spine problems, but they act towards preventing the problem, and it is not the case with the users who have some of the eye problems.

This research has shown both the differences and similarities between the respondents from the EU member countries and those from the Republic of Serbia with respect to the computer vision syndrome. Respondents from both these groups believe that eyesight problems cannot be caused by their work environment, which is completely incorrect.

If the study results are analyzed from the point of view of the respondents' gender, we obtain almost matching results. This means that additional work is needed in educating both men and women regarding detecting the causes of the syndrome occurrence, as well as regarding implementation of the protection means. Special attention should be paid to the study results regarding the ages of the respondents who experience some of the symptoms. These results are different in the EU respondents' sample from those in the Republic of Serbia. The results show that there is a high number of respondents up to 30 years of age in the EU member countries who experience some of the symptoms of the observed syndrome. Unlike the EU respondents, the respondents in the Republic of Serbia above the age of 30 predominantly have some of the symptoms which cause the CVS.

On the basis of the obtained results, it is evident that measures should be taken towards educating both computer users and employers towards the goal of reducing health problems related to the computer vision syndrome. The basic goal is to take adequate protective measures with people who use computers every day, so as to reduce causes that generate the computer vision syndrome. The measures for preventing and treating of the problems involve frequent breaks, use of proper lighting, working out, use of ergonomic chairs and use of eye aids.

This paper should raise the awareness of the CVS problem existence and incite development of new research studies in this field in the territory of the European Union as well as in the countries awaiting the accession.

In our future research, we are going to do the analyses related to the status of spine and back, as well as to other factors of influence on the normal work of employees using computers in their work. In this future paper, we intend to compare standpoints of users with respect to all the computer vision syndrome symptoms. In addition, we want to determine in what way and to what extent the computer vision syndrome symptoms affect employee motivation, their productivity at work, absence from work due to the difficulties they experience while working, etc.

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