

Psychological factors and visual fatigue in working with video display terminals

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Abstract

Objectives—To examine the part played by psychological factors in complaints about visual health reported by banking officers who work at video display terminals (VDTs).

Methods—Out of a population of 385 bank workers, a group of 212 subjects without organic visual disturbances (as determined by ophthalmological examination) who share a work environment and job duties was selected. Three questionnaires were administered to these subjects: (a) the NIOSH job stress questionnaire; (b) a questionnaire investigating subjective discomfort related to environmental and lighting conditions of the workplace; (c) a questionnaire on the existence of oculo-visual disturbances. Correlation and multiple regression analyses were performed to examine for the presence of predictors of asthenopia.

Results—Social support, group conflict, self esteem, work satisfaction, and under-use of skills were found to be predictors of visual complaints; social support played a part also as a moderating factor in the stress and strain model; this model accounted for 30% of the variance. Subjective environmental factors, although in some cases significantly correlated with asthenopia, were not found to be strong predictors of the symptoms.

Conclusions—Some part of the complaints about visual health reported by VDT workers are likely indirect expressions of psychological discomfort related to working conditions.

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Computers have become ubiquitous in the office workplace and their use is growing. They have many advantages for inventory management, record management, complex systems control, document preparation, electronic communications, and office automation. They provide efficiency, competitive advantages, and the ability to carry out work that would be impossible or less effective without their use. Computers also provide new methods for managing work and tracking the behaviour of employees. Computerised jobs are more sedentary, require more cognitive processing and mental attention, and require less physical expenditure of energy. Yet the production demands of these jobs are often high, with constant work pressure and little decision making

possibilities. Many jobs that require heavy daily computer use have been found to be stressful.¹⁻⁴

Various disturbances have been found to be related to video display terminal (VDT) work. With the spread of this type of work and the associated appearance of health complaints in workers, a vast amount of research has aimed at identifying the possible causes of the health problems associated with VDT work.⁵⁻⁷ There is a growing consensus that poor workstation design coupled with high workload, postural demands, and job demands can contribute to shoulder, neck, back, and wrist-hand discomfort and pain, as well as fatigue for many computer users.⁸⁻¹¹ Improper illumination and glare, work demands, computer screen design, and task characteristics can contribute to visual discomfort.¹²⁻¹⁴ Relations have often been found between physical disturbances and factors such as improper work organisation and job design, or with psychological factors in a broad sense.

Although there are many contributions to the scientific literature aimed at examining the part played by psychological factors in causing physical disturbances related to work at VDTs⁴; these studies have focused primarily on musculoskeletal¹⁵⁻¹⁷ or dermatological^{18, 19} disturbances. In the medical literature, there have been no reports of studies aimed at examining the possible role of psychological and occupational factors on asthenopia (visual discomfort or eye strain). So, our study was designed to examine the influence that different stressors such as social environment, task, and individual characteristics have on asthenopia in computer users; to study to what extent psychological stressors play a part in asthenopic complaints, and to verify the moderating effect of social support on job stressors.

Methods

SUBJECT SELECTION

The study was performed on 385 bank workers (mean (range) age 42 (28-53) years). Men (315) made up 82% of the sample. To select a group of subjects suitable for study, the workers were evaluated for the objective conditions of their working environment and the technology used in their work. They underwent an ophthalmological examination (consisting of visual acuity at both near and far distance, and refractometry). To avoid an influence of ocular and refractive abnormalities on the subjects' reporting of visual discomfort, only those subjects identified by the ophthalmologist as presenting no conjunctival alterations or refractive errors were selected. The following

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were considered reasons for exclusion²⁰: presence of uncorrected hyperopia ($\geq +1.0$ D for people <40 years and 0.5 D for people >40 years old), presence of uncorrected astigmatism (≥ 1.25 D for the axes of $>30^\circ$, $<60^\circ$ – 120° , $>150^\circ$; ≥ 0.75 D for the axis of $\geq 30^\circ$ – 60° , $\geq 120^\circ$ – 150°), overcorrected myopia ($\geq +0.5$ D with correction).

Of these subjects (298 employees), a further selection was made of those with an equivalent working environment (noise, lighting, crowding, smoke) and who used the same technology (computers, software) in their work. This choice was made to avoid some of the principal environmental and technological confounders on the stress process. In this manner, 212 bank officers, of whom 179 were men (85.5% of the sample with mean age 38.6) and 33 were women (15.5% of the sample with mean age 35.2), were selected as subjects for this study.

QUESTIONNAIRES

The selected subjects were administered three questionnaires: (a) the NIOSH general job stress questionnaire, Italian version^{21, 22}, (b) a questionnaire investigating subjective discomfort in relation to environmental conditions of the workplace; and (c) a questionnaire on the existence and extent of oculovisual disturbances (asthenopia).

From the NIOSH general job stress questionnaire the following measures were chosen

Role stressors

Role ambiguity and role conflict were measured respectively with six item and eight item scales.²³ The α coefficients for these scales were 0.74 and 0.80.

Social support

Caplan's 12 item scale²⁴ was used to assess support from coworkers. The α coefficient was 0.84.

Workload, underuse of skills, and work satisfaction

Workload, underuse of skills, and work satisfaction were measured with Caplan's scale.²⁴ The α coefficient was 0.86.

Interpersonal conflict

Interpersonal conflict was measured with Rahim's scale.²⁵ This scale consists of a list of 16 items that measure conflict within and between groups, and group cohesion. The α coefficients were 0.79, 0.85, and 0.81, respectively.

Self esteem

Self esteem was measured with Rosenberg's scale²⁶; it consists of 10 items. The α coefficient was 0.85.

Mental workload

Mental workload was measured with Hurrell's scale.²⁷ The α coefficient was 0.75.

Subjective discomfort related to the working environment

Subjective discomfort related to the working environment was assessed with a questionnaire

which queried the subjects' sense of disturbance by noise, humidity, temperature, smoke, stale air, illumination, and crowding. Subjects were asked to respond on a four point scale (0=never, 1=a little, 2=a fair amount, 3=a lot). A final score, defined environmental discomfort, was then obtained by summing the scores for all disturbances reported.

For every subject, information was also collected about the number of hours a day at the VDT and the number of years spent performing the same work duties.

Asthenopia

Asthenopia (visual discomfort) was measured by a questionnaire which queried the presence of blurred vision, ocular soreness, itching of the eyes, blinking, heaviness of the eyes, and double vision. Subjects were instructed to respond affirmatively only if a given symptom was felt during or soon after working time. Responses were solicited on a three point scale (0=never or rarely, 1=at least 3 days a week, 2=every day). The final score for the scale of asthenopia was calculated by adding the scores obtained for every ocular symptom.

STATISTICAL METHODS

We calculated Pearson's correlation coefficient to evaluate the relation between the psychological factors and asthenopia; the same relation with the environmental variables was calculated with Kendall's tau-b because of their non-normal distribution. A hierarchical regression procedure was used to assess the presence of predictors of asthenopia and eventual variables with moderating effects.²⁸ In the first step, the main effects of age, sex, and environmental discomfort were assessed; age and sex were controlled because they may affect both the stressors exposed to, and reactions to these stressors.^{29, 30} In the second step the psychological variables (role stressors, support from coworkers, mental workload, underuse of skills, work satisfaction, interpersonal conflict, self esteem) were inserted. To verify a moderating effect of colleague support on the relation between psychological stressors and asthenopia, in the third step the cross product terms between each stressor and support from coworkers were entered.

Results

Sixty eight of the subjects (52 men and 16 women, 31.9% of the sample) queried were found to have asthenopia as defined by our criteria, reporting at least one of the symptoms of asthenopia during or soon after the work shift three or more times a week. Twenty nine subjects (13.6% of the sample, 20 men and nine women) met the criterion of strongly asthenopic, reporting at least one of the symptoms of asthenopia every day.

Correlations between the presence of asthenopia and the various psychological factors or environmental discomfort factors investigated are presented in tables 1 and 2.

Among the psychological factors (table 1), physical workload was the only factor not significantly correlated with asthenopia,

Table 1 Descriptive statistics and Pearson's correlation coefficients among psychological variables and asthenopia

	Mean	SD	1	2	3	4	5	6	7	8	9
1 Group conflict	2.98	0.85	—								
2 Coworker support	1.75	0.80	-0.28**	—							
3 Physical workload	4.28	0.64	0.23*	-0.23**	—						
4 Underuse of skills	2.34	0.76	0.05	-0.40**	0.22*	—					
5 Mental workload	3.15	0.32	0.06	-0.08	-0.06	0.17*	—				
6 Self esteem	1.68	0.73	-0.25**	0.20*	-0.23*	-0.19*	-0.12	—			
7 Work satisfaction	3.04	0.35	-0.27**	0.10	-0.31**	-0.08	-0.04	0.18*	—		
8 Role conflict	5.42	1.06	0.21*	-0.25*	0.04	0.26**	0.20*	0.13	-0.14	—	
9 Role ambiguity	1.65	0.52	0.28**	-0.07	0.15	0.18	0.10	0.09	-0.10	0.10	—
10 Asthenopia	0.41	0.84	0.30**	-0.32**	0.10	0.23*	0.25**	-0.23**	-0.24**	0.29**	0.20*

*p<0.05; **p<0.01 two tailed.

whereas among environmental factors (table 2), asthenopia was found to be significantly positively correlated with the presence of discomfort relative to noise and smoke. It is interesting to note that lighting conditions were not correlated with eye discomfort.

No correlation (table 3) was found between asthenopia and number of hours of work a day at the VDT or number of years spent performing the same work duties. Asthenopia was correlated with age, sex, and environmental discomfort (total score).

As well as the correlations between psychological or environmental factors with asthenopia, numerous significant correlations were also found among the various psychological stress variables and among reports of distur-

bance by various environmental factors (tables 1 and 2).

Multiple regression analysis was performed to examine the presence of predictors of asthenopia. As shown in table 4, in the first step, environmental discomfort was found to account for 4% of the variance in the reporting of symptoms of asthenopia, whereas age and sex were not found to have a significant influence.

In the second step of the regression analysis, when the psychological aspects of work with VDTs were entered, self esteem, group conflict, work satisfaction, underuse of skills, and coworker support were found to be significant predictors of visual complaints, and the model accounted for 28% of the variance. Role stressors and mental workload did not reach significance ($F<0.05$) and were removed from the model.

In the third step the presence of a moderator effect of support from coworkers on the other stressors was verified. An analysis of cross product terms showed that coworker support had a moderating effect on the predictive influence of group conflict on asthenopia, whereas the other cross product terms had no significant influence and thus were removed. When this moderator effect was considered, the final model was found to account for 30% of the variance in reporting of asthenopia.

Table 2 Kendall's correlation coefficients among different environmental variables and asthenopia

Variables	1	2	3	4	5	6	7
1 Noise	—						
2 Crowding	0.23*	—					
3 Lighting	0.00	0.33**	—				
4 Smoke	0.24**	0.03	0.50**	—			
5 Stale air	0.23**	0.27**	0.33**	0.28**	—		
6 Temperature	0.00	0.02	0.05	0.00	0.08	—	
7 Dampness	0.06	0.09	0.12	0.01	0.03	0.08	—
8 Asthenopia	0.27**	0.012	0.09	0.28**	0.14	0.06	0.11

*p<0.05; **p<0.01 two tailed.

Table 3 Pearson's correlation coefficients between asthenopia, environmental discomfort, and other variables

Variables	1	2	3	4	5
1 Hours/day at VDT	—				
2 Years at VDT	0.15	—			
3 Age	0.12	0.40**	—		
4 Sex	0.07	0.04	0.04	—	
5 Environmental discomfort	0.12	0.06	0.14	0.09	—
6 Asthenopia	0.18	0.05	0.45**	0.35**	0.23*

*p<0.05; **p<0.01 two tailed.

Table 4 Hierarchical regressions of age, sex, environmental discomfort, and psychological variables on asthenopia (only variables with p<0.05 are reported)

	Unstandardised coefficients		Standardised coefficient β	p Value	R ²	Adjusted R ²
	β	SEM				
Step 1:						
Environmental discomfort	0.812	0.366	0.244	0.02	0.059	0.04
Step 2:					0.33	0.28
Self esteem	-0.328	0.128	-0.279	0.012		
Group conflict	0.394	0.117	0.335	0.001		
Work satisfaction	-0.715	0.242	0.306	0.004		
Underuse of skills	0.181	0.073	0.313	0.015		
Coworker support	-0.507	0.158	-0.344	0.000		
Step 3:					0.34	0.30
Coworker support \times group conflict	-0.188	0.051	-0.523	0.000		

Discussion

It has to be recognised that work stress can produce both physical and emotional complaints. Job demands—physical and psychological—influence the severity and frequency of health complaints of VDT operators. The expression of these complaints may be exacerbated by perceived high job demands, boring or repetitive job activity, and poor support from colleagues and supervisors. Previous investigations on visual health complaints by VDT operators have shown relations between the presence of asthenopia and environmental variables, including lighting characteristics of the workplace,⁵ and physical variables—such as the refractive index of the subjects.¹⁴ The present study verifies a role of psychological factors in asthenopia.

Certainly, there exists a difficulty at the medical level of defining and measuring asthenopia,³¹ this being identified as the more or less striking presence of any of several different disturbances including a sensation of heaviness of the eyes, conjunctival redness, a subjective per-

ception of tiredness, dry eyes due to insufficient production of tears, and sudden phenomena of double vision or clouding of vision. Essentially, we are dealing with an ophthalmological clinical picture, the distinguishing features of which are still imprecise and not well measurable. This aspect has generated many investigations in which the prevalence of the disturbance found in different populations seems extremely variable. This variability, expected on the basis of differing working conditions and oculo-visual characteristics of VDT operators, is certainly augmented as a result of the imprecise definition of asthenopia. In our work, we adopted a strict criterion, considering visual disturbances to be indicative of asthenopia only if reported to occur at least three times a week, during or shortly after the end of work at a VDT.

The prevalence of the disturbance as determined by our study (around 32%) was less than that described in other reports.⁵ This discrepancy can be explained by several factors: firstly, by the greater selectivity of the subjective measure used to identify asthenopia in our study; secondly, by the good optometric conditions of the subjects admitted into the study; and thirdly, by the workplace characteristics of our sample, typical of banks and characterised by particular attention to ergonomic construction of the working environment, in particular of lighting, workers' posture, and air conditioning.

Precisely these workplace characteristics might also explain the unexpected lack of correlation between illumination and asthenopia, which, as already stated, is amply documented in the literature. Even one other recent study has found no significant influence of the level of surrounding luminance on asthenopic symptoms.³² The questions on environmental discomfort and those of asthenopia were, furthermore, administered together, in the same sitting. This might have been expected to increase the correlations between these measures. Instead, these were negligible to low, suggesting that in our study, some of the environmental discomfort factors (lighting, temperature, stale air, dampness) had no effect on asthenopia. The same considerations were supported by the multivariate analysis, where environmental factors reported by the subjects as sources of disturbance were found to have little effect on the presence of asthenopia.

Our investigation was conducted on a selected population of subjects with superimposable environmental working conditions and work duties. All the subjects were without oculo-visual abnormalities. This selection was made to reduce or exclude the presence of asthenopic disturbances resulting from environmental, and ergonomic factors, or refractive conditions of the subject. In these conditions, the study showed clearly that several psychological factors were predictors of visual complaints. The model elaborated in the regression analysis accounted for 30% of the variance in the reporting of visual complaints.

The roles of the various psychological factors studied here are different. Although group

conflict and underuse of skills are true stressors, coworker support (which refers to the provision and receipt of tangible goods, services, and benefits—such as informal encouragement and reassurance), and self esteem are buffers that have been found in previous research to act as moderators of the weight of stressors on health complaints. The investigation confirmed this expectation; coworker support showed both a direct role in the regression terms and a role as a moderator in the relation between group conflict and health complaints. Consistent with the findings of Hagihara *et al.*,³³ the same type of moderating role of colleague support was not found on other variables—such as underuse of skills.

The factor mental workload was particularly correlated with work at VDTs, and the correlation between mental but not physical workload and asthenopia was expected. (The physical and mental demands required by jobs that use computers are very different from non-computerised office or blue collar jobs; usually computerised jobs are more sedentary, require more cognitive processing and mental attention, and require less physical expenditure of energy.) Although not found by our regression analysis to be a predictor of asthenopia, mental workload has been amply shown in past research to have a role as a stressor correlated with physical disturbances.^{4 34 35}

It does not seem possible to directly attribute disturbance to the other variables, as these are more connected to the social structure of work than to the duties required. The asthenopia in this case seems to be the indirect expression of lack of wellbeing at work, poor support from colleagues, or conflicts with colleagues.

Some limitations of our work must be pointed out. We made use only of self reported measures in the evaluation of environmental discomfort, visual discomfort, and occupational stressors. As is known, these measures, which are certainly the most commonly used in research, introduce several problems: there is evidence that their use can lead to an overestimate of the correlation between stressor and dysfunctioning. Furthermore, they make possible the interference of a third variable that influences both the dependent and independent variables (in our study this occurred in the case of support from coworkers).

Finally, the use of self reports of both job stressors and strains (the asthenopia in this study was read as an indirect expression of strain) in a study increases the potential for conceptual overlap in the measures, by which the independent and dependent variable measures, in essence, assess largely the same construct.

A possible solution to this problem would be to introduce, in future research, some more objective measures of visual disturbances and the various stressors present in the work environment. This approach, which has been used in research on analogous problems,^{7 36} seems, despite its own limitations, to be the most promising.

Conclusion

This study supports the idea that the aetiological basis of symptoms of visual discomfort symptoms among VDT workers includes psychological factors, and that the interaction between such factors might be important in the understanding of visual complaints by VDT workers. In our opinion, furthermore, the analysis of the influence of psychological factors on asthenopia increases the possibility of preventive interventions in occupational medicine aimed at creating conditions of well-being, and thus the reduction of disturbances.

Future research should be aimed at investigating the relations between various stressors, and at verifying with field studies some of the hypotheses that have been confirmed in the present work (for example the role of colleague support as a moderating factor in the perception of stress), but which still lack confirmation by experimental studies. Measures to stimulate colleagues to support one another could reduce the effect of work related stressors and confirm the theoretical studies on stress conducted to date.

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