EFFECTS ON MESOPIC SPATIAL RESOLUTION AND COLOUR CONTRAST PERCEPTION OF THE USE OF PROTECTIVE FACE WEAR DESIGNED FOR HAZARDOUS SITUATIONS

BONNIN-ARIAS C[1], PEREZ-CARRASCO MJ[2], CHAMORRO E[1], NAVARRO-BLANCO C[1], GOMEZ-VADILLO T[1], SANCHEZ-RAMOS C[1,2]

[1]Neuro-Computation and Neuro-Robotics Group, School of Optics and Optometry, Universidad Complutense de Madrid (Spain).

[2]Optica II. School of Optics and Optometry, Universidad Complutense de Madrid (Spain).

EVER 2010

celiasr@opt.ucm.es

INTRODUCTION

In emergency situations, the members of a rescue team that arrive on the scene should use Individual Protection Equipment (IPE). IPE comprises a suit and protective hood that at eyes' height has a transparent window through which the rescuer can see. The individual components of the IPE overlap and this can impair vision.

Figure 1: Example of a protective suit.

This study was designed to assess the modifications produced in several indicators of visual function when a subject looks through the overlapping transparent components of protective equipment.

METHODS

The study participants were 36 adults (men and women) aged 18 to 49 years (average 30±8 years).

The IPE used consisted of TAYVEC III protective suits providing 3 different protection levels (TN, TV, TA) and masks with filters used in hazardous situations.

Figure 2: Example of a mask worn under one of the protective suits used in this study.

The different visual variables were measured in mesopic illumination conditions (2 cd/m^2) in the following situations:

- **Without a mask**
- **Wearing a mask**
- **Wearing a mask and suit with a face-protecting screen.**

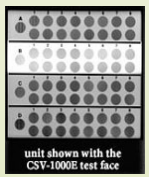


Figure 3: CSV1000 test used for contrast sensitivity measurements

Figure 4: Colour perception assessed using the Ishihara test in mesopic conditions

The results obtained using the CSV1000 for contrast sensitivity (CS) and Sloan 5% Contrast Visual Acuity were log-transformed. For the Ishihara test, the result was considered normal if the subject committed fewer than 4 errors and could not recognize any numbers in test sheets 18 and 21.

RESULTS

☐ Visual acuity (VA) – Spatial resolution

When we compared the VA results obtained wearing or not wearing the mask, the difference was highly significant. However, for VAs recorded with the subjects wearing the mask or the mask plus one of the suits differences were only significant for the TV suit.

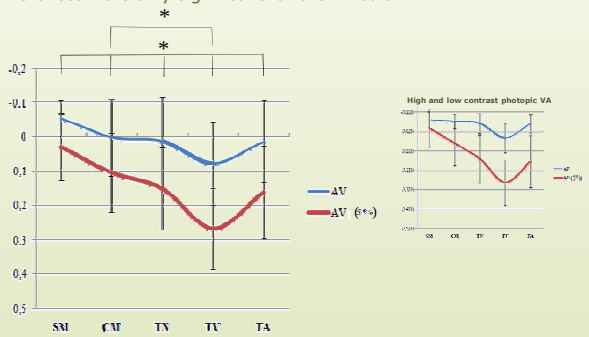


Figure 5 a and 5 b. VAs measured at maximum contrast and 5% contrast with subjects not wearing a mask (SM), wearing a mask (CM) or wearing a mask and suit (TN, TV, TA)

❑Contrast sensitivity (CS)

For a frequency of 18 cycles/º significant differences (p=0.0084) emerged when CS values were compared between TN and TV.

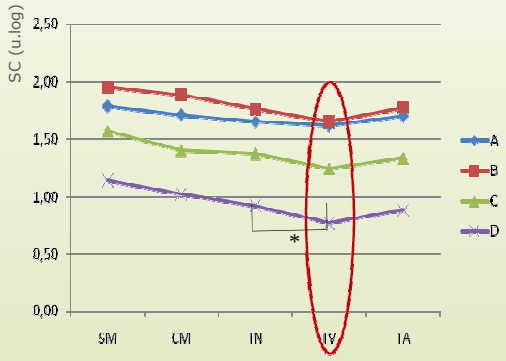
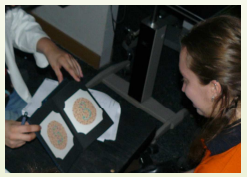


Figure 6. CS values recorded indicating a lower response for each of the four test fequencies when subjects wore the mask plus TV

❑ Colour

Colour perception in low (mesopic) illumination conditions differed significantly in the different situations compared to results obtained for the naked eye (P< 0.01).



MESOPIC	SM	sd	CM	sd	TN	sd	TV	sd	TA	sd
VA	-0.05	0.05	0.00	0.11	0.01	0.13	0.08	0.12	0.01	0.12
VA 5% contrast	0.03	0.10	0.11	0.10	0.15	0.12	0.27	0.11	0.16	0.11
cs A	1.79	0.15	1.72	0.13	1.66	0.28	1.62	0.22	1.71	0.31
cs B	1.96	0.18	1.89	0.16	1.77	0.26	1.66	0.26	1.78	0.27
cs C	1.57	0.27	1.40	0.21	1.37	0.29	1.25	0.34	1.34	0.29
cs D	1.14	0.22	1.03	0.19	0.92	0.25	0.77	0.30	0.88	0.25
Ishihara	2.14	1.90	2.36	1.99	3.75	3.05	6.03	4.14	5.36	4.16

CONCLUSIONS

In mesopic conditions, spatial resolution, contrast sensitivity and colour perception were significantly impaired when subjects wore a face mask and/or protective screen.

In practice, this could limit the vision of persons who need to wear protective equipment and thus impair their work. Our findings suggest the need to improve the transparent screens used in protective clothing and masks.

AKNOWLEDGEMENTS

This study was supported by a formal agreement between the **Complutense University of Madrid** and MAPFRE Spain.

REFERENCES

1. Haegerstrom-Portnoy G, Schneck M, Brabyn J. Seeing into old age: Vision function beyond acuity.Optometry and Vision Science 1999;76:141-158.
2. Bennett AG, Rabbetts RB. Clinical visual optics. Ed. Butterworth Heinemamm.1989 496-497.
3. Klein R, Klein BE, Lee KE.Changes in visual acuity in a population. Ophthalmology 1996;108(8):1169-1178.
4. Morgan MW. Visual function changes in eyes of aged patients. Vision and Aging: General and Clinical Perspectives. Ed, A, A, Rosenblom. New York, 1986; 198-200.
5. Putz R., Pabst R. Sobotta, Atlas de Anatomía Humana. Tomo I: Cabeza, Cuello, Miembro superior. Médica Panamericana, Buenos Aires, Madrid, 2006, 362-370.
6. Rodríguez S., Smith-Agreda J.M. Anatomía de los órganos del lenguaje, visión y audición. Médica Panamericana, España, 1999, 250-270.