

# Visual function with optical filters in speleologists exposed to cave environments

Efeito de filtros ópticos na função visual de espeleologistas

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**There is no actual or potential conflict of interest in relation to this presentation.**

# Introduction

- Speleologist's perform their activity in **demanding visual conditions of very low luminance** - many visual tasks involve resolution of detail under conditions of low contrast.



- Work related conditions in a cave as exposure to heat, chemicals, dust and poor lighting conditions could influence the integrity of the visual system and predispose the eye to diseases that eventually affect vision.

# Introduction

- Poor lighting conditions cause a variety of symptoms of visual discomfort and may increase the risk of accidents.
- Good visual acuity is crucial for several and has an important role for safety purposes.



**The aim** of this study was to evaluate lighting conditions and optical filters effects on visual performance in speleologists exposed to cave environments.

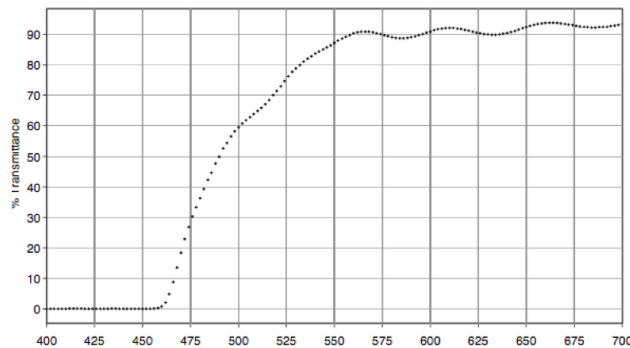
# Methods and materials

- A cross-sectional study was conducted.
- An examination of visual acuity, contrast sensitivity, stereoacuity and headlamps illuminance levels was performed in 16 speleologists at two caves deprived of natural lightning.

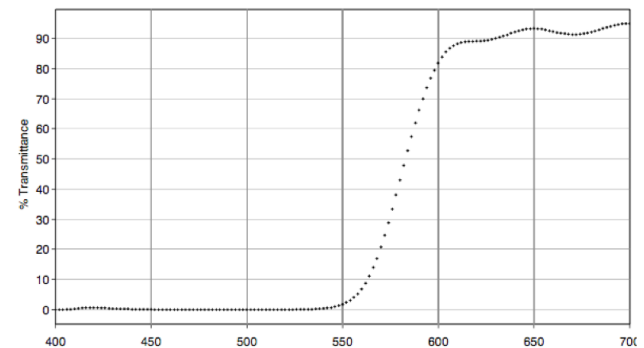


# Methods and materials

- The illuminance measurements (headlamp on the helmet or head) were made using a luximeter.
- Two organic filters (450nm and 550nm) were used to compare visual function with and without filters (ML filters optical solutions).



Graphic 1 – 450 nm optical filters transmittance.



Graphic 2 – 550 nm optical filters transmittance.

# Results

## Subjects

**Mean age** of the workers: 40.65( $\pm$ 10.93) years (The majority were males - 65.2%).

Optical correction was found in 14 subjects with 4 subjects using glasses just for near due to presbyopia.

6 participants had decreased visual acuity of which refractive error (17.4%) was the major cause.

2 subjects had a visual pathology (retinal detachment and keratoconus).

# Results

## Visual symptoms

- During the cave activity blur vision was the most referred visual symptom (n=10) - 5 had decreased visual acuity.

## Visual function

- There were no signs and symptoms of visual pathologies related to the exposition to the cave in this workers.
- **Binocular visual acuity** (BVA) in the cave environment was  $-0.05 \pm 0.15$  LogMAR (20/18) and all subjects had visual acuities LogMAR of 0.3 or higher (20/40).

# Results

	Mean ± Std. Deviation	Median	<i>p</i>
Visual acuity without filter	- 0.05± 0.15 (20/18)	- 0.10 (20/16)	
Visual acuity with 550 filter	- 0.04± 0.16 (20/18)	- 0.10 (20/16)	0.093
Visual acuity with 450 filter	- 0.07± 0.15 (20/17)	- 0.10 (20/16)	
Contrast sensitivity (3cpd) without filter	1.73±0.17	1.63	
Contrast sensitivity (3cpd) with 550 filter	1.76±0.17	1.78	0.104
Contrast sensitivity (3cpd) with 450 filter	1.84±0.12	1.78	
Contrast sensitivity (6cpd) without filter	1.99±0.24	1.92	
Contrast sensitivity (6cpd) with 550 filter	1.92±0.16	1.84	0.034*
Contrast sensitivity (6cpd) with 450 filter	2.04±0.16	2.07	
Contrast sensitivity (12cpd) without filter	1.56±0.33	1.54	
Contrast sensitivity (12cpd) with 550 filter	1.58±0.37	1.62	0.368
Contrast sensitivity (12cpd) with 450 filter	1.64±0.39	1.69	
Contrast sensitivity (18cpd) without filter	1.05±0.34	1.03	
Contrast sensitivity (18cpd) with 550 filter	0.97±0.25	0.96	0.026*
Contrast sensitivity (18cpd) with 450 filter	1.18±0.39	1.25	

Visual acuities are reported in LogMAR units with the Snellen equivalent of the mean in parenthesis.

Contrast sensitivity values are reported in log units.

\*Significant difference ( $p < 0.05$ ).

- BVA for distance without filter was not statistically different from BVA with 550nm or 450nm filters ( $p=0.093$ ).
- Significant improved **contrast sensitivity** was observed with 450nm filters for 6cpd ( $p=0.034$ ) and 18cpd ( $p=0.026$ ) spatial frequencies.

# Results

## Illuminance measurements

- In the cave environment the majority of the workers used a headlamp on the helmet or head, especially at a medium position or position 2 without diffuser.
- In this position the mean illuminance values were  $451.0 \pm 305.7$  lux

	headlamp in position 1 without diffuser (n=15)	headlamp in position 2 without diffuser (n=14)	headlamp in position 3 without diffuser (n=11)	headlamp in position 4 without diffuser (n=7)	headlamp in position 1 with diffuser (n=3)	headlamp in position 2 with diffuser (n=2)	hand lantern (n=1)
Mean ± Std. Deviation	250.2±414.3	451.0±305.7	1551.3±1165.9	1670.2±1275.4	134.0± 108.6	210.0±127.3	28
Median	100	400	840	2000	170.	210	28
Minimum	16.8	50	365	92	12	120	28
Maximum	1600	1300	3000	4000.0	220	300	28

# Discussion

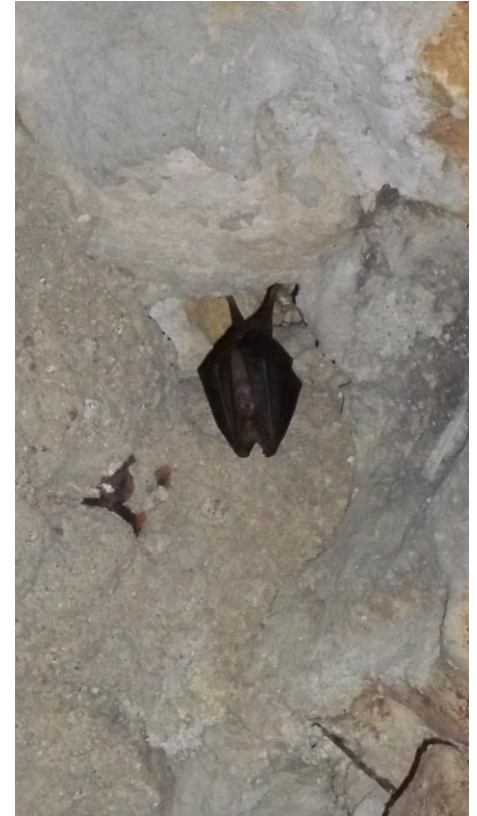
- **Mine workers** environments have an enormous impact on their health (Ovenseri-Ogbomo et al., 2012).
- None of the workers had previous history of acute or chronic conjunctivitis, which leads the authors to conclude that occupationally associated eye diseases/disorders were not obvious among the speleologist workers.
- It has been found that under **scotopic conditions**, sensitivity functions are dramatically lowered across the entire spectrum from the normal contrast sensitivity function (Sekuler & Blake, 1994).
- In this environment the binocular visual performance was not impaired by the light conditions of the cave.

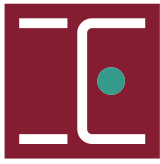
# Discussion

- A night security guard to recognize faces from a distance of 6m under low illumination need to have a visual acuity of 0.5 LogMAR (20/60) (Johnson & Casson, 1995).
- The improvement in contrast sensitivity with the 450 nm filters could be beneficial to the cave operational environments.
- It is important that eye care practitioners are able to provide accurate advice on whether filters will provide a long-term benefit, prior to their recommendation to workers.
- According to the Artificial Light norm (DIN 5035-2, 1990) the level of illuminance that should be used for normal visual tasks with medium details is 500-750 lux.

# Conclusions

- There were no signs and symptoms of visual pathologies related to cave exposure.
- Illuminance levels were adequate to the majority of the activities performed.
- The enhancement in contrast sensitivity with filters could potentially improve tasks related to bats observation.
- More investigation is therefore needed to better understand the influence of cave lighting conditions in the visual symptoms referred by the workers.





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**Thank you for your attention!**

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