INFLUENCE OF COLOURED STIMULUS IN THE MESOPIC PUPILAR DIAMETER

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INTRODUCTION

The pupil light reflex (PLR) has attracted the attention of physiologists throughout history yet it was not until the advent of videopupillography and the infrared camera (Loewenstein, 1956) that real progress in this area of research started.

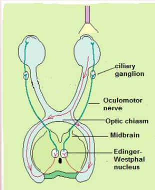

Figure 1. Pupil reflex pathway

AIM

In depth knowledge of the PLR has implications for the diagnosis of several disease states. For this purpose, the PLR first needs to be characterized in healthy subjects under mesopic illumination conditions and then in patients with a systemic or neurologic disorder (e.g., Alzheimer's disease, diabetes mellitus).

METHODS

Sample:

In a study at the Clínica de Cirugía Ocular in Madrid, pupil size measurements and their variations in response to a light stimulus were recorded in 33 healthy volunteers. All participants signed an informed consent form. The time allowed for the subjects to adapt to darkness was 15 min.

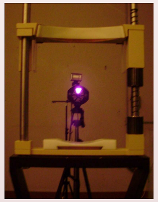

Figure 2. Infrared camera and flash.

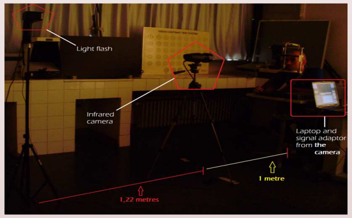

Figure 3: Laboratory set up for the pupillometry study conducted in the dark.

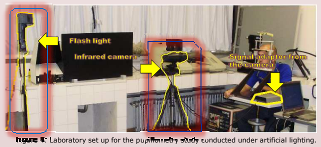

Figure 4: Laboratory set up for the pupillometry study conducted under artificial lighting.

Matherial:

Fig. 4. Power Refractor II interface (Plusoptics)

The pupillometer used was a Plusoptix Power Refractor II. The pupillometer consists of an infrared camera and a signal adaptor that sends the processed signal straight to the laptop. The camera is placed 1 meter from the volunteer's face.

The flash light (Flash Metz Mecablitz 60 CT-1) was placed 1.22 meters from the camera that was in front of the subject examined. Its colour temperature is 5600 K and GN at ISO 100/21º in the metric system is 60. Each volunteer viewed 5 flashes of light, one for every bandpass filter (450 nm, 510 nm, 600 nm) and neutral density filter (01 and 10).

The interface of the pupillometer software generates an independent logfile. A new java-swing user interface was developed (Cabanillas software) to transfer the data, analyze several parameters (latency, amplitude, speed, rebound, etc.) and construct the graphs.

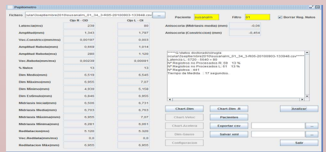

Fig. 5. Cabanillas Java Software interface to treat pupil data.

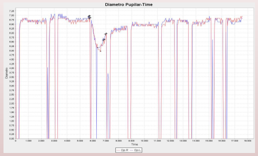

Figure 6 shows the changes in pupil diameter produced in response to one light flash. Since the signal has not been fully processed, drops can be seen in the graph indicating blinks.

The data were processed by the designed software. This application ignores blank spaces and eliminates signal noise to generate a smooth curve.

Figure 7a) curve obtained without noise elimination. Figure 7b) curve obtained after eliminating noise from the signal.

RESULTS

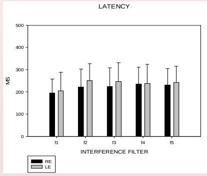

Figure 8. Latency (dependent variable) in both right and left eye, for each filter.

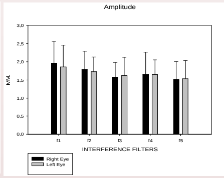

Figure 9. Amplitude (dependent variable) in both right and left eye, for each filter.

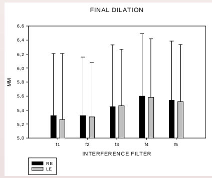

Figure 10. Final dilation (in both eyes) after the coloured-stimulus flash light for each filter.

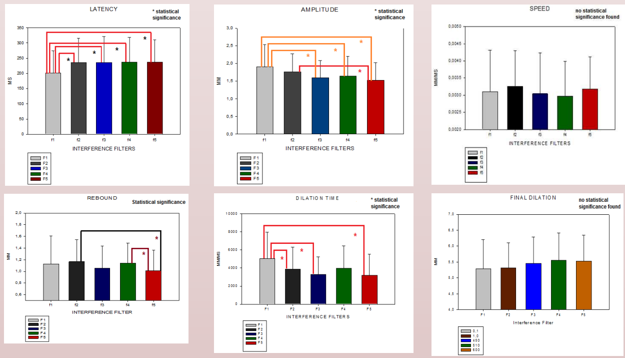

Fig. 11 (a,b,c,d,e,f). Graphs showing measure variations for each variable and filter.

	Filter types (p-values)			
	10	450	510	600
Latency	0,01	0,01	0,01	0,00
Amplitude	0,17	0,03	0,02	0,00
Dilation time	0,04	0,00	0,08	0,00

Table 1. P-Values (ND Filter 0,1 vs each filter)

	Filter types (p-values)			
	01	450	510	600
Latency	0,01	0,95	0,99	0,90
Amplitude	0,17	0,08	0,29	0,01
Dilation time	0,04	0,23	0,81	0,19

Table 2. P-Values (ND Filter 1,0 vs each filter)

VALUES AND P-Vs (FOR EACH RANGE OF AGE) ACCORDING TO THE FILTER USED :

PRE-STIMULAR MYDRIASIS (mm)											
		0,1		10		450		510		600	
n	AGE RANGE Yrs	X	DES	X	DES	X	DES	X	DES	X	DES
18	20 to 40	5,7	0,2	5,49	0,2	5,58	0,21	5,6	0,21	5,65	0,21
16	41 to 50	5,36	0,2	5,35	0,2	5,33	0,21	5,35	0,21	5,36	0,21
19	51 to 60	5,08	0,18	5,07	0,2	5,15	0,2	5,15	0,2	5,06	0,2
6	61 to 80	4,33	0,31	4,12	0,35	4,33	0,32	4,33	0,32	4,35	0,34
	P-Value	0,00		0,02		0,02		0,02		0,01	

FINAL DILATION (mm)											
		0,1		10		450		510		600	
n	AGE RANGE Yrs	X	DES	X	DE	X	DES	X	DES	X	DES
18	23 to 40	5,87	0,19	5,62	0,19	6,01	0,18	5,88	0,19	5,97	0,17
16	41 to 50	5,25	0,2	5,4	0,18	5,56	0,17	5,86	0,21	5,36	0,18
19	51 to 60	5,11	0,18	5,12	0,18	5,23	0,16	5,36	0,18	5,54	0,18
6	61 to 80	4,28	0,33	4,52	0,38	4,54	0,27	4,62	0,32	4,62	0,3
	P-Value	0,00		0,05		0,00		0,00		0,00	

LATENCY and AMPLITUDE for 0,1 ND FILTER and 450nm INTERFERENCE FILTER:

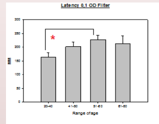

Figure 11. Latency for ND 0,1 Filter for each age range.

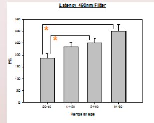

Figure 12. Latency for 450 nm Interference Filter for each range of age.

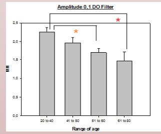

Figure 13. Amplitude in ND 0,1 Filter for each age range.

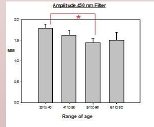

Figure 14. Amplitude in 450 nm Interference Filter for each age range

P-VALUES for MEN-WOMEN for each filter

	Filter types				
	01	10	450	510	600
Latency	0,09	0,75	0,64	0,44	0,74
Amplitude	0,03	0,04	0,09	0,15	0,00
Speed	0,13	0,62	0,67	0,19	0,08
Mydriasis	0,00	0,00	0,00	0,00	0,00
Rebound	0,27	0,96	0,22	0,54	0,00
Dilation time	0,19	0,02	0,37	0,00	0,23
Dilation Point	0,03	0,00	0,00	0,01	0,00

Table 3. Resulting p-values for the sample of Women versus the sample of Men, for each filter (Neutral Density filters: 0,1 and 1,0; and Interference filters: 450mm, 510mm and 600mm).

CONCLUSIONS

1. No differences were detected between both eyes for any variable.
2. The stimulus wavelength gives rise to variations in latency, redilation, and amplitude of the pupil reflex.
3. Sex significantly affects starting and final mydriasis for stimuli of different intensity and colour.
4. Age significantly but differently affects latency, amplitude, starting and final mydriasis, speed and rebound, depending on the intensity and wavelength of the stimulus.

AKNOWLEDGEMENTS

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