The effect of ambient light conditions on quantitative pupillometry measurements in healthy subjects

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BACKGROUND AND METHODS

Background: Automated devices collecting quantitative measurements of pupil size and reactivity are increasingly used for critically ill patients with neurologic disease. However, there is limited data on the effect of ambient light conditions on pupil metrics. To address this issue, we tested the range of pupil reactivity in healthy volunteers in both light and dark conditions.

Methods: We measured quantitative pupil size and reactivity in seven healthy volunteers with the Neuroptics-200 pupillometer in both bright and dark ambient lighting conditions. Bright conditions were created by overhead LED lighting in a room with ample natural light. Dark conditions consisted of a windowless room with no overhead light source. The primary outcome was the Neurologic Pupil Index (NPi), a composite metric ranging from 0-5 in which >3 is considered normal. Secondary outcomes included resting and constricted pupil size, change in pupil size, constriction velocity, dilation velocity and latency. Results were analyzed with multi-level linear regression to account for both inter and intra-subject variability.

PUPILLOMETER MEASUREMENTS

	Median		Standard Deviation	
	Light	Dark	Light	Dark
Neurological Pupil Index	4.20	4.30	0.29	0.18
Resting Pupil Size (mm)	3.45	6.19	0.62	0.78
Constricted Pupil Size (mm)	2.63	3.64	0.34	0.55
Size Change (%)	25.50	39.90	5.84	3.57
Constriction Velocity (mm/s)	2.30	3.31	0.70	0.36
Maximum Constriction Velocity (mm/s)	3.21	5.29	0.95	0.58
Dilation Velocity (mm/s)	1.00	1.40	0.36	0.27
Latency (seconds)	0.23	0.23	0.03	0.03

Table 1. Repeated pupillometry measurements of 7 healthy subjects in light and dark conditions. The mean and standard deviation of the various measurements are displayed.

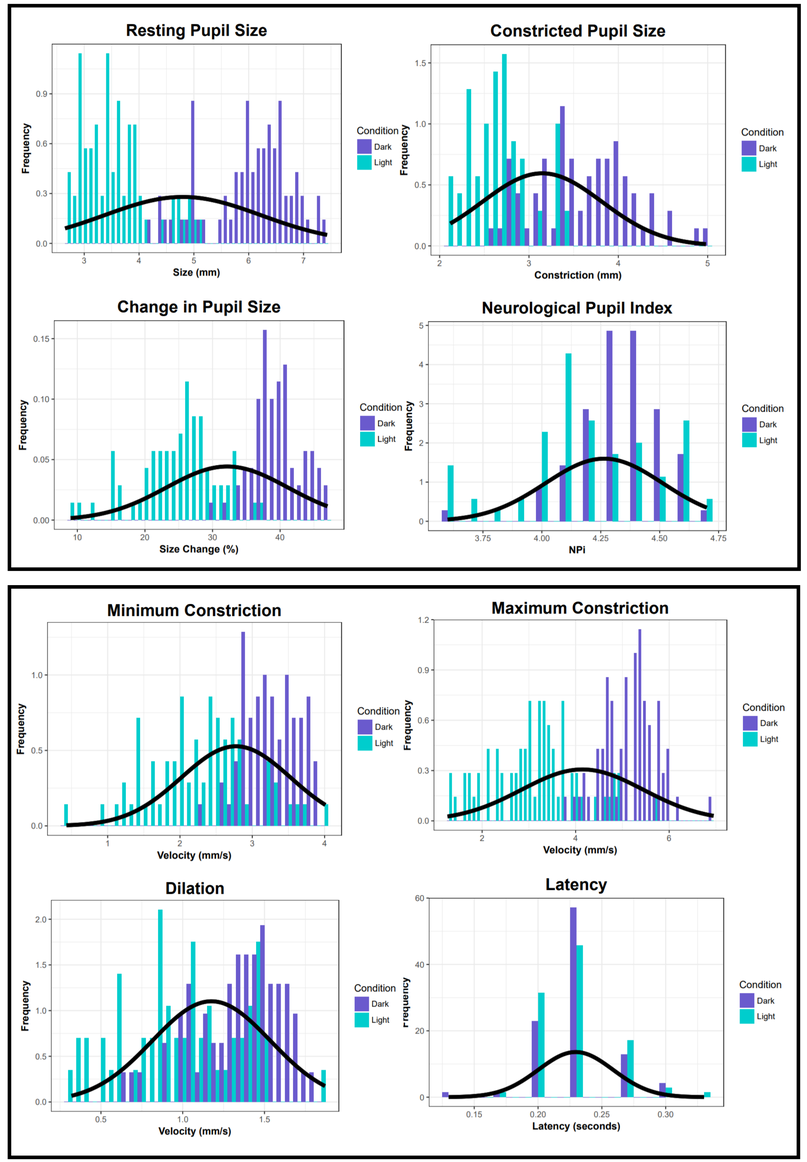
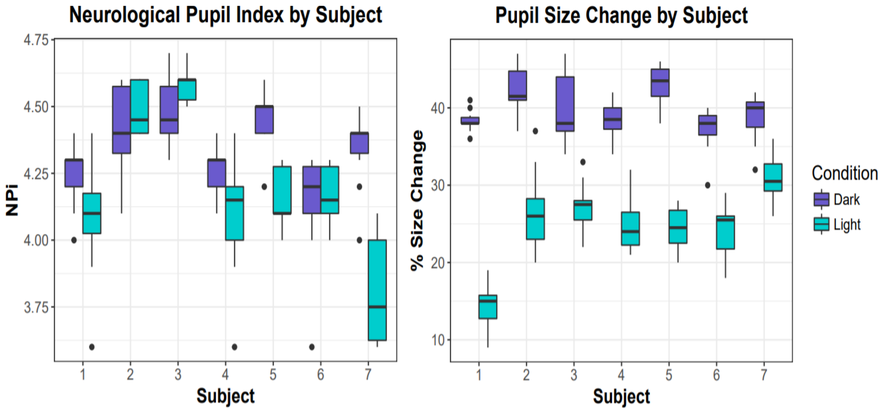


Figure 1. Frequency distributions of the resting pupil size, constricted pupil size, neurological pupil index, change in pupil size, neurological pupil index, constriction velocity, dilation, and latency recorded in both light and dark conditions for each subject.

CONCLUSIONS

Conclusion: We found that ambient light levels impact pupil parameters in healthy subjects. However, changes in NPi are small and more consistent in varying lighting conditions than other metrics. Further testing of patients with poor pupil reactivity is necessary to determine if ambient light conditions could influence clinical assessment in the critically ill. Practitioners should standardize lighting conditions to maximize the reliability of their measurements.



	Beta	SE	95% Confidence Limits		p-value
NPi Intercept	4.20	0.095	3.98	4.41	p<0.01
Dark Conditions	0.14	0.084	-0.051	0.33	0.14
% Pupil Size Change Intercept	24.59	1.904	20.33	28.84	p < 0.01
Dark Conditions	15.16	1.82	11.051	19.26	p < 0.01

Table 2. Multilevel model controlling for subject and eye demonstrates that pupil size difference is significantly affected by light conditions and that NPi is not.

Results: Seven subjects underwent ten pupil-readings in bright and dark conditions, yielding 140 total measurements. Mean resting pupil sizes were 3.56 v. 6.04 mm (Difference 2.48 mm, CI [2.36-2.60], p<0.001). The mean NPi was 4.19 v. 4.33 in the bright and dark group respectively, (Difference 0.14, CI [0.08-0.19], p<0.001), and average change in pupil size was 24.6% v. 39.7% (Difference 15.1%, CI [13.8-16.4], p<0.001). When controlling for subject and eye in a multi-level model, the difference in NPi between light conditions was no longer significant, though.