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Using sensory and physiological approaches to assess the effects of temporal light modulation on reading tasks under LED lamps

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CONTEXT AND OBJECTIVES

Correlations between attention, concentration, and physiological reactions during cognitive tasks have been widely studied in different fields and sometimes in interaction with other senses.

Several lighting characteristics such as illuminance level and uniformity, color temperature and color rendering indices are known to **influence reading performances**.

New lighting technologies such as LED lamps and luminaires associated with new characteristics : **temporal light modulation (TLM)**, rapid cyclic variations in their light output arising from their ac-powered electronic circuits. TLM has visible effects including flicker or stroboscopic effects.

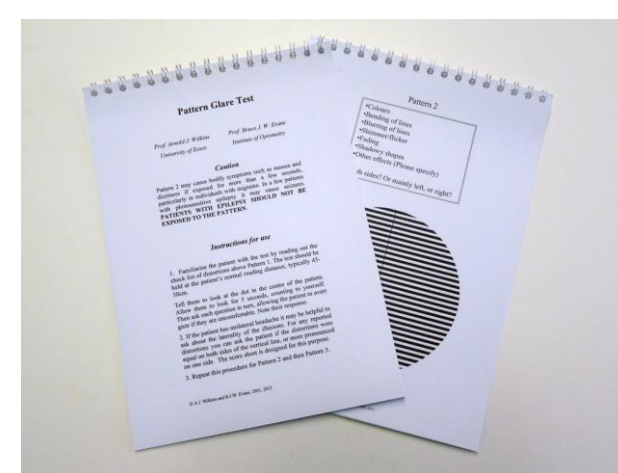
Study of **the sensory and physiological signals during a reading activity** carried out under **three levels of TLM** found in commercially available LED lamps.

MATERIALS AND METHODS



1 | Selection of 12 subjects

- aged from 25 to 39,
- non-smokers,
- normal vision with correction if needed.



Characterization of their colors (Farnsworth test) and contrasts vision (Wilkins/Evans « Pattern Glare Test »)

2 | Evaluation of three LED lamps

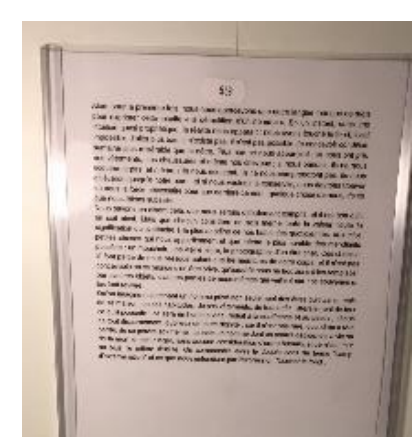
- no flicker,
- different levels of the stroboscopic effect, characterized by their Stroboscopic Visibility Measure: SVM=0 (m0), SVM=1 (m1) and SVM=5.7 (m2),
- dominant modulation frequency of the light output: 100 Hz.



3 | Reading task with seven texts

Selected from literature with a typography according to the ophthalmology standards

Standardized to be homogeneous in length, font and size.



4 | Quantitative evaluation of the perceived visual characteristics

4 scoring scales from 0 (very unpleasant) to 10 (very pleasant): light intensity, visual comfort, reading facility and pleasantness
+ 1 question : Have you ever read this text? and comments



5 | Monitoring of physiological responses

- Heart rate,
- Respiratory rate,
- Skin blood flow,
- Electrodermal response,
- Eye-tracking.



CONTACT

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MAIN RESULTS

Lamp effect **not significant** on all the sensory descriptors

Significant lamp effect on the electrodermal response

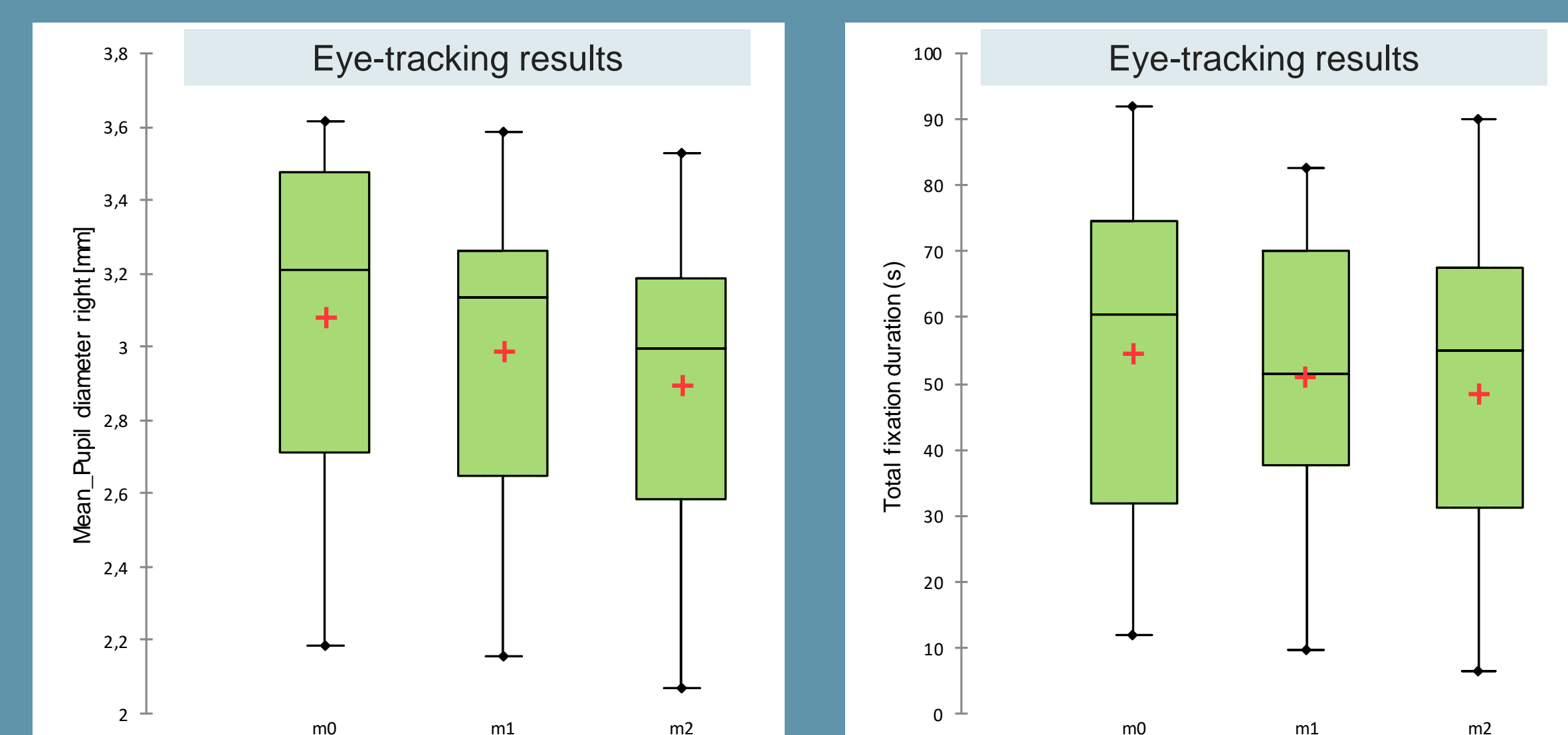


Figure 1: Boxplots of the mean pupil diameter and the total fixation duration for each lamp measured with the eye-tracker

Significant effect of the lamps on the mean pupil diameter, the number of fixations and the total duration of fixation
→ when SVM increases, the mean pupil diameter and the total duration of the fixations both decrease

CONCLUSION AND PERSPECTIVES

Physiological parameters (EDR integral, number of fixations, total fixation duration, pupil diameter) **can be used to define the order of relation between the 3 lamps**: Lamp M0 > Lamp M1 > Lampe M2.

Influence of the modulation level of the lamps on the reading strategy -> less fixations with a higher modulation level

Perspectives in data analysis, lighting standardization and development of specific lighting systems, for helping subjects with language or reading disabilities (dyslexia for example)