A Case Study with Implications of the *Mobile* Cognitive Pupillometry Research Toolkit

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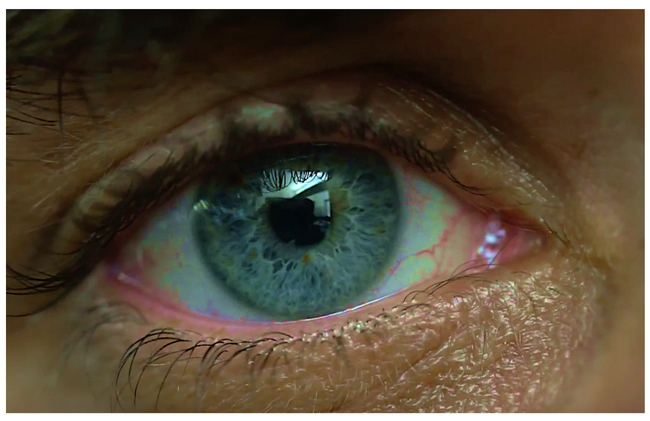
■ Cognitive Pupillometry Research

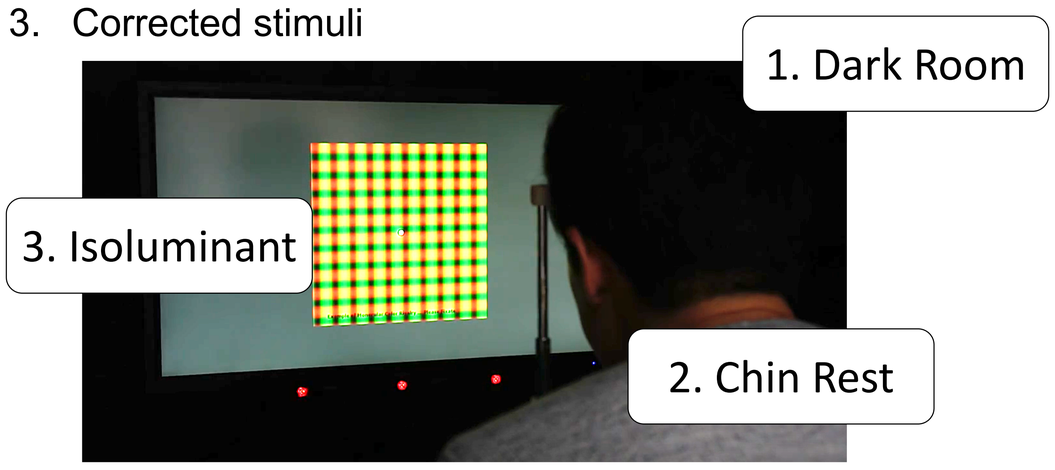
Measuring the size of the eye's pupil using a video-based eye tracker has been widely done to link with a variety of cognitive processes [Einhauser, 2017]:

- Attention
- Awareness
- Cognitive Load
- Arousal
- Perceived attractiveness



* Restricted to well-controlled lab settings

1. Controlled environmental light sources
2. Stabilized head movement
3. Corrected stimuli

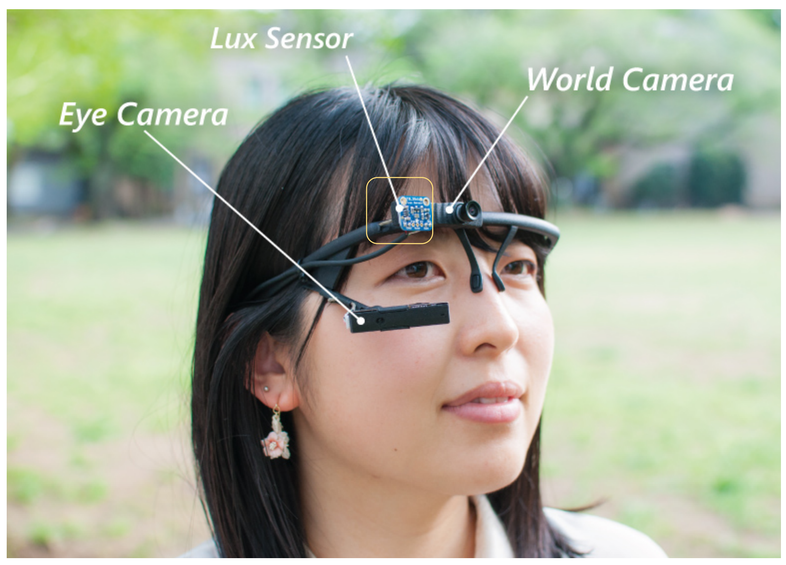


■ Purpose of Study

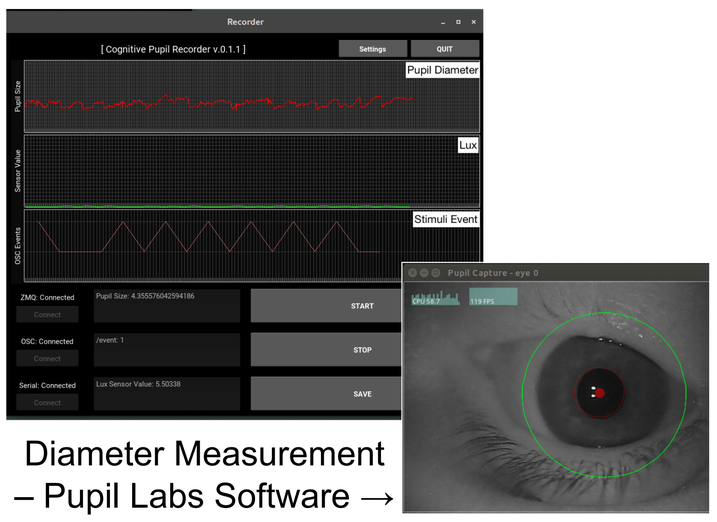
How much *"less-controlled"* will have implications for pupillometry research*?*

GOAL: Address potential applications of the **mobile pupillometry toolkit**
- To expand traditional experimental conditions and fields of analysis

METHOD: Conduct a **case study** to use our mobile equipment in replicating prior cognitive pupillometry experiments



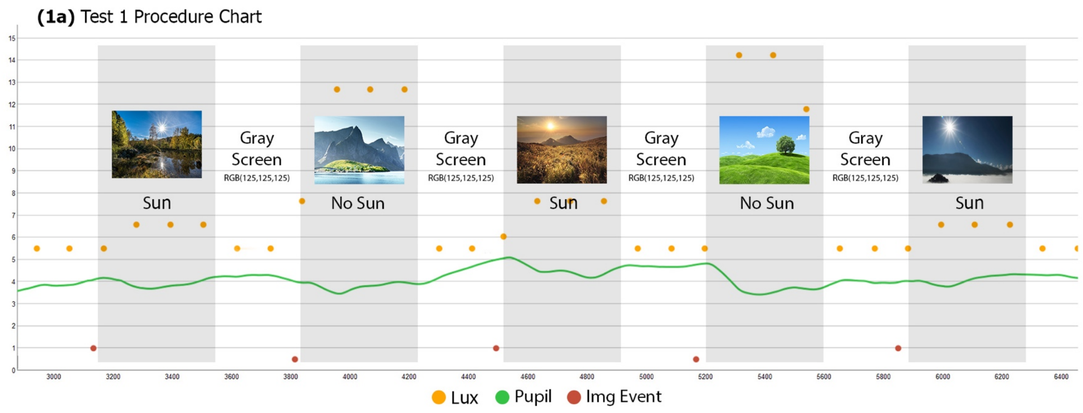
↓ Our Recorder Prototype



Diameter Measurement – Pupil Labs Software →

■ Case 1

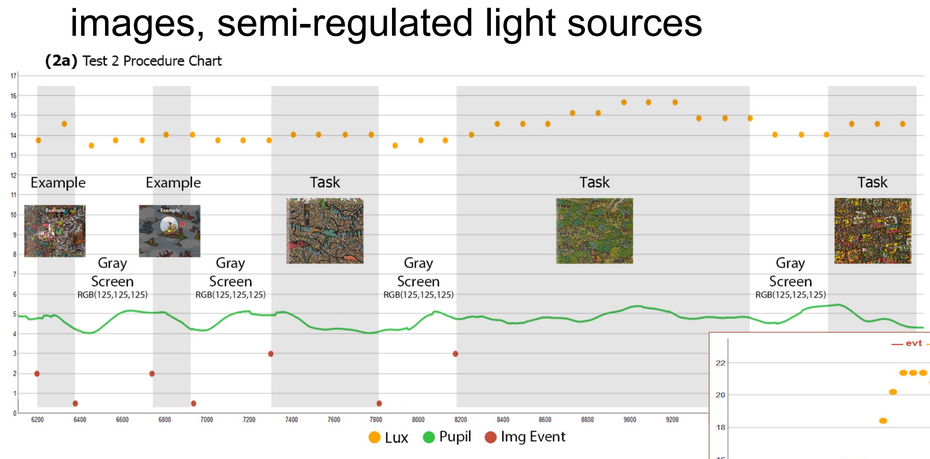
- Pupil constriction when exposed to brightness illusions [Naber+, 2013]
- Replicated in the same controlled setup properties
  - As a baseline test to validate our use of lux sensor

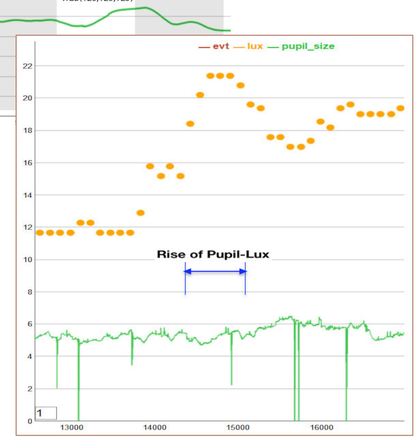


ANALYSIS
- Sun-images: avg. 7.75 Lux, No-sun: avg. 14.00 Lux ($p = 0.02$, Non-pairwise T-test).
  - Captured appropriate values for corresponding stimuli
- Avg. pupil diameter size - 7 subjects: 3.93mm (sun), 3.58mm (no-sun), 4.28mm (gray)
  - Subject to data [*1] & indivi. attention qualities [Naber+]

■ Case 2

- Large pupils at fixations during goal-oriented visual search for targets [Matht+, 2015]
- Allowed free head movements, no-luminance-corrected images, semi-regulated light sources

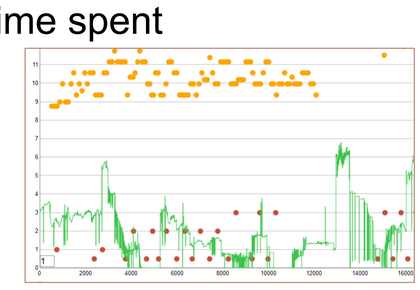




ANALYSIS
- Avg. pupil size – 10 subjects: 5.03mm (search for Waldo), 4.43mm (no-search)
- Observed large pupils under tasks with mental effort
- [*2] Found pupil size increase, even while observers leaning closer to the screen (= rise of lux values)

■ Design Implications

- Mobile platforms may expand the design of experiments, in understanding top-down behaviors on task exploitation
  - State of focus and processing of task complexity can be considered in natural settings.
    - Took into account free head movements: [*2] lux constantly increased in the semi-controlled and pupil size increased in accordance with the time spent
- Technical difficulties in tracking of pupil size
  - No differences in quality of data captured (Case 1 & 2)
  - Expected loss of data and limited analysis due to [*1] noise→ resulting in sudden jumps and continuous fluctuations



FUTURE WORK
- More dataset/device trials
- Extract pupil-lux patterns for learning models

[Einhauser, 2017]: The pupil as marker of cognitive processes.
[Matht+, 2015]: Large pupils predict goal-driven eye movements.
[Naber+, 2013]: Pupil responses to high-level image content.

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