A comprehensive eye-tracking test battery: Pupil Labs vs. EyeLink 1000

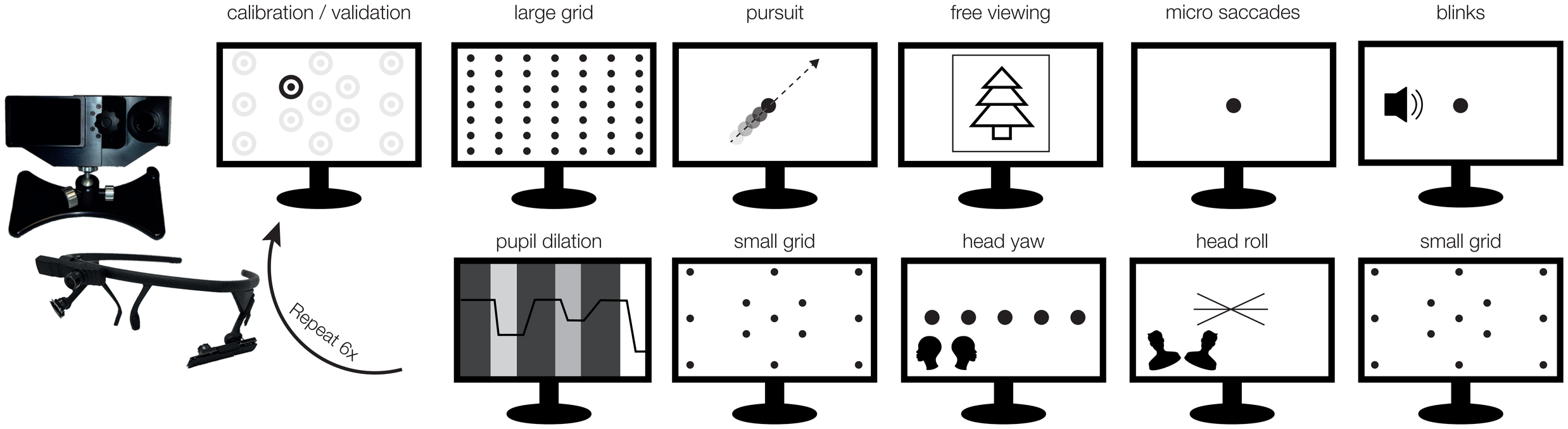
Katharina Groß[1,*], Benedikt V. Ehinger[1,2,*], Inga Ibs[1], and Peter König[1,3]

[1] Institute of Cognitive Science, University of Osnabrück * Authors contributed equally
[2] Donders Institute for Brain, Cognition and Behaviour, Radboud University
[3] Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf

Summary

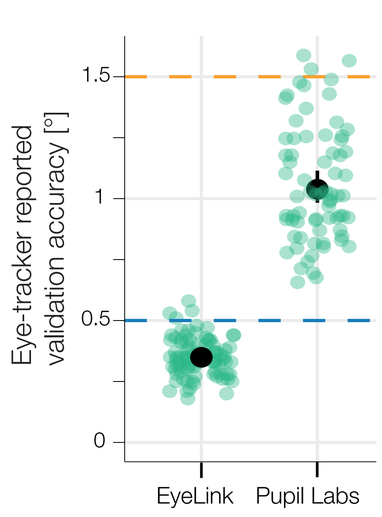
How can we measure eye-tracker performance?

We developed a test battery with multiple tasks and measured different metrics of eye-trackers. Simultaneous data collection with the remote EyeLink 1000 against the mobile Pupil Labs glasses allow for direct and powerful within-subject comparisons.

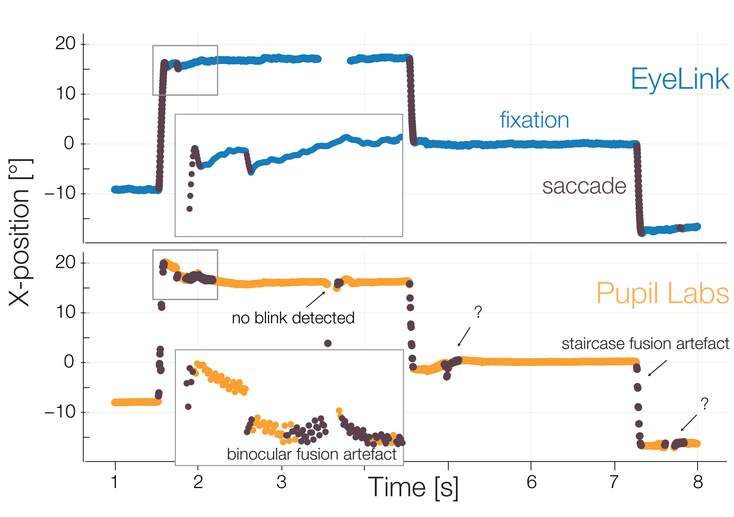


Calibration

N = 15. For preprocessing we used the same algorithms where possible. For saccade classification we used the Engbert mergenthaler algorithm (λ = 5).

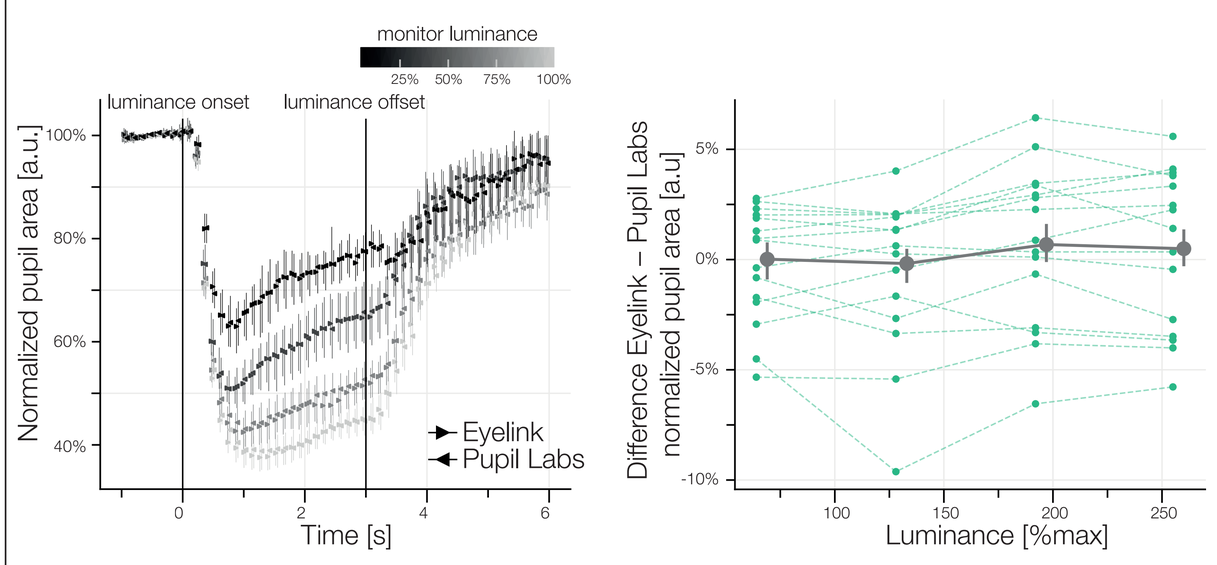


Validation accuracy before each block reported by the eye-tracker's manufacturer software.



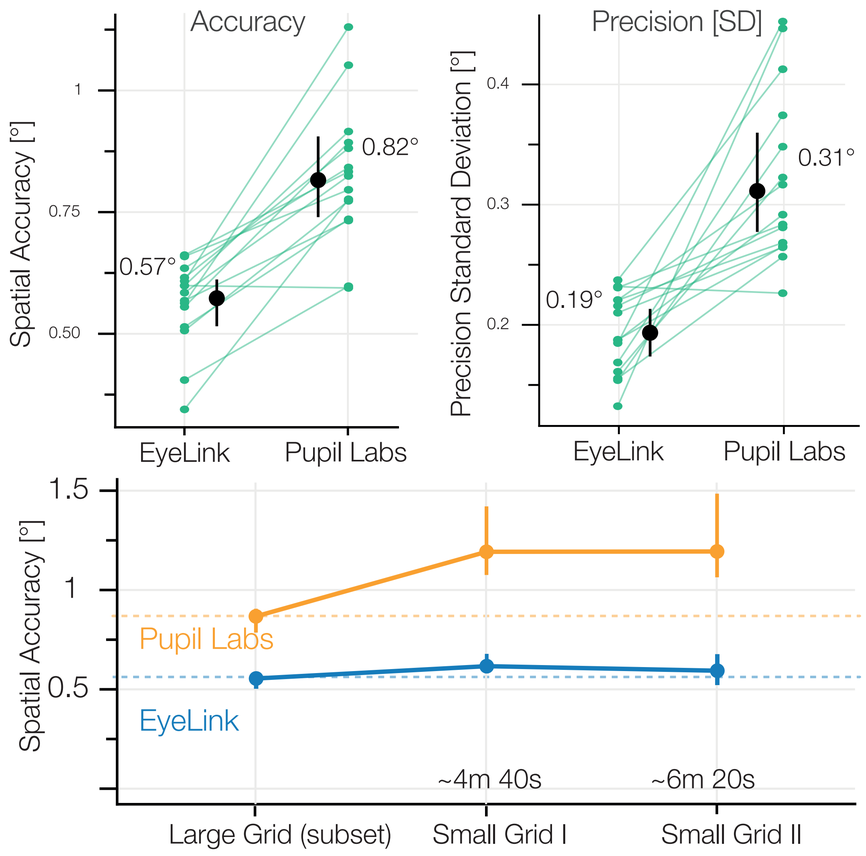
Samples of horizontal gaze movement during the grid task. Note the sample-wise eye movement classification. Blink samples were removed.

Pupil dilation



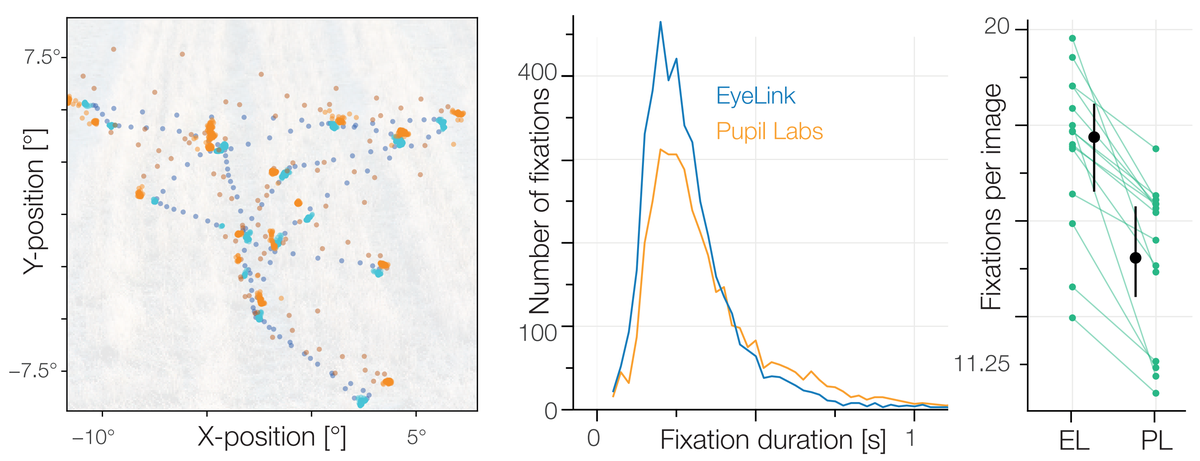
On the group level, both eye-trackers report the same normalized pupil area; on the single subject level, the eye-trackers show a reliable subject-specific bias.

Accuracy & Precision



EyeLink shows 40% better accuracy and 60% better precision. Pupil Labs exhibits strong calibration decay after ~ 4 minutes of recording.

Freeviewing



Pupil Labs shows much higher variance in estimated gaze positions and finds fewer and shorter saccades than EyeLink and, consequentially, on average longer fixation durations.

Take home

- Researchers have to know the strengths and weaknesses of their devices
- Eye-tracking data quality cannot be reduced to a single value for all tasks
- Concurrent measurements can reveal consistent subject-biases

Find 700 GB of eye videos:
10.6084/m9.figshare.c.4379810.v2

Stimulus & Analysis Code:
10.5281/zenodo.2553176

Get the full paper:

A new comprehensive eye-tracking test battery concurrently evaluating the Pupil Labs glasses and the EyeLink 1000
doi: 10.7717/peerj.7086

Funding
This work was supported by the European Union (H2020-FETPROACT-2014, SEP-210141273, ID: 641321 socSMCs)