



EYE TRACKING EDA

Gaze Behavior Analysis in Schizophrenia Research

Control Group Baseline

Tobii Glasses 3 · Subject 01 · Neurorobotics Lab · Short Route Walking Run – Tristan Lee

Why Eye Tracking?



Saccadic Biomarker

Disrupted smooth pursuit & voluntary saccades, documented since 1970s, correlates with PANSS severity.



Fixation Instability

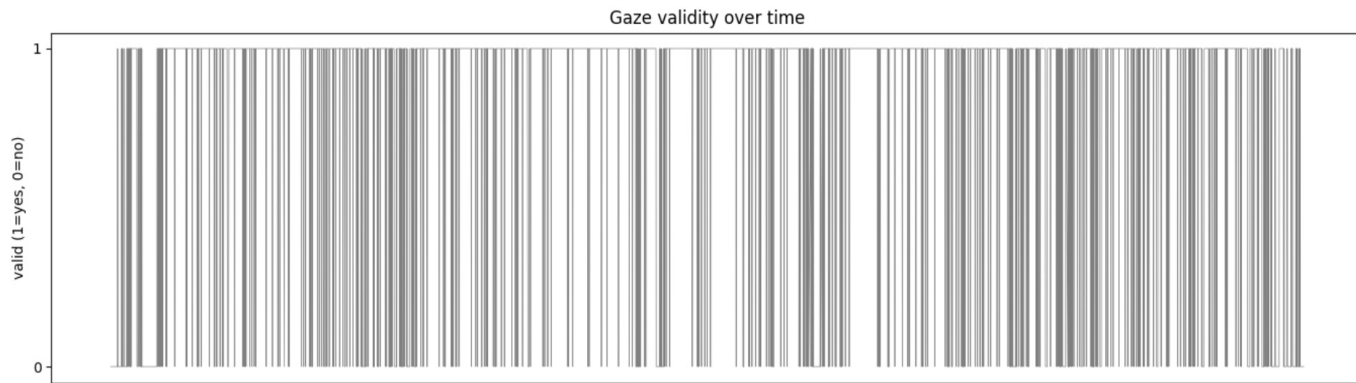
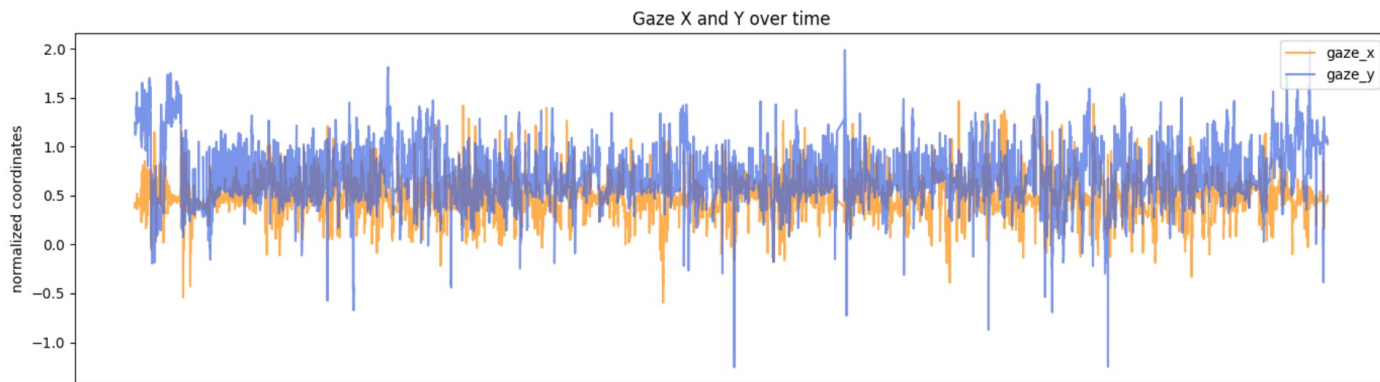
Reduced fixation stability and altered scanpaths are consistent across patient cohorts. Linked to working memory deficits.



Control Baseline

Healthy baseline required under identical hardware, task, and pipeline conditions to enable valid between-group comparison.

Gaze Validity



```
Total gaze points: 64815
Valid normalized gaze points: 56310 (86.9%)
Invalid or off-screen gaze points: 8505 (13.1%)
Gaze X range: -0.592 to 1.463
Gaze Y range: -1.255 to 1.993
Timestamp range: 0.008 to 694.975
```

```
Median sample interval: 0.0101 sec
Mean sample interval: 0.0107 sec
Max sample interval: 4.0773 sec
Samples with dt > 0.1 sec: 182
```

```
invalid_reason
valid                56310
y_out_of_bounds      7505
x_out_of_bounds       931
x_and_y_out_of_bounds    69
Name: count, dtype: int64
Invalid block count: 462
      count  duration
count  462.000000  462.000000
mean    18.409091    0.205116
std     51.599528    0.590741
min       1.000000    0.000000
25%       2.000000    0.009885
50%       5.000000    0.049944
75%      16.000000    0.160290
max     807.000000    8.845836
Median gaze speed: 0.5689 units/sec
Max gaze speed: 27.9462 units/sec
```

Gaze Validity

86.9%

Valid gaze fraction

56,310 / 64,815 samples

462

Invalid blocks

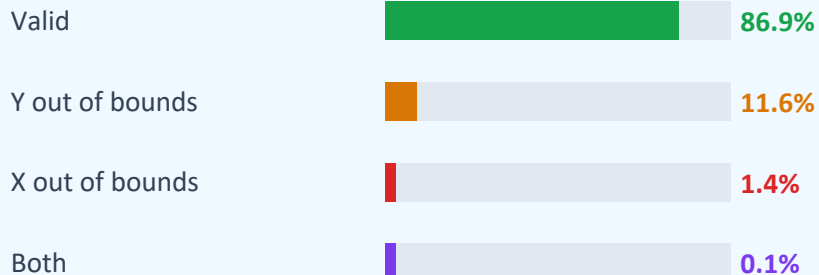
Median duration: 0.05 sec

13.1%

Invalid Points

8,505 / 64,815 samples

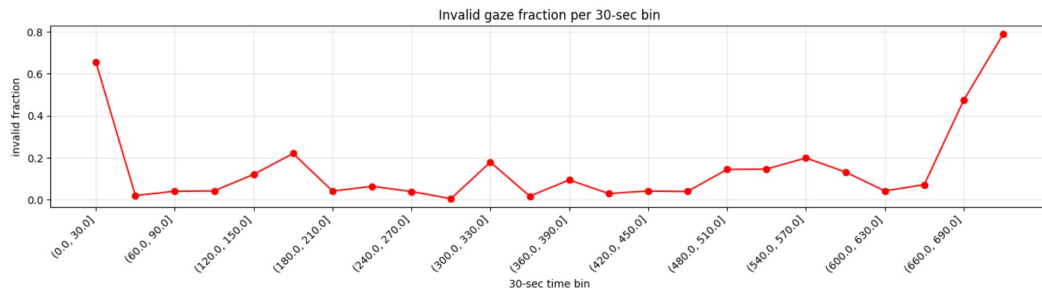
Invalid Breakdown



Schizophrenia Contrast

- › Expect lower valid fraction; elevated blink rates and tracking loss are well-documented.
- › Stronger Y-drift may reflect attentional disengagement rather than head movement.
- › High baseline valid fraction (~85%+) here anchors the statistical comparison.

Gaze Dynamics Over Time



First 30 sec

65.6% invalid — calibration/startup artifact. Not representative.

Steady state

Most windows 2–10% invalid after $t=30$ s. Stable tracking.

```
invalid_reason valid y_out_of_bounds x_out_of_bounds
timestamp
(0.0, 30.0]      974          1818          34
(30.0, 60.0]    2666           26          30
(60.0, 90.0]    2466           85          20
(90.0, 120.0]   2510          100          12
(120.0, 150.0]  2401          320          11
```

```
invalid_reason x_and_y_out_of_bounds invalid_fraction
timestamp
(0.0, 30.0]      3          0.655709
(30.0, 60.0]    0          0.020573
(60.0, 90.0]    0          0.040840
(90.0, 120.0]   0          0.042715
(120.0, 150.0]  0          0.121157
```

INVALID BLOCKS BY START TIME (Top 10)

```
=====
Start Time | Duration | Samples
=====
0.008s | 4.007s | 386
4.035s | 2.154s | 195
6.510s | 0.110s | 12
6.760s | 0.721s | 55
7.722s | 1.603s | 155
9.485s | 0.030s | 4
9.796s | 0.090s | 10
10.106s | 0.150s | 16
11.058s | 0.000s | 1
11.228s | 0.150s | 16
=====
```

$t = 120\text{--}150$ s

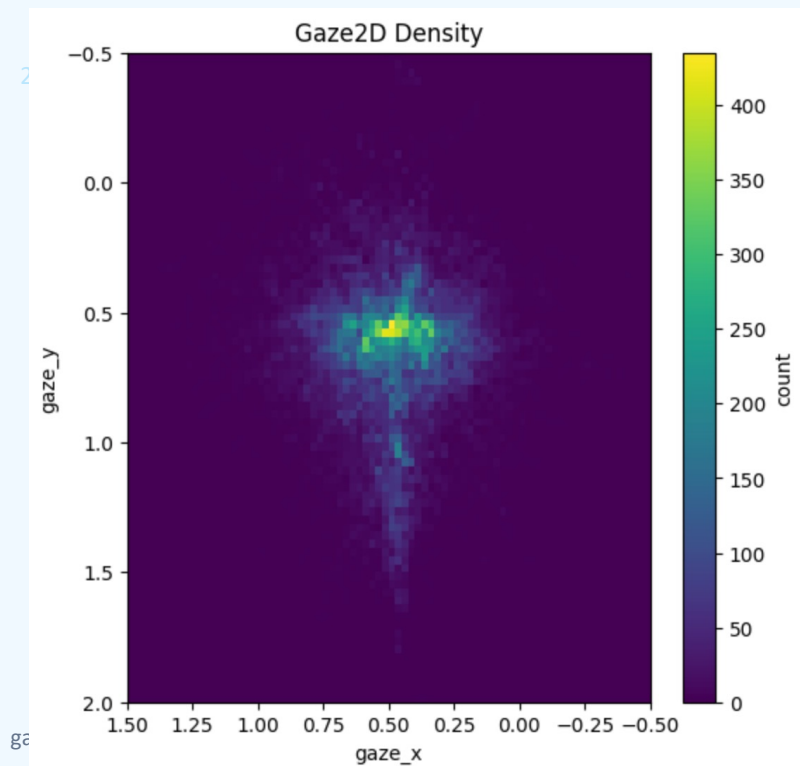
12.1% spike, one longer dropout block, patient on escalator.

Gaze velocity

Median: 0.57 units/sec. Max saccade: 73.8 units/sec at $t \approx 511$ s.

Schizophrenia: Expect longer invalid blocks, higher per-window invalid fraction, and more frequent high-velocity saccades.

Where Did the Subject Look?



Central clustering

$x \approx 0.4\text{--}0.6$; consistent with forward-facing walking posture.

Downward anchoring

y distribution skews 0.5–0.8; typical gaze-down gait behavior.

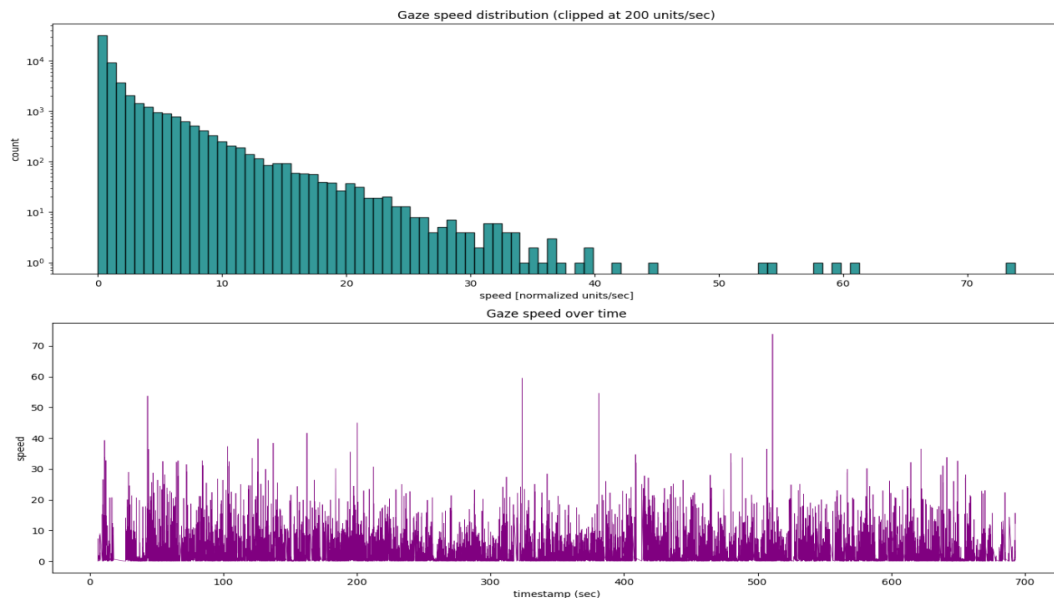
Structured invalids

Off-screen points cluster outside $[0,1]$ not random noise.

No calibration drift

Mean gaze coordinates stable across the full recording.

Saccade Profile



Median gaze speed: 0.5689 units/sec
Max gaze speed: 27.9462 units/sec

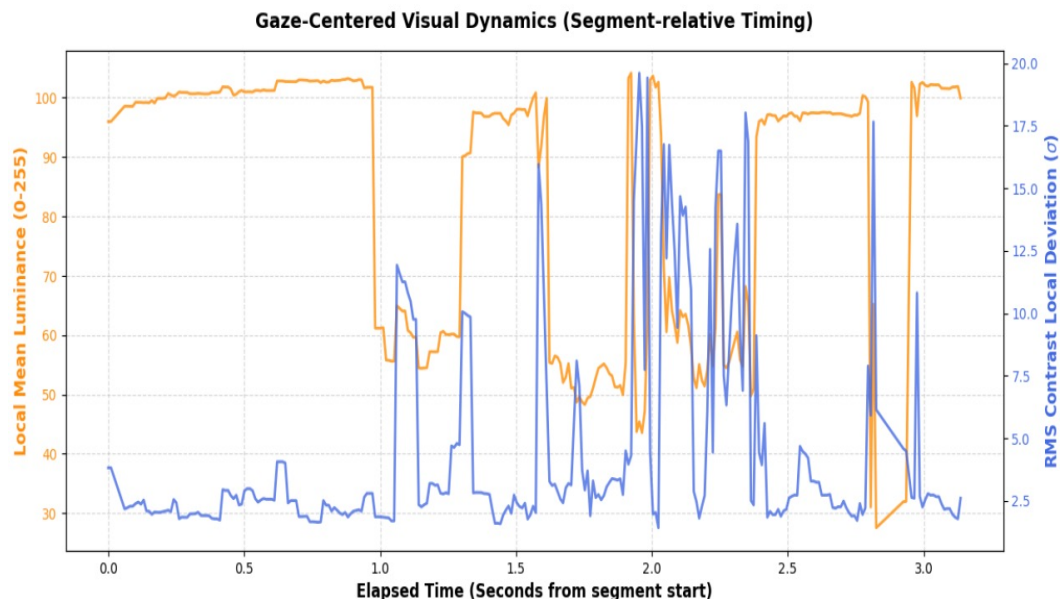
Top Speed Outliers

Likely genuine saccades should be verified against scene video frames.

TOP GAZE SPEED OUTLIERS

Timestamp	Gaze X	Gaze Y	Speed
511.16s	0.3164	0.9147	73.83 u/s
511.15s	0.1507	0.1880	60.82 u/s
323.65s	0.6709	0.8028	59.55 u/s
323.64s	0.5520	0.2243	57.68 u/s
...			
162.64s	0.8774	0.4480	41.67 u/s
125.97s	0.9217	0.4728	39.83 u/s
11.16s	0.8964	0.1587	39.31 u/s

Gaze-Centered Luminance & Contrast



Mean Luminance

Peaks = gaze on bright areas (sky, surfaces).
Controls show active, varied luminance tracking.

RMS Contrast (σ)

High contrast = gaze on textured edges. Controls show synchronized peaks with scene features.

Clinical Implication

- › Schizophrenia patients may show flatter luminance curves; reduced exploration of environmental features.
- › Hypo-contrast seeking (fixating low-texture areas) has been linked to negative symptom severity.

Method: 40×40px patch extracted from scene video at each gaze point. Mean luminance (0–255) and RMS contrast (σ) computed via OpenCV grayscale conversion.

Control vs. Schizophrenia

Metric	Control (This Dataset)	Expected: Schizophrenia
Valid gaze fraction	86.9%, stable after t=30s	Lower — elevated blink/loss rates
Invalid block duration	Median 0.05s; 21 blocks >1s	More frequent long blocks
Spatial distribution	$x \approx 0.4\text{--}0.6$, $y \approx 0.5\text{--}0.8$, stable	Broader spread, dysregulated scanpath
Saccade velocity	Median 0.57; max 73.8 units/sec	More frequent high-velocity bursts
Luminance tracking	Active, high variance (~140–160)	Reduced variance, hypo-exploration
Calibration drift	None detected over 695 sec	Possible systematic drift

Schizophrenia column based on published literature (Holzman et al.; Ettinger et al.; Javitt et al.). Patient data collection ongoing.

Summary & Roadmap



Key Conclusions

- › 86.9% valid gaze — stable after startup artifact at $t=0-18s$.
- › 462 invalid blocks; median 0.05s. 21 blocks $>1s$, 7 blocks $>2s$.
- › Primary invalid cause: Y-axis drift from walking biomechanics.
- › Gaze clusters at $x \approx 0.4-0.6$, $y \approx 0.5-0.8$. No calibration drift.
- › Saccade profile healthy: median 0.57 units/sec, sparse outliers.
- › Luminance/contrast: active, varied scene exploration confirmed.



Next Steps

Recruit patient cohort

Same task, hardware, and pipeline — enable direct statistical comparison.

ROI analysis

Extract high-density regions from control heatmap; compute patient dwell times per ROI.

Statistical tests

Two-sample tests: valid fraction, block duration, gaze speed, luminance variance.

Saccade classification

Segment velocity trace into fixations/saccades; compare group-level metrics.

Startup exclusion

Exclude $t=0-18s$ from metric calculations — large startup invalid block.