

Comparing a camera monitor system (CMS) with conventional mirrors in heavy goods vehicles (HGVs)

Drivers glanced at CMS displays more often than at mirrors during on-road driving, while mental workload, visual fatigue and sleepiness stayed similar.

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Background

Camera monitor systems (CMS) are increasingly replacing conventional mirrors on heavy goods vehicles (HGVs). A key motivation has been reduced drag and fuel consumption, but CMS is also expected to improve driving performance, comfort and safety. Drawing on interviews with field test drivers, we compared CMS and mirrors in a semi-naturalistic study.

Research question: How does a CMS compare with conventional mirrors in terms of glance behavior, mental workload, visual fatigue and sleepiness?

Method

10 professional drivers
70 h mixed on-road driving
40 reverse-parking tasks

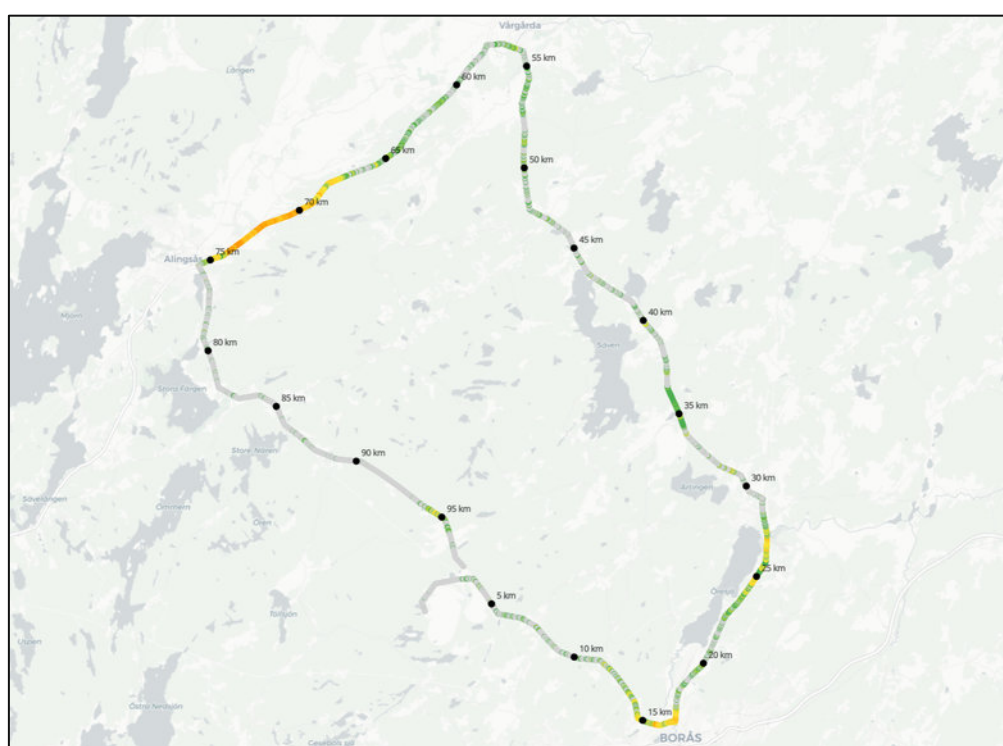
Ten test drivers from AB Volvo (7 men, 3 women; mean age 43, range 25–65; 4–36 years of driving experience) took part in a 2 × 2 within-subjects study (mirror type × drive). Each driver did one session per condition on separate days, in counterbalanced order.



Two Volvo FH trucks with similar drivetrains and trailers: orange with conventional mirrors, pink with CMS.

Each session started at Hällered test track near Borås, Sweden: a 100 km loop of mixed driving followed by free reverse parking into a slot.

Drive 1 ca 15:00–17:00 Daylight to dusk, more traffic	Reverse parking	Drive 2 ca 18:00–20:00 Dark, less traffic	Reverse parking
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A loop of mixed highway, rural, and urban roads.

Data from eye-tracking sensors (Smart Eye Pro) and cameras facing each mirror were logged and synchronized in iMotions. After each drive, drivers rated mental demand (NASA-TLX), visual fatigue (VFS) and sleepiness (KSS). A closing interview compared the two conditions.

Results

Glances were derived from eye-tracking data using areas of interest (AOI) for the left and right CMS displays and mirrors. During driving, drivers spent significantly more time glancing at the CMS displays (Fig. 1). Mean glance durations were similar (~450 ms), so the difference came from more frequent glances, mainly at the left display.

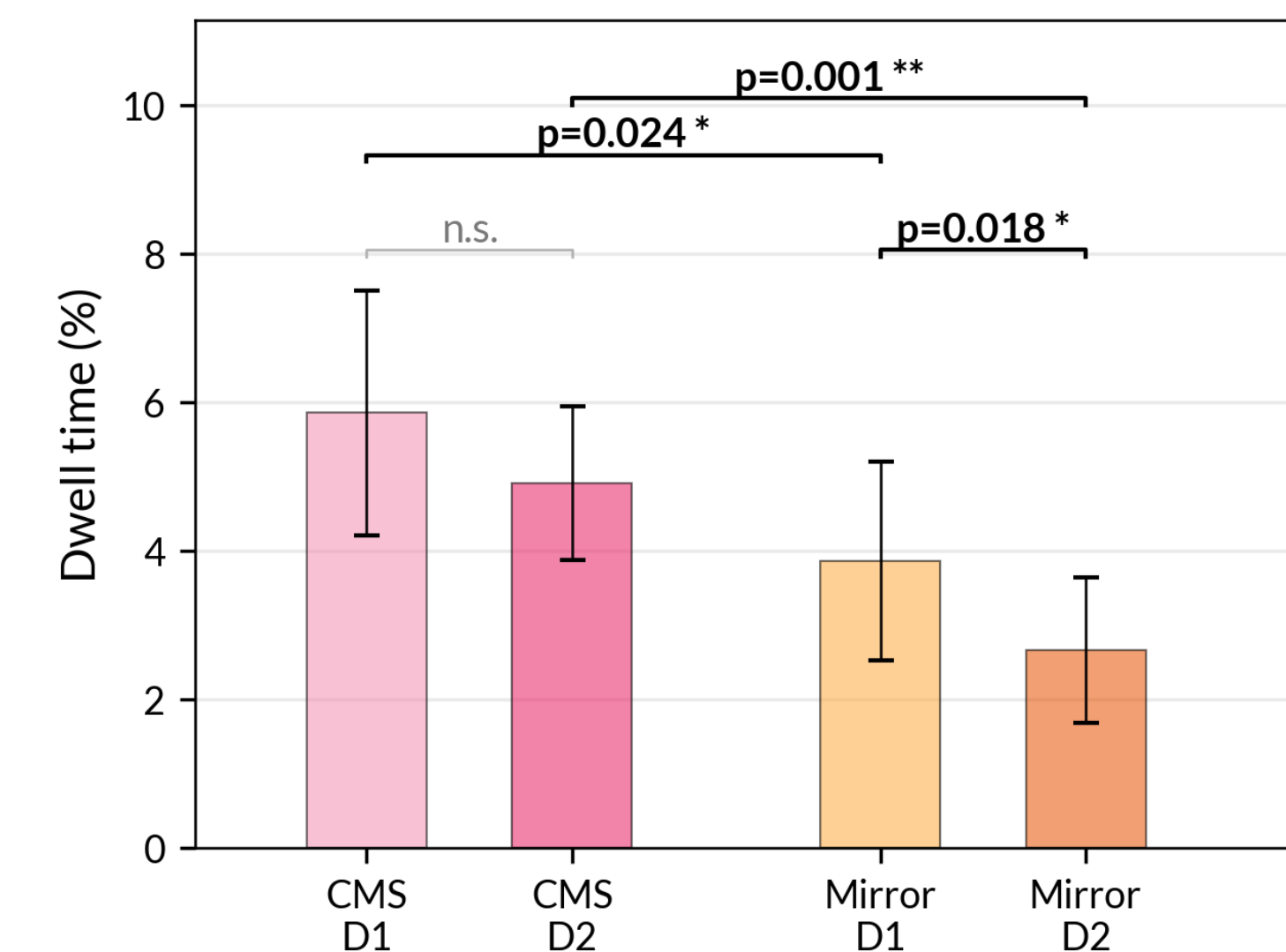


Fig. 1. Driving: AOI dwell time per condition and drive. Mean ± 95% CI; brackets = Holm-corrected post-hoc tests.

Reverse parking showed no significant differences between CMS and mirrors, only lower dwell time in daylight (Drive 1) with mirrors (Fig. 2).

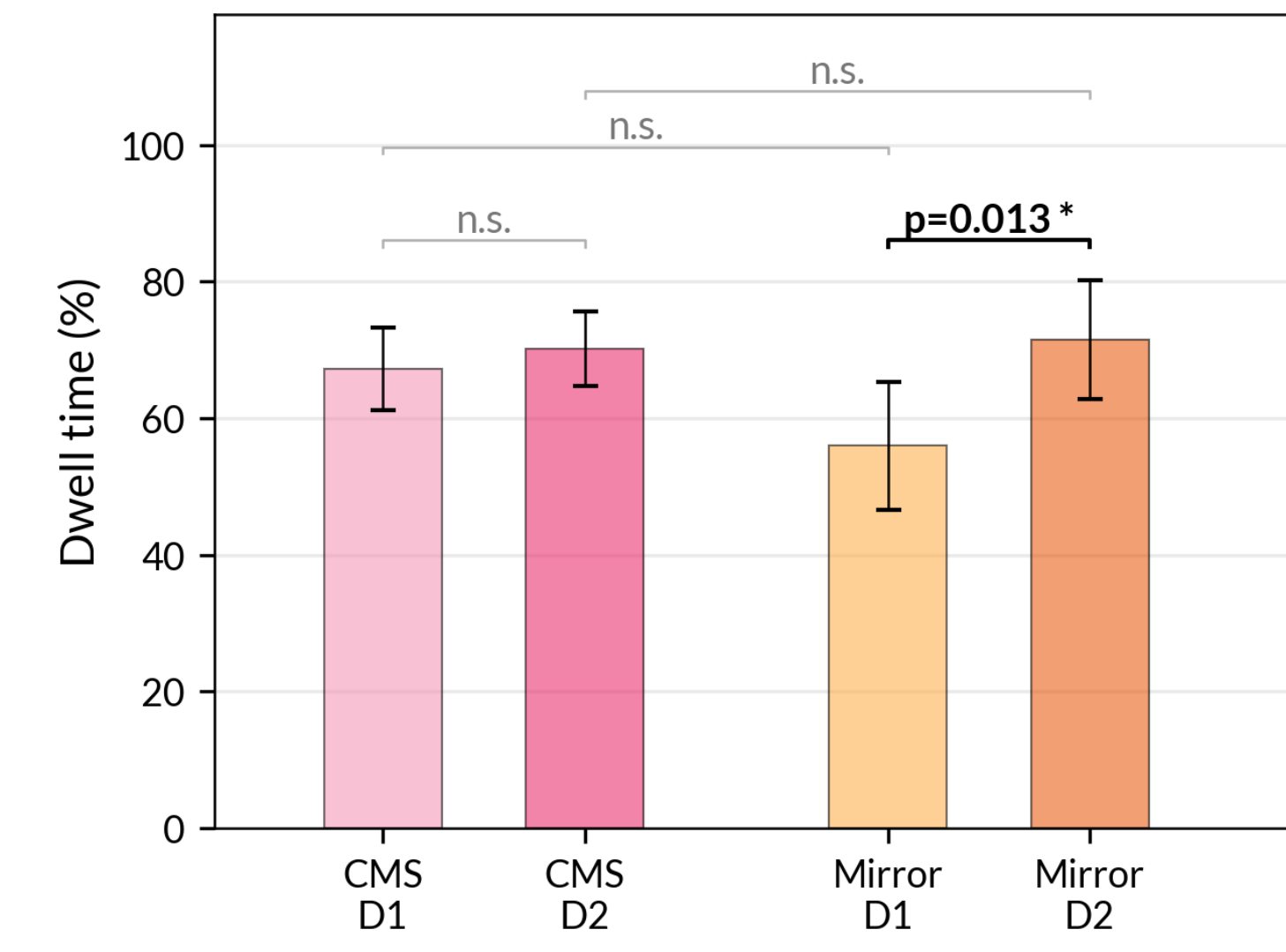
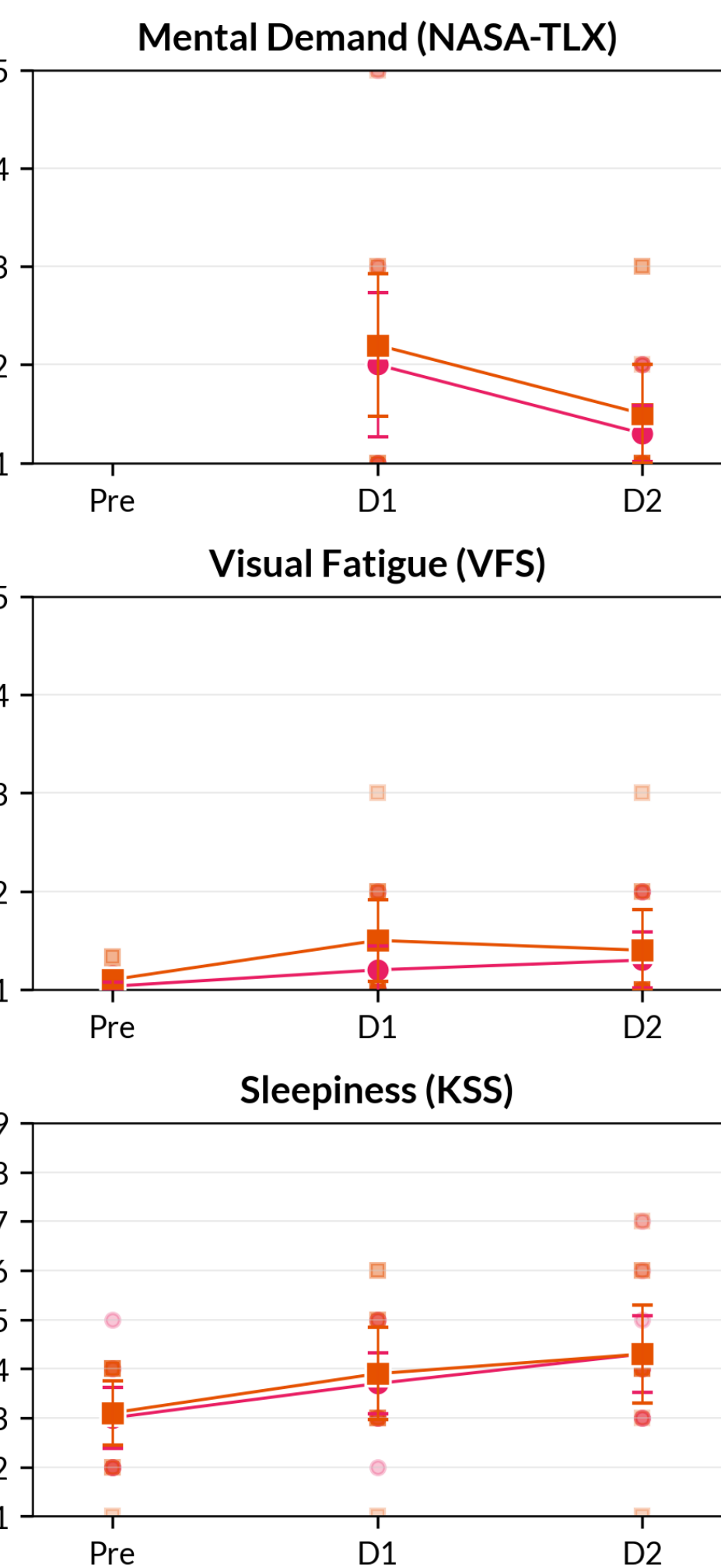


Fig. 2. Reverse parking: AOI dwell time. Mean ± 95% CI; Holm-corrected post-hoc tests.

Subjective ratings and comments

Mental demand, visual fatigue and sleepiness were similar for CMS and mirrors (Fig. 3). In the interviews, drivers reasoned about the pros and cons of each setup:



“The displays are closer to my field of view, so I use them more frequently. They draw focus to themselves.”

“It is an old habit to use mirrors, and it is easier to reverse straight and judge distances with them.”

Fig. 3. Subjective ratings: CMS (pink circles) and mirrors (orange squares). Mean ± 95% CI; individual ratings in the background.

Discussion and conclusions

- Drivers glanced at the CMS displays more often than at mirrors, but not for longer.
- No such effect in reverse parking, which is a more focused, self-paced task.
- Mental workload, visual fatigue and sleepiness were similar between conditions.

Unlike, for example, a phone screen, a CMS display is itself a source of driving-relevant information, so more frequent glances are not distraction in the conventional sense, even though attention drawn to one relevant source may come at the cost of others. Determining appropriate glance patterns requires clearer, context-specific sampling benchmarks for the attention and scanning a driving situation demands.

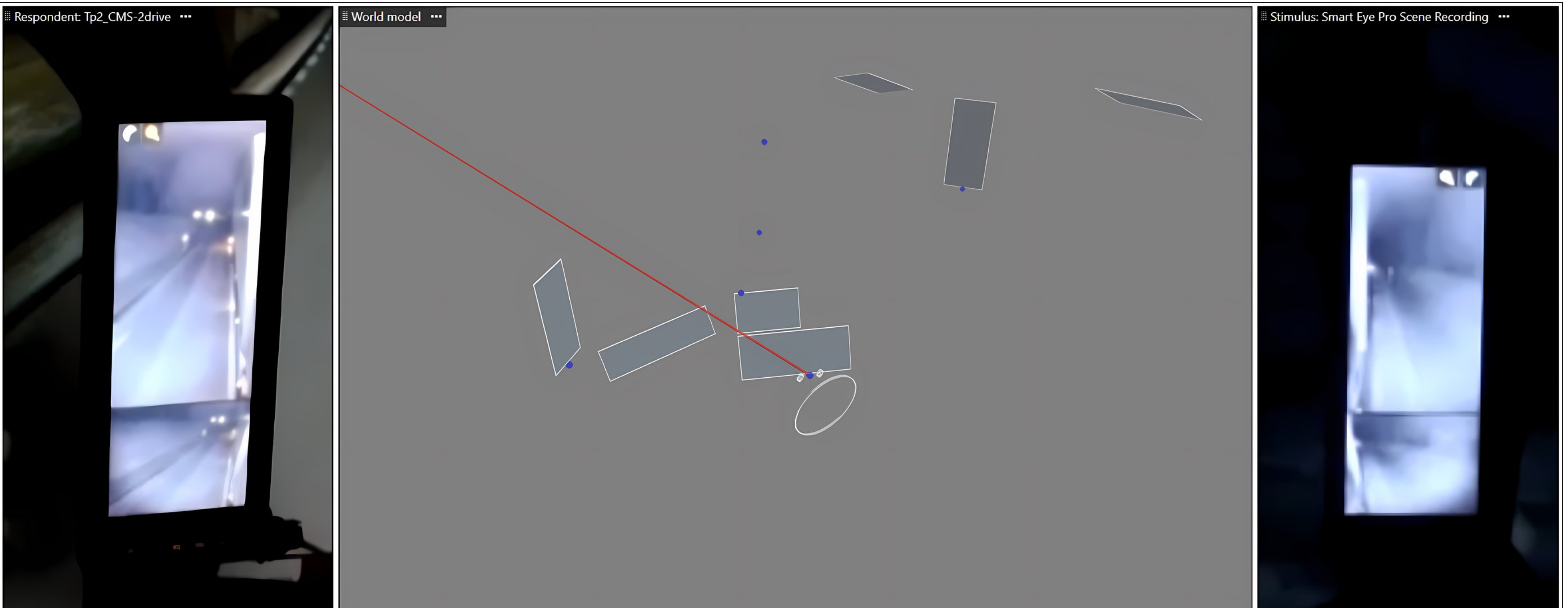


Fig. 4. Eye-tracking setup in iMotions during a CMS drive in darkness, including cameras facing the CMS displays and the 3D world model with gaze vector and AOIs.