Systematic Evaluation *of* Driver's *Behavior*

a multimodal biometric study

IMOTIONS

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OBJECTIVE

The main aim of this work was to characterize the driver's responses through eye-tracking, electrocardiography (ECG), electromyography (EMG), galvanic skin response (GSR), respiration frequency (RSP), and facial expressions analysis (FEA), while completing driving tasks with different workload intensities.

eye-tracking | ECG | EMG | RSP | GSR | FEA

METHODS

Ten healthy respondents (5 female) participated in this evaluation.
The inclusion criteria included healthy individuals within an age range of 18-40 years (31.4±7.1), who have a driver's license and no previous experience driving a car simulator, whereas the exclusion criteria included visual and motor disabilities, chronic or current acute pain at the time of the experiment, and cardiorespiratory disorders.

Experimental procedure

Respondents were instructed to complete 3 driving tasks (low, medium and high workload) in a multiscreen professional driving simulator with dedicated steering wheel and pedals. Biometric signal data was collected for Eye tracking, ECG heartrate, EMG, Respiration, GSR/EDA, and Facial Expressions. All signals were recorded and analyzed by a biometric software (iMotions 9.3.3, iMotions A/S, Denmark).

Low workload (baseline) → [Medium workload → High workload] Pseudorandomized

Low workload (baseline):
Drive on a free open highway, without traffic, doing double lane changes, maneuvers, acceleration and braking.

Medium workload:
Slalom the car between traffic cones and perform a double lane change maneuver as fast as reasonably possible.

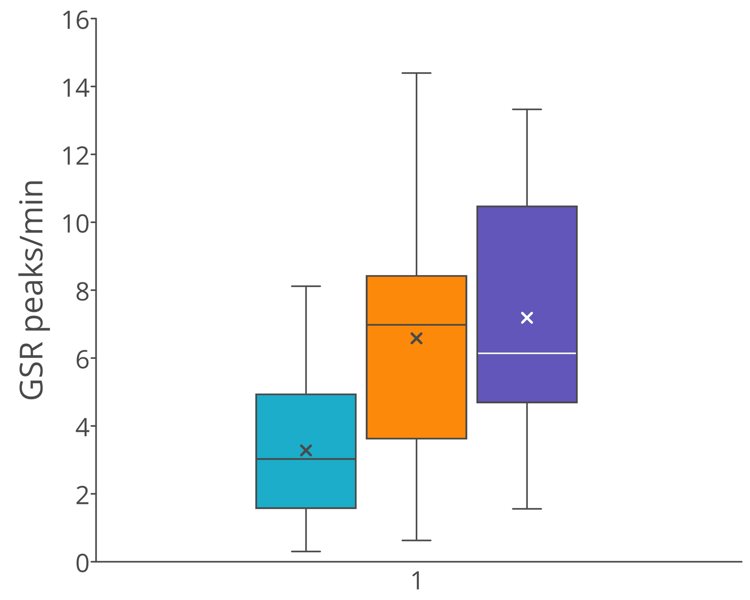
High workload:
Drive through a city with random traffic conditions, traffic lights, multiple vehicles circulating in it, and pedestrians crossing the street.

RESULTS

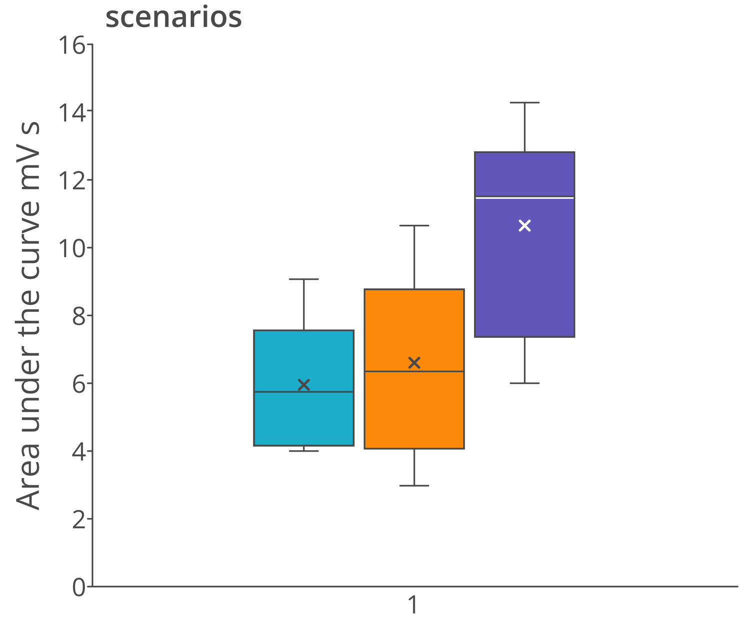
Preliminary results show that drivers' responses as indexed through GSR, EMG and eye-tracking are modulated across workload tasks.

Figure 1: Replay in the iMotions software. The driver's physiological responses were recorded and analyzed with this software.

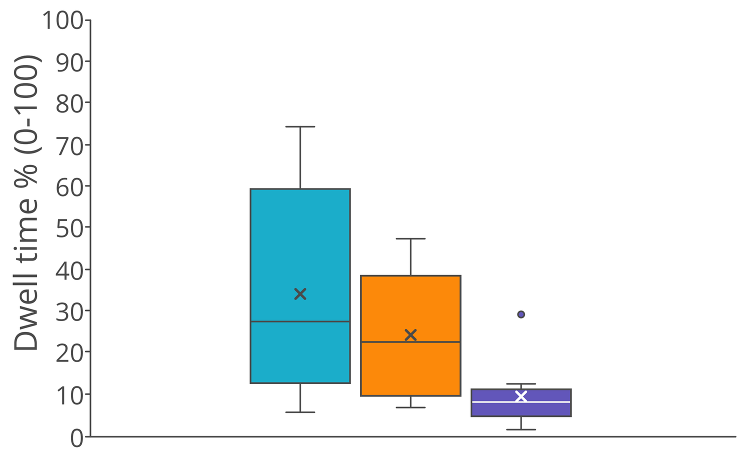
↑ GSR peaks/min in the traffic scenario compared to the baseline



↑ Muscle activation in the traffic scenario compared to the baseline and cones scenarios



↑ Dwell time % on the speedometer in the baseline compared to the cones and traffic scenarios



↑ Dwell time % on the left screen in the traffic scenario

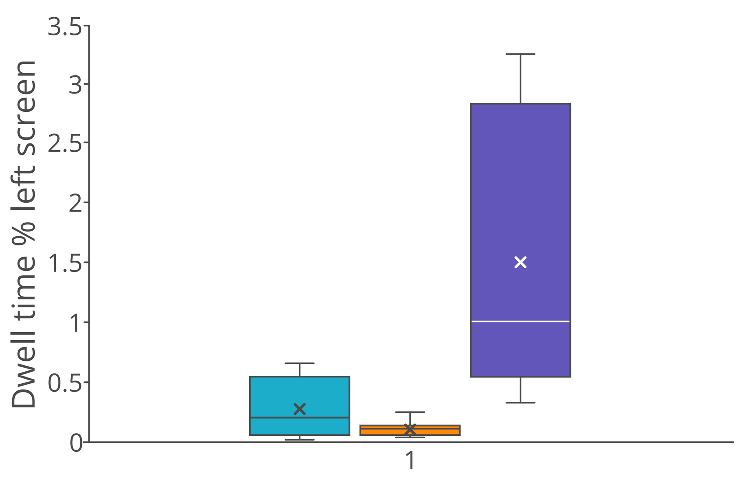


Figure 2: Additional analysis with Areas of interest (AOI) evaluating drivers' visual attention towards the speedometer and passing cars during the high workload task.

CONCLUSION

The preliminary results of the present study indicate **higher muscle tension** (EMG activity), **modulated arousal** (heart rate and GSR peaks/min) and **higher perceptual load** (dwell time %) in complex driving scenarios.

The application of multiple biosensors in driver research has the potential to advance our comprehension of driving behavior, guide the creation of fresh driver training initiatives and safety interventions, produce the desired driver's experience, and aid in lowering the rate of traffic accidents.

Full powered studies are warranted to quantify the interaction between different driving conditions and driving expertise levels on these outcomes and to triangulate both neurophysiological and behavioural responses.

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