



# Automotive R&D

## Increase Insights with Biosensors

Automotive R&D

Confidential © 2023 Redistribution is not permitted without written permission from iMotions

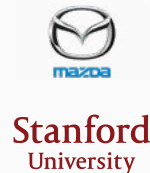
# Automotive Insight

## State-of-the-art driver experience research

The iMotions platform is a versatile software solution that allows automotive researchers to conduct in-car human behavior research with a wide range of sensor modalities. From eye tracking and expressed emotion tracking via facial expression, to gold standard EEG, GSR, ECG, EMG and other sensors - all integrated in iMotions' easy-to-use platform.

- Understand driver emotions & behavior
- Develop the human aware car
- Improve driver experience & safety

With the iMotions R&D automotive solution you can take your nonconscious driver insight to the next level.



Some of the automotive companies and researchers that are currently using iMotions.



# Automotive Research Benefits

## Beyond traditional methods

### Non-intrusive physiological data insights

Introducing eye tracking devices such as the Smart Eye Pro multi-camera system, camera based facial expressions, and video recordings of subjects from multiple angles without adding intrusive hardware on respondents.



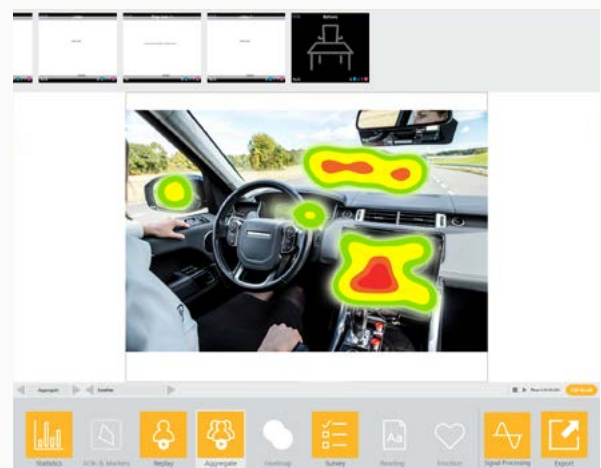
### Gold standard data collection from multiple sensors

Obtain high quality human behavior insights from gold standard sensors. Measure and analyze GSR, ECG, respiration, and data from other sources in one place. These sensors provide detailed information about the physiological, cognitive and emotional state of the participant. Integrate with iMotions for R&D and gold standard metric validation.

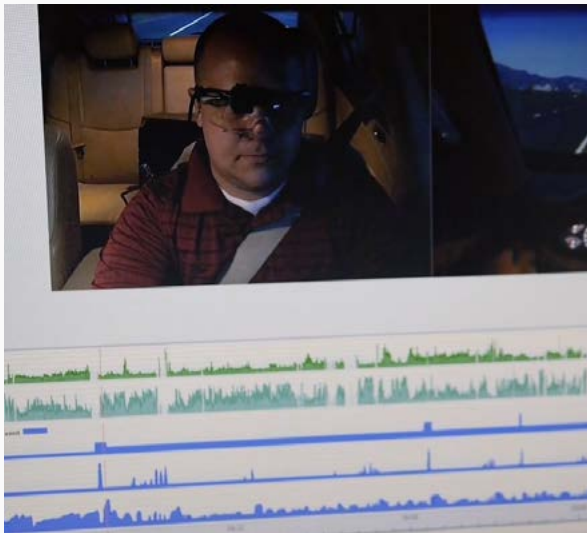


### Quickly discover points of interest with live data observation

Observe data from sensors in real-time to make qualitative observations of participant behavior and responses. Annotate the data with live markers to easily find points of interest after data collection.







## Adaptable integration of systems and feedback loops for customization

Integrate eye tracking and behavioral data streams with events and signals generated from the environment such as car events, alternative sensors, and more. All data is synchronized and live visualized, and can be forwarded for closed loop or contingent condition experiments.

## Powerful visualization and analysis options for faster time to conclusions

Strong visualization and analysis tools specifically designed for biosensors and eye tracking data. Generate individual replays, aggregation, heatmaps, emotional correlations, and much more with iMotions' powerful analytics engine for automotive R&D insights.



# Automotive Application Areas

## The ideal solution for diverse research approaches

### 1. Safety Domains

Using methodologies like eye trackers and facial expression analysis allows you to monitor driver attention, distraction, and drowsiness. Use human behavior data insights to help activate brakes, take over steering control, modify audio volume and much more to ensure optimal safety.

Examples include:

How fast will the driver easily find the information necessary to operate the vehicle?

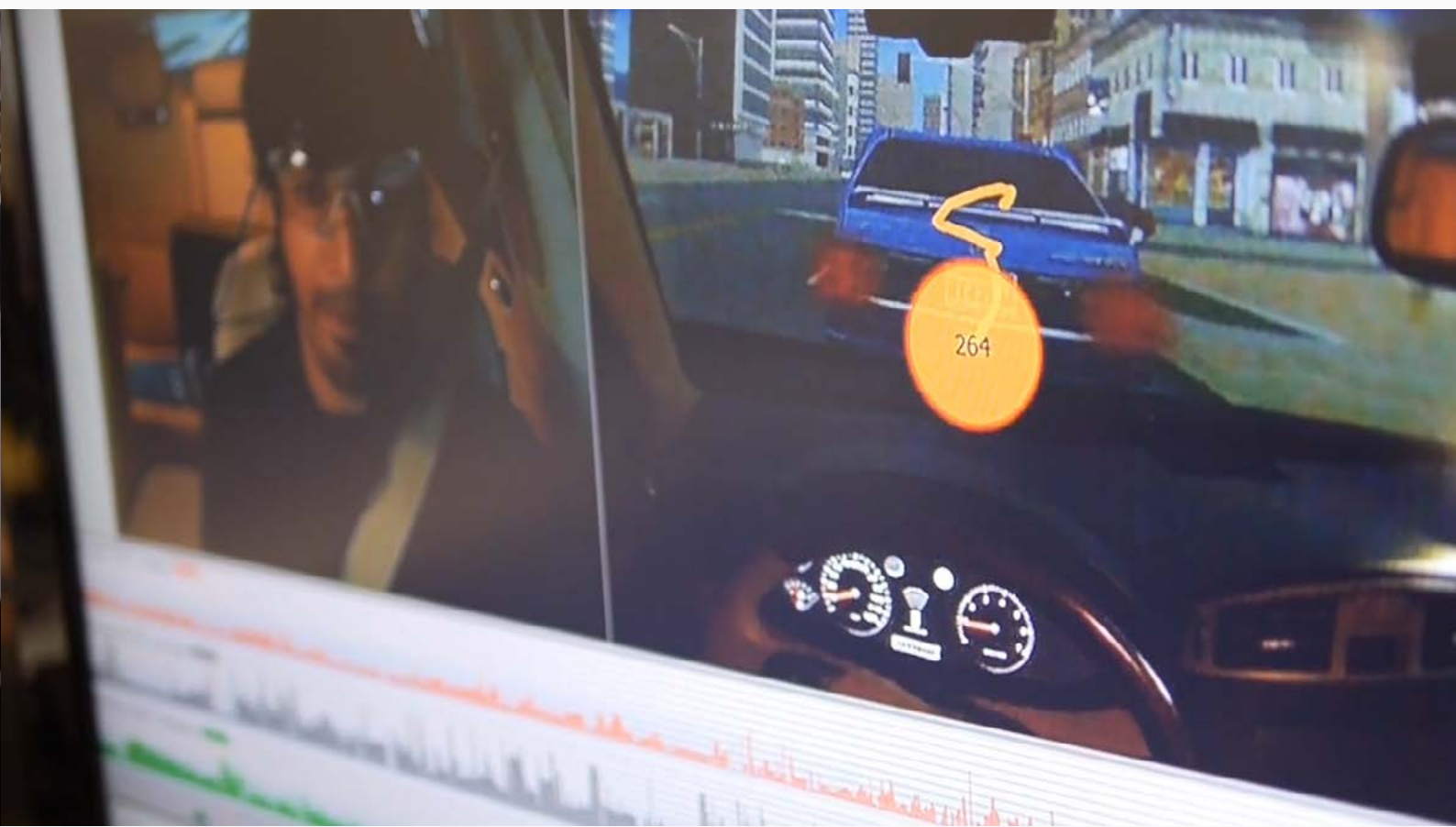
Use eye tracking to discover when the driver gets confused and what elements in the visual field cause confusion.

How can the car detect the psychological state of the driver that can impact driver performance and safety?

Measure drowsiness through nonverbal visual cues such as yawning, head nodding, eyelid position and more.

How fast does the driver regain control of the situation in a near accident?

Use visual attention and physiological measures to detect the sequence of events needed that allow the driver to regain control of the car



## 2. Driver User Experience

Optimize the driver experience by testing impact of car functionality, interaction, infotainment systems, and more. Develop user-based sensor controls with eye, face or hand gestures.

Examples include:

How is the first time user experience?  
Is the environment comfortable for the driver and passengers?

Use physiological measures to gain insights into absence or presence of emotional states during particular automotive environments.

How can you control certain elements of the car with your eyes?

Test personalized experiences with behavioral interaction control

Is the in-car entertainment user-friendly to operate?

Use eye tracking to gain insights into how the user interface of the entertainment system can be optimized.

Watch the video below to see how [Mazda](#) and researchers at the [University of Fribourg](#) used iMotions to investigate driver experience, and produce a new advertising campaign.





### 3. Autonomous Vehicles

Optimize the car experience when the driver is no longer operating the vehicle. Make the car human-aware to respond most appropriately.

Examples include:

When is it safe to give control back to the driver in a problematic situation?

Use the research platform to evaluate cognitive and emotional states of the driver, and when it is safe to hand back control to the driver. Determine which sequence of events validate transfer of control.

Will it be more dangerous to switch to the driver rather than the car maintaining control?

Combine data from in-car events with biosensor data from driver to inform decisions about control. Determine car environment and driver state to make the best available decision.

Does the absence of control induce motion sickness, and can it be reliably detected by observing the driver remotely?

Uncover biomarkers of motion sickness.



# R&D vs. OEM

## Discover the impact of new technologies

iMotions is an R&D platform for researchers, that allows you to collect and analyze data from a broad range of OEM and Research grade biosensors - giving you insights into attention, cognition, emotion, and the behavior of drivers.

iMotions is typically used to:

- Provide new insights by conducting research experiments
- Develop new sensor metrics for areas like drowsiness, distraction, etc
- Validate OEM sensors, metrics, and KPIs against gold standard sensors
- Benchmark experience and functionality

<b>Non-intrusive sensors (integrated in-car)</b>	<b>OEM Solution</b>	<b>iMotions R&amp;D Solution</b>
Smart Eye OEM	✓	✓
Affectiva Facial Expression	✓	✓
Video	✓	✓
Seat belt, movement etc.	✓	✓
Others	✓	✓

### Research Sensors

Eye tracking	✓
Affectiva Facial Expression	✓
GSR (Galvanic Skin Response)	✓
EEG (appropriate only within controlled environments)	✓
ECG / EMG	✓

### Standard Metrics / Algorithms

Drowsiness, blinks, emotions	✓	✓
Cognitive workload, motivation, stress		✓

### Use cases

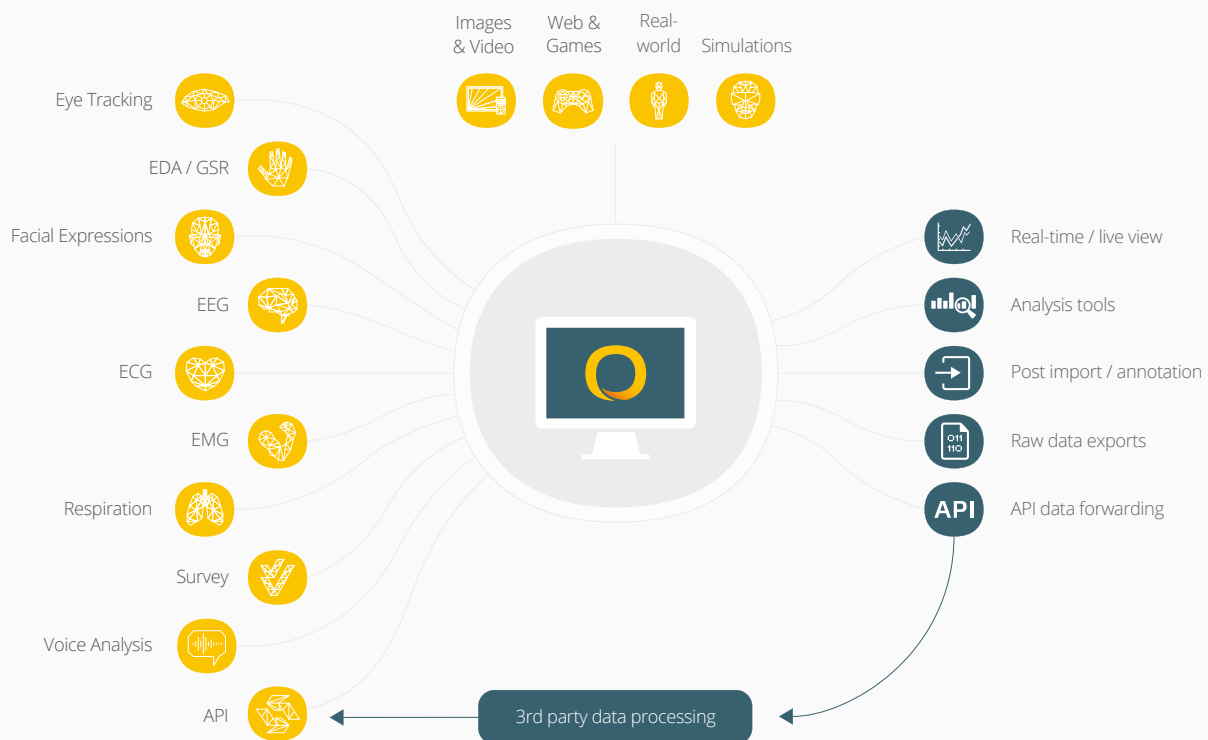
Develop algorithms	✓	✓
Validate algorithms		✓
Benchmark algorithms		✓



# iMotions Software Solution

## Multimodal research in any environment

iMotions reduces the complexity of carrying out multimodal research, enabling a wide array of sensors to be seamlessly connected. By combining these biosensor measurements, it's possible to get a better understanding of human thoughts, feelings, and behaviors in any environment.



iMotions enables multimodal research to be carried out in a wide array of research environments.

Real-world



Basic simulations



High-end simulations



# Data & sensor inputs supported

Mix & match with plug-and-play solutions

Highlighted brands for automotive research:

## Smart Eye Pro Eye Tracking

For non-intrusive eye tracking in automotive research, Smart Eye is the recommended solution. Offering high-end research grade eye tracking and tightly integrated with iMotions.



With the Smart Eye Pro/iMotions solution you can perform the following tasks:

- Record data with iMotions directly capturing eye tracking from Smart Eye
- Record scene video, environment video, eye tracking and biosensors in one software
- 3D world model support for vector based eye tracking data
- Live visualization of eye tracking data
- Overlay eye tracking data on scene camera
- Aggregate eye tracking data in 2d space
- Markup and annotation both post and live
- Create heatmaps of eye tracking data
- Extract standard metrics like time to first fixation and many more
- Export all raw data for further statistical analysis
- Live forward all synchronized data via API for real-time processing



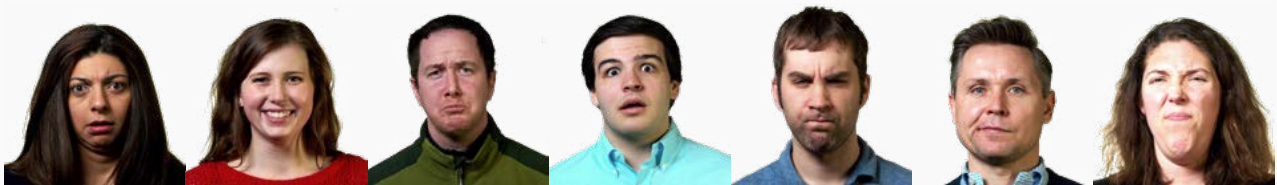
# :) Affectiva

## Affectiva Facial Expression Analysis

Getting insights into the emotional expressions of a driver is crucial for understanding the driving experience. With Affectiva's world-leading facial expression analysis engine tightly integrated into iMotions, you can now get detailed objective and real-time emotional data like the 7 basic emotions, behavioral head movement data, and 21 facial landmarks.

With the combined Affectiva & iMotions Solution you can perform the following tasks:

- Real-time processing of emotional data
- Live visualization of processed data
- Synchronize real-time with eye tracking data from Smart Eye and other biosensors
- Markup and annotation
- Powerful analytics to aggregate and uncover trends in the data
- Live forward all live synchronized data



Fear

Joy

Sadness

Surprise

Anger

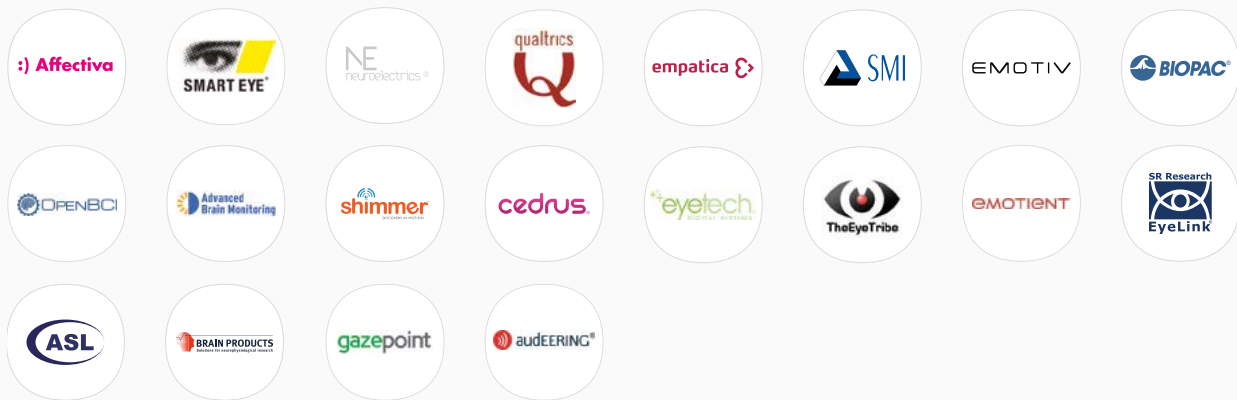
Contempt

Disgust





iMotions supports leading 3rd party sensor products. Additional sensors can be integrated via our API.



## Biosensors

iMotions has a suite of partners that provide biosensor hardware like EEG, electrodermal activity (EDA), ECG, EMG, etc that are suitable for automotive research.

- Eye tracking: SMI, Smart Eye, EyeTech, Gazepoint
- EEG: Advanced Brain Monitoring (ABM), NeuroElectrics, Brain Products, Emotiv, OpenBCI
- EDA: BIOPAC, Shimmer, Empatica
- ECG: BIOPAC, Shimmer
- EMG: BIOPAC, Shimmer
- Respiration: BIOPAC

## Additional sensor integration

iMotions has a powerful API equipping researchers with the tools to:

- Integrate new sensors with real-time data capture in iMotions
- Live synchronize all data streams
- Live forward all synchronized data streams
- Control the iMotions application via remote control
- Supports standard sensor protocols like LSL and TTL

EEG



EDA



ECG / EMG



# Selected Publications

## Automotive research made possible with iMotions

### **Psychophysiological responses to short-term cooling during a simulated monotonous driving task**

Authors: Elisabeth Schmidt, Ralf Decke, Ralph Rasshofer, Angelika C. Bullinger  
Company: BMW

[View publication](#)

### **Effect of cognitive load in autonomous vehicles on driver performance during transfer of control**

Authors: Mishel Johns, Srinath Sibi, Wendy Ju  
Institute: Stanford University

[View publication](#)

### **Correlation Between Subjective Driver State Measures and Psychophysiological and Vehicular Data in Simulated Driving**

Authors: Elisabeth Schmidt, Ralf Decke and Ralph Rasshofer  
Company: BMW

[View publication](#)

### **Face Emotions and Short Surveys in Automotive Tasks**

Authors: Lee Quintanar, Peter Trujillo, Jeremy Watson  
Company: J.D. Power

[View publication](#)

### **Advanced Driver Monitoring for Assistance System (ADMAS) based on emotions**

Authors: Javier Izquierdo-Reyes, Sergio Navarro-Tuch, Ricardo A. Mendoza-Ramirez et al  
Institute: Monterrey Institute of Technology and Higher Education

[View publication](#)

### **Emergency, Automation Off: Unstructured Transition Timing for Distracted Drivers of Automated Vehicles**

Authors: Brian Mok, Mishel Johns, Key Jung Lee, David Miller, David Sirkin, Page Ive, Wendy Ju  
Institute / company: Stanford University, Robert Bosch LLC

[View publication](#)

### **Music Recommendation System for Human Attention Modulation by Facial Recognition on a driving task: A Proof of Concept**

Authors: Javier Izquierdo-Reyes, Sergio Navarro-Tuch, Rogelio Bustamante – Bello et al  
Institute: Monterrey Institute of Technology and Higher Education

[View publication](#)

### **Introducing the Wayfaring Approach for the Development of Human Experiments in Interaction Design and Engineering Design Science**

Authors: Kittil Kittilsen Leikanger, Stephanie Balters, and Martin Steinert  
Institute: Norwegian University of Science and Technology

[View publication](#)

Wendy Ju, **Executive Director of Interaction Design Research at Stanford University**, describes her experience of using iMotions in automotive research in the video below:



**Stanford**  
University

Want to know more?

**GET IN TOUCH**



**Copenhagen, Denmark**

Kristen Bernikows Gade 6  
4th floor  
København K, 1105  
TEL +45 71 998 098

**Boston, USA**

38 Chauncy Street  
Floor 8, Suite 800  
Boston, MA 02111  
TEL +1 617-520-4958

Synchronize, Visualize and Analyze your research in Eye Tracking, Facial Expression Analysis, Galvanic Skin Response, Surveys, EEG and much more in one software platform.

[www.imotions.com](http://www.imotions.com)

**China**

NO.1 Fortune Avenue,  
Room 2902  
Yubei District, Chongqing  
TEL +886 931684806