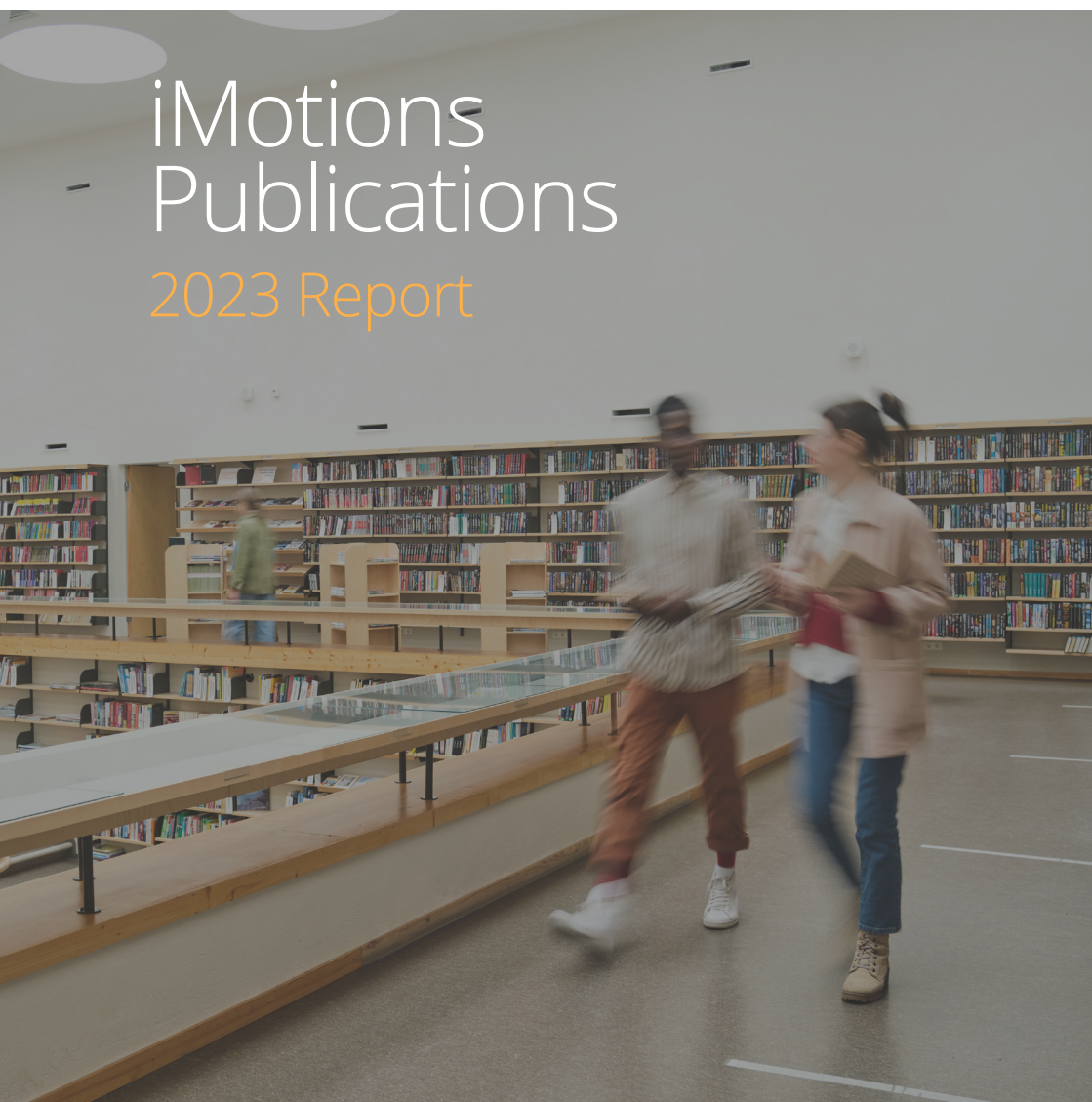# O IMOTIONS®

# iMotions
# Publications
## 2023 Report

# Looking back at 2023
## New trends and approaches emerge

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iMotions is a trailblazing research software that has enriched the academic world with hundreds of publications over the last two decades. We're excited to share with you an inspiring overview of the groundbreaking research accomplished with the help of iMotions in 2023.

This past year has once again shown the productivity of our clients, who have published an impressive array of articles, book chapters, conference papers, and posters. These contributions span a diverse range of fields, including clinical and educational research, user experience, human factors, communication psychology, traffic psychology, sensory research, and across many more fields.

A notable trend in 2023 was the integration of multimodal research methods, with a quarter of the articles published leveraging more than one biosensor to gain deeper insights. Eye tracking emerged as the most popular modality, offering invaluable data on where and how individuals direct their attention. This was often paired with sensors designed to capture further dimensions of the experience, such as facial expression analysis and galvanic skin response (GSR) data, enriching the findings with valence and arousal data. Additionally, the use of electrocardiography (ECG) for behavioral research gained significant momentum, marking an exciting development for this biosensor.
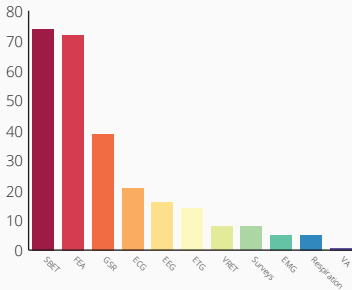
25% of studies published in 2023 were multimodal

Eye tracking was the most-used standalone biosensor
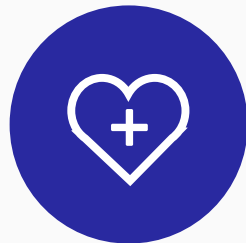
ECG was found in more publications than ever before

Splitting the studies by sensor type, we can see that the majority of studies using iMotions used screen-based eye tracking (SBET), followed closely by facial expression analysis (FEA). GSR = galvanic skin response, ECG = electrocardiography, EEG = electroencephalography, ETG = eye tracking glasses, VRET = virtual reality eye tracking, EMG = electromyography, VA = voice analysis.
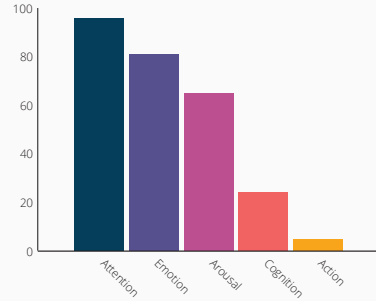
Looking into the modality type, we can see that most studies investigated attention (all eye tracking types), followed by emotions (FEA and voice), then arousal (GSR, ECG, respiration), cognition (EEG, surveys), and finally action (EMG). While the exact type of use and methodology of these sensors can vary, this provides a broad overview of the modality types employed in iMotions studies.

To provide a comprehensive understanding of the advancements and future directions of biosensor research, this report is divided into four main sections:

1. Human factors and usability

2. Communications and applied sciences

3. Healthcare

4. Consumer psychology

Each section has been set out to not only showcase the significant achievements of the previous year, but also to illuminate the pathways toward further discoveries and innovations in biosensor research.

# Human factors & usability

Human factors and usability research provides new insights into how human beings perform under various conditions, and how the environment around them can be improved based on this understanding of human behavior. A significant amount of this research focuses on understanding humans in new and emerging technologies, such as with virtual reality. The research is also focused on improving existing systems, such as in industrial workplaces, signboards across cities, placements of rear-view mirrors in cars, and crash prevention measures in vehicles.

Screen-based eye tracking is the most popular biosensor within this field, and is often used alongside measures of galvanic skin response. Together they inform researchers about when,

where, and how visual attention is allocated; and how the body reacts to the environment it is in. This field shows itself to be curious and open to physiological measures of stress, focus, and well-being such as the use of ECG, electromyography (EMG) and respiration.

The previous year also saw the publication of an iMotions study at the Human-Computer Interaction International conference (Minen et al.). The study utilized measures of eye tracking, GSR, ECG, and respiration, finding significant differences across biosensor data within increasingly complex driving conditions. The publication supports the use of a multimodal approach to understand drivers' cognitive and affective states in varying traffic scenarios.

## Highlights

- Eye tracking dominates the field with its flexible use in different real-life, lab-based and virtual environments.

- Engagement with a wide variety of physiological measures, such as GSR, ECG, EMG and respiration

- A broad range of topics cover how humans react to different environments and can be aided to improve performance and decrease stress and cognitive workload.

# Research stories
## Learn from your peers

In a captivating exploration of trust in automated driving, Ayoub et al. developed a machine learning model that delves into the nuances of driver behavior. Their research focused on critical moments where drivers needed to regain control of their vehicles. By integrating eye tracking, heart rate, and galvanic skin response data, they provided a comprehensive picture of the drivers' visual attention, emotional arousal, and stress levels. This rich dataset fed into their machine learning models, aiming to pinpoint the most reliable indicators of a driver's trust during automated driving – a leap forward in understanding the human-automation relationship.

Meanwhile, Hui Xiang Yang et al. embarked on an intriguing journey into the realm of virtual reality, tackling the phenomenon of cybersickness. Leveraging the power of ECG and EEG, they ventured beyond the surface to uncover the physiological and neural underpinnings of this discomfort. With an impressive group of 50 participants and sophisticated neural network models, their research illuminated critical brain regions – specifically, the premotor and supplementary motor cortex, along with the primary visual cortex. These findings offer a groundbreaking perspective on predicting cybersickness, providing invaluable insights into the design of more comfortable and immersive virtual environments.

# Communications and applied sciences

Impactful communications often produce physiological arousal in response to salient information, and are often designed to elicit emotional responses of either a positive or negative valence. Consequently, the most widely used biosensors in this field this year have been facial expression analysis and galvanic skin response. These tools work in tandem to provide insights into the emotional intensity and nature of participants' responses. Eye tracking is also occasionally utilized to pinpoint the specific stimuli that provoke these emotional reactions.

The research using iMotions software in this area is remarkably broad and varied, spanning numerous captivating questions and experimental designs. Particularly noteworthy is its application in dyadic interactions, where studies focus on collaborative learning and problem-solving. Notable among these is iMotions' own dyadic study, presented at the International Communications Association Conference in 2023, which utilized eye tracking, EEG, facial expression analysis, skin conductance, and voice analysis ([Bülow et al.](#)). Other studies have explored decision-making in financial risk-taking and the impact of sustainability communications on corporate image. Additional research has delved into cognitive aspects like uncertainty and decision-making biases. This field also extends to subtle perceptions in interpersonal dynamics, examining varied topics from perceived attractiveness and resume assessments to the involuntary attention drawn by unintended notifications. Each study, with its distinct emphasis, enriches our understanding of human perception and interaction, highlighting the dynamic and multifaceted aspects of communication research advanced by iMotions software.

## Highlights

- Facial expressions dominate the field

- Galvanic skin response pairs well to give another dimension to the emotional measures

- The breadth of topics cover how people and messages in the environment are perceived and evaluating interpersonal interactions.

# Research stories
## Learn from your peers

In a fascinating study by Dirks et al., researchers delved into the realm of sports broadcasting, measuring arousal and emotional responses in participants viewing male and female sportscasters. The findings revealed intriguing patterns: while male participants exhibited more physiological arousal when viewing female sportscasters, female participants showed a more pronounced emotional response. This study, illuminating the nuanced interplay between gender and media perception, was made possible by the innovative combination of facial expression analysis and galvanic skin response measurements. This approach not only captured the emotional expressions but also the intensity of emotional arousal, showcasing a unique double dissociation between different groups.

Meanwhile, Romero-Luis et al. developed a model that evaluates the impact of environmental awareness initiatives. Their methodology is a novel blend of traditional and neuropsychological approaches, merging semi-structured interviews with cutting-edge techniques like eye tracking and facial expression analysis. This multifaceted tool allowed the researchers to assess both the cognitive understanding and emotional reactions to environmental messaging. Beyond its immediate findings, this study serves as an exemplary model for future research in this area, offering a comprehensive and dynamic framework for investigating the intersection of knowledge, emotion, and environmental communication.

# Healthcare

Screen-based eye tracking has emerged as a favored tool within healthcare research, and is often paired with facial expression analysis. The majority of the research in this field is devoted to unraveling the emotional and cognitive responses of clinical populations, including individuals with major depression, anxiety, and cognitive decline. A significant portion of these research endeavors is focused on developing advanced machine learning models capable of classifying patients' responses into distinct diagnoses. The metrics obtained from biosensors are proving invaluable in the creation of effective clinical biomarkers.

What's particularly striking about the research emerging from the healthcare sector is its profound impact on understanding varied clinical profiles. By examining behavioral and psychophysical responses during specific cognitive tasks, this research is not only enhancing our comprehension of different mental health conditions but is also paving the way for more tailored and potentially more effective treatment options. This highlights the critical role of biosensor research in advancing our knowledge and capabilities in the realm of mental health care.



# Highlights

- Eye tracking dominates the field

- Combination of sensors aimed at emotional and cognitive evaluations of disorders.

- Trends show advancements in machine learning models to identify clinical biomarkers.

# Research stories
## Learn from your peers

In an intriguing study, [Singleton et al.](#) delved into the realm of social cognition in patients with various cognitive conditions, including a behavioral variant of Alzheimer's, frontotemporal dementia, subjective cognitive decline, and typical Alzheimer's disease. Utilizing eye tracking and galvanic skin response (GSR) technologies, they uncovered distinctive patterns. The study revealed that patient groups could be differentiated based on their GSR responses, social cognition impairments, and unique eye movement patterns. This research is groundbreaking in its potential to identify differential biomarkers for specific clinical groups, paving the way for clinicians to craft more personalized assessments and targeted treatment strategies.

In another innovative study, [Segal et al.](#) incorporated biosensors into forensic interviews concerning child sexual abuse. By analyzing data from galvanic skin response and heart rate, they gained profound insights into the physiological responses elicited by different types of questions, such as open-ended versus close-ended. Additionally, the study explored emotional reactions to the realism of simulated avatars used in the research. This approach provided a deeper understanding of the physiological and emotional dynamics in sensitive forensic interviews, offering valuable perspectives for improving investigative methods in such crucial areas.

# Consumer
# psychology

In the field of consumer psychology, eye tracking has become a valued tool, frequently coupled with EEG to glean deeper insights into consumer motivations and approach-avoidance behaviors towards brands and products. The research landscape of 2023 has seen an increased interest in exploring consumer reactions to sustainable, eco-friendly products in advertising and packaging. This surge in studies mirrors the growing consciousness among consumers about environmental impact, indicating a significant shift in market trends and preferences.

These innovative research efforts are pivotal in understanding how consumers perceive and respond to green initiatives by brands. By analyzing where a consumer's gaze lingers and combining this data with brain activity, researchers can unravel the complex interplay of attraction, attention, and environmental values in purchasing decisions. This research not only highlights the evolving preferences of consumers but also guides companies in tailoring their marketing strategies to align with the heightened environmental awareness. It's a compelling blend of science and marketing, revealing the nuanced relationship between consumer behavior and the drive for sustainability.

## Highlights

- Eye tracking dominates the field

- Combination of sensors aimed at understanding emotional and motivation parameters.

- Scope shows a combination of interviews and think aloud tasks and therefore a growing interest in voice analysis.

# Research stories
## Learn from your peers

Bigné et al. employed eye tracking and facial expression analysis to unravel the impact of negative emotions in cause-related marketing on social media platforms like Instagram. Their focus was on how such emotions influence consumer trust and their likelihood of sharing these posts. Intriguingly, they discovered that fear led to diminished trust in posts lacking brand feedback, while both disgust and fear reduced the intention to share posts when brands responded to negative comments about their cause-related initiatives. This study highlights how measuring visual attention and emotional arousal can intricately dissect the dynamics between trust and sharing behavior in the context of cause-related marketing.

On a similar innovative front, Pawar et al. utilized a combination of eye tracking and electroencephalography to probe how prior events influence subsequent consumer behavior. Their unique approach involved studying participants under conditions of water deprivation, thereby setting a precedent to examine its effects on consumer neuropsychology. Through a series of experiments, they showcased the power of multi-method neurophysiological tools in tracing the journey from motivating events, through their impact on behaviors like attention, choice, and consumption, to the resulting consequences. This research offers groundbreaking insights into the complex web of factors steering consumer decisions.

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