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PRESS RELEASE | FRONTIERS IN PHYSICS PUBLICATION

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Innovative Scientific Study Reveals How Racecar Driving Reflects Human Brain Function

- A pioneering scientific study using race car engine sound as a tool to investigate human cognition has been published in the international peer-reviewed journal Frontiers in Physics.

- The research shows how sound produced by a race car on track can be used to identify measurable links between driver cognition, individual driving style and performance.

- The research suggests new perspectives in the study of neurodegenerative diseases, including Parkinson's and Alzheimer's.

The article, entitled "Engine Sounds Reflect a Racecar Driver's Cognition", introduces an original and innovative approach to the study of brain function by analysing the engine sound of Formula 4 race cars. The research was developed through the synergy between **ACI Sport**, the **GIOYA Higher Education Institution**, and the **Center for Nonlinear Science** at the **University of North Texas**, as well as other important institutions. The research shows that driving behaviour can be understood as a structured cognitive process, in which decision-making, motor control, and individual driving style are reflected in the way a driver accelerates, brakes, and changes gears.

Drawing an analogy with musical performance, the study shows that just as musicians convey intention, expertise, and emotional state through sound, racecar drivers translate their internal cognitive organisation into acoustic signals through gear changes, braking, acceleration, and speed modulation on track. In this sense, the race circuit becomes a "score", the car becomes a music instruments and the engine sound a medium through which cognition is expressed.

The research is based on experimental data collected during events of the **Italian Formula 4 Championship**, including **E4 Championship**, and other professional motorsport activities as well as the ACI Sport Federal "Supercorso". Through advanced analytical methods, the study enables the development of predictive models capable of identifying individual driving styles and cognitive patterns, offering new perspectives on performance analysis in high-level motorsport.

Beyond its relevance in competitive racing, the findings open promising avenues for broader scientific applications. In particular, the methodology developed in this study may contribute to future research in areas such as motor control, rehabilitation processes, and, in the longer term, the study of neurodegenerative conditions including Parkinson's and Alzheimer's disease.

Key Messages

- First scientific study to analyse human cognition through racecar engine sound.
- Based on real-world data from the Italian Formula 4 Championship and E4 Championship collected in professional motorsport environments.
- Demonstrates how the **sound produced by a race car** can be used to identify measurable links between driver cognition and real performance on track.
- Opens new perspectives for applications beyond motorsport, particularly in **rehabilitation and the study of neurodegenerative conditions, including Parkinson's and Alzheimer's disease**.

An Interdisciplinary and International Research Collaboration

The project represents a long-term interdisciplinary collaboration integrating expertise from motorsport training, physics, neuroscience, pedagogy, and complex systems analysis. The research combines on-track experimental activity with advanced laboratory-based theoretical and analytical work.

The experimental phase was coordinated by the Research and Training Department of the **Scuola Federale ACI Sport**, under the aegis of the **Automobile Club d'Italia**, in collaboration with the GIOYA Higher Education Institution. Key contributors included instructors Raffaele Giammaria—also Director of the Scuola Federale—Glenda Cappello, and Lucio Tonello, long-standing references for the Federation's research activities as well as professors at Gioya HEI. Data collection took place during tests and races of the Italian Formula 4 Championship, E4 Championship and other ACI Sport activities, with contributions from Federal Instructors, professional drivers, and leading Formula 4 teams.

The analytical phase was conducted by an international group of scientists from the Center for Nonlinear Science at the University of North Texas, together with researchers from other prominent U.S. institutions. The scientific team included Paolo Grigolini, Bruce J. West, Scott Kerick, Jaskeerat Singh, and Yawer Shah. Special recognition is given to Dr. Jaskeerat "Jace" Singh, who earned his Ph.D. in Physics at the University of North Texas on the basis of this research.

Scientific and Institutional Impact

This publication positions the participating institutions at the forefront of international research at the intersection of sport, cognition, and complex systems science. It highlights the value of collaboration between elite motorsport organisations and higher education institutions.

ACI SPORT

The Automobile Club d'Italia holds, at national level, the authority for automobile sport delegated by the **Fédération Internationale de l'Automobile** (FIA) and represents Italy within international sporting bodies. ACI is the national federation for automobile sport recognized by the **Comitato Olimpico Nazionale Italiano** (CONI).

ACI Sport is the brand used by ACI in the field of automobile sport. The Federation promotes and organizes sporting activities, contributes to the drafting of regulations, issues technical and sporting standards, recruits race officials, approves race routes, and homologates technical equipment used in competitions. ACI Sport also carries out promotional, communication, and enhancement activities for races and championships organized under the aegis of ACI.

THE SCUOLA FEDERALE ACI SPORT

The Italian university of motorsport—this is how the Scuola Federale ACI SPORT "Michele Alboreto" can be defined. Based in Rome at ACI SPORT headquarters and operating in collaboration with CONI, since 1982 it has trained and specialized new generations of motorsport professionals.

Dedicated to young drivers seeking to grow in the sector, the Scuola Federale—supported by its instructors, all professional drivers—provides comprehensive training that goes beyond driving skills, covering sporting regulations, race conduct, psychophysical preparation, and fundamental knowledge of automotive engineering.

GIOYA HIGHER EDUCATION INSTITUTION

GIOYA Higher Education Institution is an accredited higher education institution based in Malta, operating within the Malta Qualifications Framework and aligned with the European Qualifications Framework. GIOYA offers flexible university programmes designed for professionals, executives, athletes, and entrepreneurs, combining academic rigor with recognition of prior learning and real-world experience.

Through its academic and research activities, GIOYA promotes interdisciplinary approaches that connect education, science, sport, and innovation. The institution collaborates with international partners, research centres, and professional organisations to support advanced research initiatives and to foster the development of knowledge at the intersection of human performance, leadership, and applied sciences.

The full article is available in Frontiers in Physics:

https://www.frontiersin.org/journals/physics/articles/10.3389/fphy.2025.1633608/full

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