17th Edition
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Presentation ceremony of the 17th edition

The Frontiers of Knowledge Awards celebrate the universal value of scientific truth, rationality and culture in the face of the defining challenges of our time

- **The gala of the 17th edition of the BBVA Foundation's international awards** honored 20 individuals from diverse realms of scientific research and artistic creation whose work has led to particularly significant advances

- **"This ceremony is an exceptional opportunity to highlight what truly unites and enriches us as a species:** the ability to generate new knowledge to interpret our physical, biological and social reality, contributing innovative, evidence-based conceptual perspectives and devising rational and sustainable solutions to the key challenges and expectations of our time," said Carlos Torres Vila, President of the BBVA Foundation

- **The President of the Spanish National Research Council, Eloísa del Pino,** referred in her speech to the "shared aspiration" that unites the awardees: not only "to better understand the behavior of the natural and social world," but also to "identify possible ways to transform such behavior when it departs from the optimal" and by this means "contribute to the common good"

- **Among the awardees are the researchers** whose work sparked a pharmacological revolution in the treatment of diabetes and obesity; the scientists leading the transition to a more efficient and sustainable green chemistry; the creators of transformative technologies like biometrics and generative artificial intelligence; and the ecologist who identified the impact of climate change on the geographical ranges of species worldwide

- **Recognition was also extended to key contributions elucidating** the central role of attitudes in understanding human behavior in multiple areas of the public and private spheres; fundamental models to analyze and steer the economy through times of crisis; the philosophical analysis of core questions in science and technology, democracy and social life. In the music and opera category, the award honored the extraordinary reach of Toshio Hosokawa's rich and wide-ranging creative output, which tends a bridge between the Japanese tradition and Western aesthetics

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The ceremony of the 17th edition of the Frontiers of Knowledge Awards celebrated the universal value of scientific truth, rationality and culture in the face of the defining challenges of today's global society. This was the message conveyed by the President of the BBVA Foundation, Carlos Torres Vila, during the event held in Euskalduna Bilbao, which honored 20 pioneers in the global vanguard of scientific research and artistic creation. "This ceremony is an exceptional opportunity to highlight what truly unites and enriches us as human beings: the ability to generate new knowledge to interpret our physical, biological and social reality, contributing innovative, evidence-based conceptual perspectives and devising rational and sustainable solutions to the key challenges and expectations of our time."

In today's complex and uncertain international landscape, Torres Vila continued, the contributions of "highly innovative individuals" like those honored by the Frontiers of Knowledge Awards "allow us to plot a roadmap informed by scientific rationality and artistic creativity that can lead us to the best decisions on both the individual and collective plane. Decisions that serve the general interest and help conserve the diversity of life on Earth."

Co-chaired by the BBVA Foundation President and the President of the Spanish National Research Council (CSIC), Eloísa del Pino, the ceremony also featured a welcome address by the Mayor of Bilbao, Juan Mari Aburto, and a closing speech from the President of the Basque Government, Lehendakari Imanol Pradales.

The CSIC President referred in her speech to the "shared aspiration" that unites all of this year's awardees: not only "to better understand the behavior of the natural and social world, its determinants and consequences" but also to "identify possible ways to transform such behavior when it departs from the optimal." The 20 laureates, she affirmed, "show us that it is possible to reconcile the ideal of pure knowledge with the duty to contribute to the common good."

"The times we live in demand that we defend the role of science and critical thinking more strongly than ever before. Not only as a driver of competitiveness, social cohesion and quality of life, but as a cornerstone of democracy and co-existence," said Lehendakari Pradales, pronouncing the ceremony's closing address. "Knowledge and culture make us more free. The creation of advanced knowledge is both a pillar and a competitive advantage of advanced societies."

The ceremony also welcomed a sizable representation of the international committees deciding the eight award categories, which draw their members from some of the top universities in Europe and North America. Among the more than 1,200 people in attendance were eminent researchers, artists, university professors, science policy leaders and representatives of scientific societies, along with leading figures from the worlds of business and the media.

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The minds behind a "green" chemistry that is economically and socially transformative

Research in the catalysis field currently accounts for "more than one third of the global GDP, making products from fuels to food to pharmaceuticals, and everything in between," explained Professor John Hartwig (University of California, Berkeley, United States) during his acceptance speech on behalf of himself and his co-laureates in the Basic Sciences category: Avelino Corma (Institute of Chemical Technology, Universitat Politècnica de València-CSIC) and Helmut Schwarz (Technical University of Berlin, Germany). The three researchers share the award for creating the catalysts that are leading the move to a more efficient, sustainable chemistry.

Catalysts, said Hartwig, "are matchmakers in a flask, bringing molecules together that would ignore each other in their absence, causing strong bonds to break, and new bonds to be formed in ways and at places on the molecule that would not happen in their absence." Within this board-ranging field, Corma has led the conception and synthesis of solid catalysts with the ability to accelerate the reactions of liquid and gas-phase agents, resulting in over 100 patents currently in use to improve the efficiency and sustainability of fuel, plastic, cosmetics and food production.

Hartwig himself developed metal-based catalysts that have been game changers in the manufacture of drug treatments for conditions ranging from leukemia to HIV to depression. His specialty is homogeneous catalysis, in which both the catalyst and the molecules undergoing the chemical reaction are in the liquid phase, dissolved in a solvent.

Schwarz, finally, combined experiments and computational tools to elucidate the functioning of chemical reactions atom by atom, with an unprecedented level of detail. With this discovery-led research, he has come to transform major industrial processes like precious metal refining, where he managed to mitigate issues with a key reaction, improving its efficiency.

"All three of us are inspired by how chemistry, as a central science, touches so many aspects of our lives," said Hartwig in closing. "Our teams work to improve chronic human diseases, to tackle global environmental issues, and even to begin to predict chemical reactivity using machine learning – all of them subjects of this year's prizes. These connections are why catalysis has such a large impact on our world economy and wellbeing."

A "wave of innovation" that has revolutionized the treatment of diabetes and obesity

The combined work of the four awardees in Biomedicine has caused nothing short of a pharmacological revolution, enabling the development of "multiple new medicines with a range of unanticipated and unprecedented benefits that are improving the quality of life and health of people challenged by a wide range of chronic metabolic disorders." With these words, Professor Svetlana Mojsov (The Rockefeller

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University, New York) described the potential unlocked by the fundamental biological discoveries made by herself and her co-laureates Daniel Drucker (University of Toronto, Canada), Joel Habener (Harvard University, United States) and Jens Juul Holst (University of Copenhagen, Denmark), which have brought into being a new therapeutic arsenal against diabetes and obesity.

Their groundbreaking research revealed the biological activity of the GLP-1 hormone, produced in the small intestine after food intake, which has a fundamental role in maintaining glucose levels and regulating appetite. No surprise then, as Dr. Drucker remarked in his speech, that GLP-1 "has emerged as one of the most important hormonal discoveries in metabolic disease since the discovery of insulin in the 1920s," supporting the development of medicines "firstly to lower glucose for the treatment of people living with type 2 diabetes, and, secondly, to generate unprecedented weight loss in people with obesity."

The impact of the winning contributions testifies to the importance of basic biomedical research. As Dr. Holst recalled in his own speech, in under two decades the first fundamental discoveries of the actions of GLP-1 led to the 2005 approval of the first drug for type 2 diabetes, followed by the first GLP-1 medicine approved for weight loss and the treatment of obesity in 2014.

Not only that, recent research in the field suggests that we may be just at the start of a far bigger biomedical revolution. GLP-1, Dr. Mojsov points out, has been shown to have "a wide range of useful actions" beyond the reduction of blood sugar and body weight. It can, for instance, lower blood pressure and reduce rates of heart attacks, strokes, and death from cardiovascular causes, improve breathing in people with obstructive sleep apnea, and lessen the severity of knee osteoarthritis and metabolic liver disease. It is even being studied for its possible application in people with substance use disorders, like smoking or alcohol use, as well as in individuals with neurodegenerative conditions like Parkinson's or Alzheimer's disease. What we have, in short, is "a wave of innovation ushering in a broad range of new GLP-1 medicines, offering new, more powerful options for people with metabolic disorders."

AI: the transformative power of engineering based on human preferences and decisions

"It is growing rapidly and having major effects on science, technology, and society that are only just beginning." With these words, Michael I. Jordan (University of California, Berkeley, United States) described the state of the art in machine learning, after picking up the award in the Information and Communication Technologies, which he shares with Anil K. Jain (Michigan State University, United States). The two were recognized for their core contributions in teaching computers to recognize patterns and make predictions on the basis of large data sets.

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On the one hand, as Jordan explained, referring to the field led by his co-awardee, one of machine learning's major success stories has been "biometrics, which aims to identify individuals based on body traits such as faces, fingerprints, and the irises of the eyes." Since Jain first deduced, with the aid of machine learning, that a machine could detect matches between two fingerprints 100 times faster than any previous method, his group has become a world authority in fingerprint recognition. And his ideas, said Jordan, "have spawned the technology being used by billions of people every day for multiple purposes, ranging from unlocking our mobile phones to making payments securely to traveling safely and easily."

Jordan himself has devised mathematical and computational techniques that underlie multiple artificial intelligence applications, from restaurant recommender systems to generative language models like ChatGPT. His contributions were decisive in getting these systems into real-world operation, and the awardee has also worked with business partners to bring some of his own applications to market.

"What we are seeing – he affirms – is the emergence of a new engineering field. But whereas previous engineering fields focused on physical components such as electrons and molecules, the new field includes human preferences, values, and decisions as key ingredients. It is the first engineering field to do so."

Given that collective intelligence wins out over individual intelligence, the ICT co-laureate posits what he calls the "grand challenge": to devise societal mechanisms that can create wealth and opportunity to enhance the lives of all individuals, not merely an elite few. This goal, he believes, will require "academic innovation but also informed dialog with the public at large." And for this dialogue to be fruitful, people must be reminded that "AI is not magic, but it is built on basic science and engineering." The focus, he adds, "should be on the social context of AI," and the awareness that "AI must be an international effort if it is to fully realize its potential for enhancing human welfare."

The impact of the "climate emergency" on species displacement round the globe

"Wild species pay no attention to political boundaries," observed Professor Camille Parmesan, who received this year's award in Climate Change and Environmental Sciences for identifying the impact of climate change on the geographical displacement of species. It is for this reason, she contends, that the fight against the twin environmental crises of global warming and biodiversity loss demands a coordinated effort, despite the complex geopolitical landscape: "Tackling the problems that have arisen because of human-driven climate change requires transboundary research, planning and action. Attacks on science, not only in the United States but around the world, are coming at a time of climate emergency when international cooperation is most needed."

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In the mid 1990s, Parmesan discovered that several butterfly species in the United States and Europe were moving northwards and to higher elevations to escape rising temperatures. Over the next three decades, she expanded on this work to confirm that the same climate change impact was being felt by thousands of plant and animal species worldwide on land and in the oceans. She was thus able to establish that rising temperatures had left a globally coherent fingerprint on biodiversity; an insight that underpinned the new field of climate change ecology, at the forefront of tackling the environmental crisis.

"I took advice from the great detective, Sherlock Holmes, who said 'When you have eliminated the impossible, whatever remains, however improbable, must be the truth'," the awardee recalled. "Using a systematic approach of elimination, we were able to conclude that climate change is indeed affecting a majority of species, changing when, where and how they live."

This finding has provided vital input to the design of effective policies to halt biodiversity loss, as Parmesan explained: "Conservation in a time of rapid climate change requires a new way of thinking that allows for dynamic changes in local communities; that aids rather than hinders these changes."

Above all, she is convinced that successfully addressing the monumental challenge of environmental degradation calls for engagement "in the art-science interface" that can mobilize society not just with proven scientific data, but through media like film and photography with the power to "reach people's hearts." In closing, the ecologist expressed her gratitude at receiving the award in these difficult times, "in light of increasing disinformation about not only climate change, but science in general."

Attitudes as the key to behavior and the power of social psychology

Dolores Albarracín spoke at the ceremony on behalf of the five laureates in the Social Sciences category to defend the importance of attitudes in understanding human behavior. The researcher expressed her thanks for the award on behalf of her colleagues Icek Ajzen, Mahzarin Banaji, Anthony Greenwald and Richard Petty, with whom she shares a scientific legacy focused on understanding how the evaluations we make of the world around us are formed, modified and shape our subsequent behavior.

Albarracín referred in her speech to Gordon Allport's definition of attitudes as "the most distinctive and indispensable concept in contemporary social psychology." The discipline, she continued, has since come a long way, to the extent that "in less than a century, social psychologists have figured out how to measure attitudes, how to change attitudes, and how attitudes impact behavior."

In the terrain of attitude measurement, Icek Ajzen designed models to measure beliefs, perceived social norms and perceptions of control over one's behavior. Mahzarin Banaji and Anthony Greenwald developed the influential implicit association test, able to detect racial or gender biases that are outside

the holder's conscious control. "These procedures – she added – have been extensively refined to assess attitudes people try to hide, most notably the types of sexist attitudes that can reduce women's pursuit of careers in scientific fields."

In regard to attitude change, Richard Petty solved a longstanding empirical contradiction about mechanisms of persuasion, showing that people bow to the strength of an argument only when they have the time or the interest, and that if they are distracted or uninterested they are likelier to be swayed by the attractiveness of the source (the elaboration likelihood model, developed jointly with John Cacioppo). Albarracín's own work has clarified when messages affect not only attitudes, but also behaviors, and how people find rational explanations after the event for what were, in fact, impulsive decisions.

The other main strand in the awardees' collective enterprise is the prediction of behavior, where they have demonstrated that strong, confident attitudes predict behavior better than weak ones, that action goals can strengthen this connection, and that implicit attitudes can guide our conduct in ways of which we are not consciously aware.

In closing, Albarracín defended the importance of social psychology for its ability to connect the inner world with social behavior, while decrying the tendency in some political contexts to undermine the social sciences: "This award tells us that meaningful research must persist even amid political assaults on the discipline. So, in the words erroneously attributed to Don Quijote, 'They bark, Sancho, a sign that we are riding'."

The New Keynesian approach: guiding the economy through times of crisis

Michael Woodford spoke at the ceremony on behalf of the laureates in Economics, Finance and Management – himself, Olivier Blanchard and Jordi Galí – to explain the value and continuing relevance of New Keynesian economics; the macroeconomic paradigm the three helped build.

He described the awardees' combined work as "seeking to provide a coherent analysis of the effects of monetary and fiscal policies in an imperfect world, in which cognitive and institutional frictions prevent the market from efficiently adjusting to economic disturbances." The wide influence attained by this theoretical framework was singled out by the committee deciding the award, particularly its integration of real elements such as price and wage rigidity, market power and rational expectations, which helped Keynesian economics stage a comeback after its perceived failures in the 1970s.

The models they developed – Woodford explained – "posit that wage and price setters do not instantaneously reconsider their demands at each moment, but instead economize on information and decision costs by leaving wages and prices fixed for variable intervals of time." This feature makes them

better able to account for economic fluctuations. Moreover, "they also imply that monetary and fiscal policies can substantially affect the way the economy responds to unexpected economic developments, and that well-designed policies can do much to improve the stability of both prices and economic activity."

Among the strengths of the framework, Woodford believes, is its appeal to transparency, credibility and effective guidance on the part of the monetary authorities. Private-sector expectations, he explains "are crucial in shaping macroeconomic outcomes," a fact that places communication strategies firmly center stage.

The awardees' framework would find vivid practical expression during the financial crisis of the late 2000s, when the leading central banks found themselves unable to provide sufficient economic stimulus through their standard tool of choice, having reached what was then considered the effective lower bound on short-term interest rates. At this point, "forward guidance about the future evolution of policy became an important substitute for and complement to immediate policy actions."

Woodford also spoke of the versatile nature of the framework, making it open to theoretical additions like those developed by Ben Bernanke and Mark Gertler – BBVA Foundation Frontiers of Knowledge laureates in the 13th edition of the awards – who extended the basic model to take into account imperfections in financial contracting, or, most recently, the introduction of household income heterogeneity, allowing inequality to be factored in, or analysis of the implications of social insurance policies for aggregate demand.

The economist concluded his speech with an appeal to the new generations: "I hope this award will provide encouragement to young researchers to strive to address fundamental questions about our subject."

The union of science and the humanities, a project for moral progress

Philip Kitcher used the occasion of his speech to consider his own intellectual journey, concluding that far from being a "random walk" it has been guided throughout by a profound conviction: that the sciences and humanities should engage as complementary partners in a common project whose finality is human progress. The philosopher describes himself as "a recruiter" of "diverse areas of inquiry" for this project. "Throughout my career I have sometimes reflected on scientific questions from the perspectives of philosophy, history, literature and the arts. At other moments, I have drawn on the sciences to tackle an issue in the humanities."

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Although he had his academic start in mathematics, Kitcher was already alert to the possibility of bridges between disciplines. It was a question from one of his students, he relates, that prompted him to explore the philosophy of natural sciences. Later, in the 1990s, he was invited by the U.S. Library of Congress to write on the ethical consequences of the Human Genome Project. "Writing that report changed the direction of my thinking. I came to see the search for knowledge as socially embedded, in ways intended to promote the common good."

He also referred in his speech to one of his career constants, the study of the ethical evolution of human beings. Kitcher has examined our moral progress in regard to such pressing problems as climate change or the nature of young people's education in Western societies. And he voices serious concerns about where we stand now: "Societies seem to fasten on simplified measures of well-being, derived from a crude picture of humanity. Any commitment to ethics in politics, expressed in crafting measures to advance the common good, seems to have been eroded."

Despite seeing evidence that "the ethical project that has made us the beings we are" has stumbled to a halt, Kitcher underscored the importance of such an award existing in the field of the humanities, "at a time when they are often written off as unnecessary." He also talked about how privileged he felt to be among tonight's awardees as someone whose parents lacked the opportunity even for a secondary education.

Toshio Hosokawa, the "sea of sound" the lies concealed in the depths

Toshio Hosokawa took time to reflect on how his music tries to conjure the "vast, endless 'sea of sound' that lies deep within the human heart." In his creative process, said the Japanese composer, he sees himself as a connecting vessel between nature and sound: "From the vibrations of that sea, words and music are born. This sea may be what depth psychology refers to as the 'collective unconscious' or what Buddhism calls the 'Alaya consciousness.' My composition is the process of listening to the vibrations that emerge from it and transcribing them onto sheet music. It is not my ego that composes; I become a medium that listens to the voice of the sea."

The 17th Frontiers of Knowledge Awards laureate in Music and Opera looked back at the start of his career and explained how his gaze became increasingly drawn to Eastern music. As a child, he took piano lessons and fell in love with the music of Bach, Mozart and Beethoven, while the tunes his mother played on the koto, a traditional Japanese string instrument, seemed to him "boring and sleep-inducing." It was not until his time in Germany that he awoke to the beauty and importance of Japanese music: "In the late 1970s, there was a strong interest in non-European music in Europe. My composition teachers strongly encouraged me to study traditional Japanese music and aesthetics. In this way, I went outside of Japan

for the first time, learned about Japan, and came to understand its beauty. Then I began the process of creating my own music by exploring my musical roots."

At the ceremony, the composer spoke clearly about his music's engagement with the protection of nature, expressed in his scores condemning the nuclear disasters suffered by Japan and the growing plastic pollution of the world's oceans: "I have oratorios and operas themed around Hiroshima, Fukushima, and environmental destruction. I think our hearts' seas are also beginning to be polluted little by little. In such an era, I want to reclaim the 'primordial sea' once again, listen to the voice from that untainted sea, and deliver that voice to the world through music."

He also dedicated the award to his compatriot Arata Isozaki, "a great architect" who was his "mentor in life." The designer of Barcelona's 1992 Olympics stadium and the Isozaki Atea in Bilbao "loved Spain and taught me about its greatness and beauty," said Hosokawa, who also reserved praise for the culinary skills of his late friend, who passed away two years ago.

Toshio Hosokawa received the award for "the extraordinary international reach of his work," which "has built a bridge between the Japanese musical tradition and contemporary Western aesthetics," in the words of the selection committee. The composer's "extensive, genre-spanning catalogue," as the citation describes it, "is inspired by Zen philosophy and characterized by the use of timbral writing of great rigor, and a richness that is at once original and wholly recognizable." All these qualities could be enjoyed by the public at the previous evening's gala concert in honor of the 17th edition laureates, at which the Basque National Orchestra, under conductor Fabián Panisella, performed his violin concerto *Genesis* with Akiko Suwanai as soloist.

About the BBVA Foundation Frontiers of Knowledge Awards

The BBVA Foundation centers its activity on the promotion of world-class scientific research and cultural creation, and the recognition of talent.

The Frontiers of Knowledge Awards recognize and reward contributions of singular impact in basic sciences, biomedicine, environmental sciences and climate change, information and communication technologies, social sciences, economics, the humanities and music. Since they were established in 2008, the goal of the awards has been to celebrate and promote the value of knowledge as a public good without frontiers, of benefit to all humanity; the best instrument at our command to take on the great challenges of our time, and expand our individual worldviews. Their eight categories are congruent with the knowledge map of the 21st century.

The Foundation is partnered in this family of awards by the country's foremost public research

organization, the Spanish National Research Council (CSIC), which appoints evaluation support panels made up of leading experts in the corresponding disciplinary domain, who are charged with undertaking an initial assessment of candidates and drawing up a reasoned shortlist for the consideration of the award committees. The Council also designates the chairperson of the eight committees deciding the eight award categories and collaborates in the election of their members, thus helping to ensure objectivity in the recognition of innovation and scientific excellence. The CSIC president, finally, has a prominent role in the award presentation ceremony that takes place yearly in Bilbao, the permanent home of the BBVA Foundation Frontiers of Knowledge Awards.

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