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SPARC WEEKLY

DECISIONS THAT DEFINE US: THE SCIENCE BEHIND LIFE'S BIGGEST CHOICES

Transformative life decisions, such as emigrating, changing careers, or ending relationships, profoundly shape personal identity and life paths. Researchers at the Max Planck Institute for Human Development propose a new framework to understand these impactful choices, emphasizing the complexity and unpredictability of such decisions.

The study, published in American Psychologist, critiques oversimplified decision-making models and adapts a text-based approach for analyzing real-world decisions using natural language processing. Five key dimensions of transformative decisions were identified: conflicting cues, self-change, uncertain experiential value, irreversibility, and risk

For instance, emigration might promise safety but entail separation from loved ones, illustrating conflicting values. Similarly, uncertain experiential outcomes and the irreversibility of decisions, like divorce or career changes, add to their complexity.

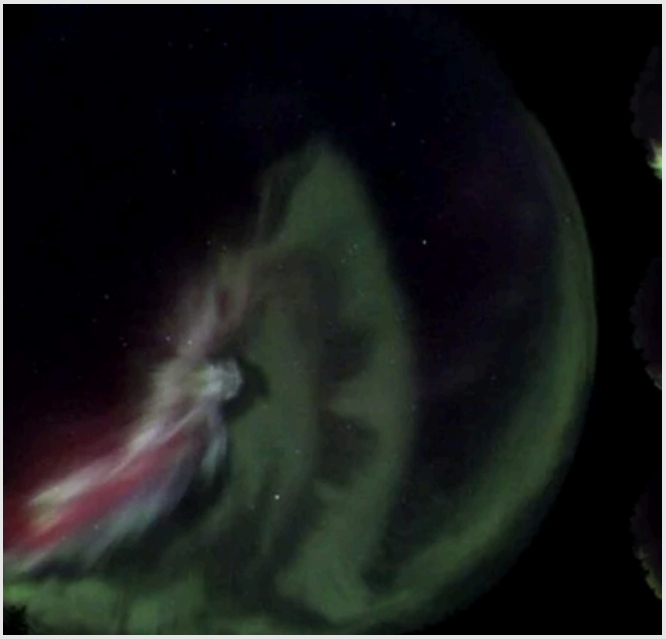
To navigate these challenges, the researchers propose practical strategies. The tallying heuristic simplifies choices by counting reasons for and against options. Aligning decisions with one's ideal self can guide personal growth. Observing others' experiences reduces uncertainty, while reversible steps help manage irreversibility. Incremental approaches, like securing housing before emigrating, mitigate risks.

The framework advances ecological rationality by integrating subjective dimensions like identity and values into decision-making models. Co-author Ralph Hertwig emphasizes the importance of adapting strategies to individuals and their environments. This perspective broadens traditional theories of rationality, offering practical insights for individuals, policymakers, and support organizations.

Future research will further explore decision-making across domains such as relationships, migration, and work, examining factors like mental health and risk-taking behavior. This innovative approach holds potential to improve understanding and support for navigating life's most significant decisions.

https://scitechdaily.com/decisions-that-define-us-the-science-behind-lifes-biggest-choices/

NORTHERN LIGHTS MYSTERY SOLVED: SCIENTISTS REVEAL HIDDEN HEAT SOURCE



Researchers at the University of Calgary have unraveled the mystery behind a peculiar whitish-grey patch often seen alongside the aurora borealis. This phenomenon, known as "structured continuum emission," was investigated in a groundbreaking study published in Nature Communications on December 30. The research concludes that this emission is a heat source closely tied to the aurora, revealing new complexities about the northern lights.

The whitish-grey patch, occasionally observed near the vibrant green and red displays of the aurora, has puzzled scientists for decades. Despite its mention in earlier scientific literature, its nature remained unexplained until now.

Dr. Emma Spanswick, lead author of the study and associate professor in the Department of Physics and Astronomy at the University of Calgary, emphasized the scientific curiosity it sparked: “The first response of any scientist is, ‘Well, what is that?’”

"Using advanced true-color imaging technology, the researchers discovered that this pale patch is indeed a heat source, challenging prior assumptions about the simplicity of auroras. The study not only provides an explanation for the phenomenon but also highlights the intricate and dynamic nature of auroral displays.
Technological Breakthroughs Enable Discovery
The discovery was made possible by advancements in camera technology. Modern digital sensors, now commercially available, have revolutionized observational astronomy, allowing both amateurs and scientists to capture high-quality, true-color images of celestial events. Spanswick noted that such technological progress has been instrumental in identifying and studying previously unnoticed phenomena.

The structured continuum emission bears similarities to another recently discovered auroral phenomenon called STEVE (Strong Thermal Emission Velocity Enhancement), a glowing ribbon of purple light. However, unlike STEVE, which is distinct and crosses the sky independently, the whitish-grey patch appears embedded within the dynamic aurora, making it harder to detect. Both phenomena share spectral similarities, providing researchers with a broader understanding of auroral complexity.

This groundbreaking study not only advances auroral research but also had a significant educational impact. It involved three University of Calgary students, including undergraduate intern Josh Houghton, whose contributions played a critical role in the analysis. Houghton's work earned him co-authorship in the Nature paper and marked a defining moment in his academic journey.
Reflecting on his experience, Houghton said, "I was still learning things at the time. I had just started my internship, and I very quickly got involved. It's just very, very cool." His involvement in this research forms the basis of his undergraduate honors thesis and paves the way for his upcoming master's studies at the University of Calgary.

The study's findings reveal the aurora borealis to be more complex than previously understood. By demonstrating the structured continuum emission's intricate connection to the aurora, it opens new avenues for investigating auroral phenomena. The research highlights the interplay of physical processes that produce the aurora, encouraging further exploration of how these events connect to other atmospheric occurrences.

The discovery also emphasizes the importance of collaboration and technological innovation in pushing the boundaries of scientific knowledge. The team's work showcases how curiosity and advanced tools can deepen our understanding of natural wonders. This study serves as an inspiring reminder of the value of fostering educational opportunities, as students like Houghton gain firsthand experience in cutting-edge research.
Future investigations aim to delve deeper into auroral complexities, exploring connections between phenomena like STEVE and structured continuum emissions. Researchers are particularly interested in understanding the underlying mechanisms and their implications for broader atmospheric and celestial studies.

https://scitechdaily.com/northern-lights-mystery-solved-scientists-reveal-hidden-heat-source/

TRANSFORMING INDUSTRIAL WASTE TO POWER THE FUTURE OF ENERGY STORAGE

Batteries for phones, devices, and electric cars rely on metals like lithium and cobalt, extracted through environmentally harmful mining. With rising demand for energy storage, finding sustainable alternatives is critical. Researchers at Northwestern University have made a breakthrough by repurposing an industrial waste product, triphenylphosphine oxide (TPPO), for use in redox flow batteries, which are ideal for large-scale energy storage.

Produced in large quantities during organic industrial processes like vitamin synthesis, TPPO has been a waste byproduct requiring careful disposal. However, researchers developed a “one-pot” reaction to convert TPPO into an energy-storing molecule, paving the way for waste-derived organic redox flow batteries. This innovative approach, published in The Journal of the American Chemical Society on January 7, highlights the potential of transforming waste into valuable resources.

Unlike lithium-ion batteries that store energy in electrodes, redox flow batteries store energy in liquid electrolytes through a chemical reaction. While less efficient for small-scale use, they are better suited for grid-scale energy storage.

Mirror life presents serious dangers,

The global market for redox flow batteries is projected to grow by 15% annually between 2023 and 2030, reaching €700 million.
The team achieved high-energy density and stability with TPPO, a challenging combination in battery research. Inspired by a 1968 study on phosphine oxides, they engineered molecules to pack electrons tightly without losing capacity. Testing showed the battery maintained exceptional performance, retaining capacity over 350 charge-discharge cycles.
“This is the first instance of using phosphine oxides as redox-active components in batteries,” said lead researcher Christian Malapit.
Traditionally unstable, these molecules were stabilized through molecular engineering. The study demonstrates the viability of organic waste-derived batteries as sustainable alternatives to metal-based solutions.
Researchers hope others will explore TPPO’s potential to advance sustainable energy storage technologies further.

https://scitechdaily.com/transforming-industrial-waste-to-power-the-future-of-energy-storage/

PUPIL SIZE IN SLEEP REVEALS HOW MEMORIES ARE SORTED, PRESERVED

Cornell University researchers have identified a critical link between pupil dynamics and how the brain forms, consolidates, and retains memories during sleep. By studying mice equipped with brain electrodes and eye-tracking cameras, the team discovered that pupil contraction during a specific substage of non-REM sleep corresponds to the consolidation of newly learned memories. Conversely, when the pupil dilates, older memories are replayed and integrated.

This study, led by assistant professors Azahara Oliva and Antonio Fernandez-Ruiz, highlights the brain's ability to separate memory consolidation into distinct substages, preventing "catastrophic forgetting," where new memories overwrite older ones. This finding could lead to advancements in human memory enhancement techniques and improvements in artificial neural networks.

Over a month, the researchers taught mice tasks, such as navigating a maze for water or cookie rewards. The mice's neural activity and pupil dynamics were recorded while they slept. The researchers observed that non-REM sleep is the primary phase for memory consolidation, with key processes occurring during microseconds-long events undetectable to humans.

The study showed that when a mouse’s pupil contracted, recently learned tasks were replayed and consolidated, while older knowledge was not. Conversely, dilated pupils corresponded to the reactivation and integration of older memories. This fluctuation—new learning, old knowledge—occurs repeatedly throughout sleep, guided by a previously unknown microstructure within non-REM sleep.

By interrupting mice’s sleep at specific moments and testing their recall, researchers confirmed that this temporal sleep structure mirrors human sleep stages more closely than previously thought. Oliva described this mechanism as the brain’s way of separating new learning from existing knowledge on an intermediate timescale.

The research, funded by the National Institutes of Health, the Sloan Foundation, and others, sheds light on the intricate relationship between sleep, memory, and brain function. It holds promise for developing strategies to enhance memory and train more efficient artificial neural networks.

https://www.sciencedaily.com/releases/2025/01/250101132020.htm

BUTTERFLIES INSPIRE MAGNETIC ROBOTS THAT FLY MORE EFFICIENTLY

Scientists have developed robotic wings inspired by monarch butterflies, which use magnetic fields to mimic the natural movement of butterfly wings. Unlike traditional flying robots, these magnetic wings eliminate the need for bulky electronics or batteries, enabling lightweight, energy-efficient designs.
The research, led by Muhammad Khan of TU Darmstadt in Germany, was inspired by monarch butterflies' exceptional migratory capabilities, which depend on their lightweight and flexible wing structure. Monarchs travel thousands of kilometers each year due to their wings' ability to create thrust through both active movement and passive bending, conserving energy.

The team, led by Oliver Gutfleisch and Denys Makarov, replicated this design using 3D-printed magnetic composites.

https://www.advancedsciencenews.com/butterflies-inspire-magnetic-robots-that-fly-more-efficiently/

The wings incorporate magnetic particles within flexible plastic materials, allowing them to bend and deform in response to external magnetic fields. Testing included 12 wing designs of varying sizes, with vein patterns mimicking real butterfly wings. Larger wings (28 mm long) with vein patterns proved superior, being less stiff and more adaptable during flight.

However, challenges arose in fabricating ultra-thin structures—less than a millimeter thick—that were both functional and durable. Adjustments in 3D printing settings, such as laser energy levels, were critical to achieving the desired mechanical properties. While thinner designs improved bending performance, they were more prone to damage.

The magnetic wings offer flexibility and complex movements, positioning them as tools for applications like environmental monitoring, pollination studies, search-and-rescue missions, and biomedical devices. They could also inspire innovations in artificial muscles and shape-morphing robotics.

Current prototypes rely on external magnetic fields, limiting their autonomy. The team aims to integrate miniaturized magnetic field generators for independent operation and explore diverse wing movements. Further research will optimize the wings for real-world applications, potentially enabling autonomous flight without human input. This bioinspired approach represents a significant step toward more adaptable, efficient robotic systems across various fields, combining flexibility and sustainability with nature-inspired innovation.

WHO ARE WE?

SPARC Robotics Team's mission and vision is to make our environment the best it can be. On a volunteer basis, we look at the problems that are happening around us and make them our problems, both as SPARC and individually, and help as much as we can with appropriate projects. NASA ACCP (Astro Camp Community Partners) was only in the US until four years ago. This year they came to Turkey with us after four years of traveling to many countries. ACCP educates school-age children from kindergarten to high school on science-related topics of interest with practical knowledge and application, while also supporting children's craft development, general culture and questioning skills. As SPARC, we have brought this training provided by NASA to our country in the most comprehensive way and our continuous communication with NASA not only enables us to improve our trainings day by day, but also gives us the opportunity to learn about the innovations in the field of STEM instantly, from the most accurate source and to spread the knowledge we have around us.

EDITOR

Dear reader,

Greetings from SPARC Weekly, in which we gather latest scientific news.

We would be delighted to hear your comments or suggestions and we encourage you to write to us if you have any views or opinions on the stories in SPARC Weekly. We look forward to hearing from you.
Have a nice week and enjoy the magazine.

Defne Şehidoğlu and Reyhan Doğanca