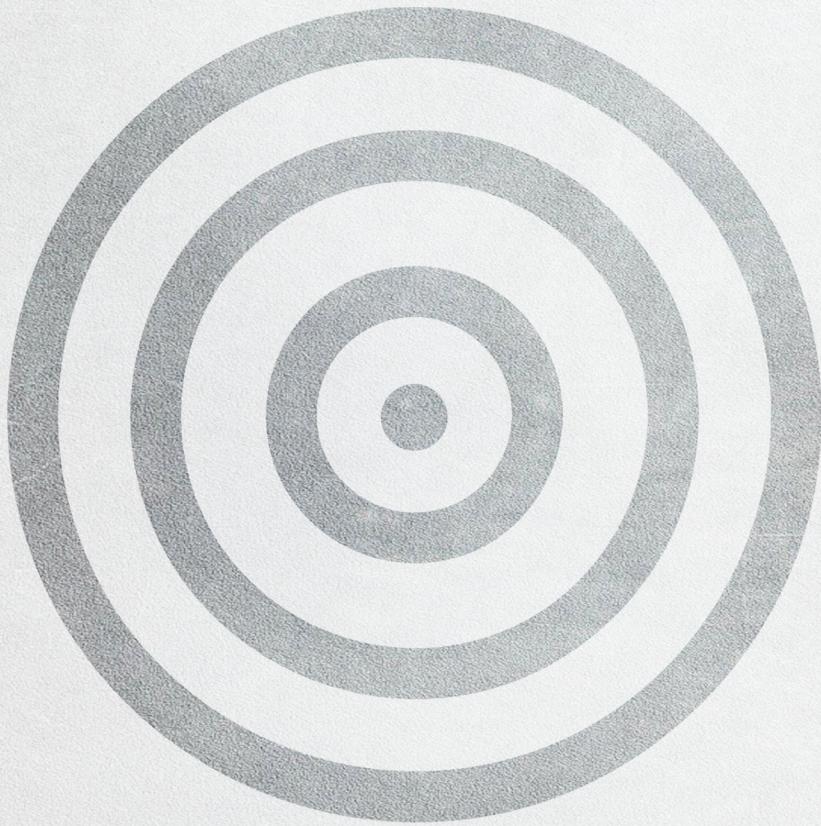


Fall 2015

ISSUE 25

NUSCI



STRATEGY

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LETTER FROM THE EDITOR



Scientists are constantly strategizing to achieve a particular goal, whether that's to find a cure for a disease, to develop a better way to carry out a task or to learn why a certain phenomenon occurs. A scientist's strategy is key to their success, and since the conditions of the world are constantly in flux, that strategy changes with each passing day.

In the newest issue of NUSci, you can read about strategy in a range of forms. Everything from Donald Trump's mystifyingly successful political strategy to the symbiotic tactics of the Hawaiian bobtail squid. You'll also find a career breakdown of one of the world's most renowned strategists: John Nash, and an explanation of how gameplay has evolved over time.

The large variety of topics explored in this issue is part of our own strategy as an organization. We're hoping to appeal to a broader audience by touching on stories from multiple fields. We're also trying out multiple mediums – note the new infographic spread and the larger number of photos and illustrations.

Our latest strategy expands far beyond the content of our print edition, and as a result, so does our writers' enthusiasm. Head to the newly redesigned NUSci website to explore more stories of strategy, like how researchers are mapping out incidences of infection or how a team of Boston engineers is working to develop a microneedle pill that reduces the unpleasantness of an injection while also increasing drug delivery efficiency.

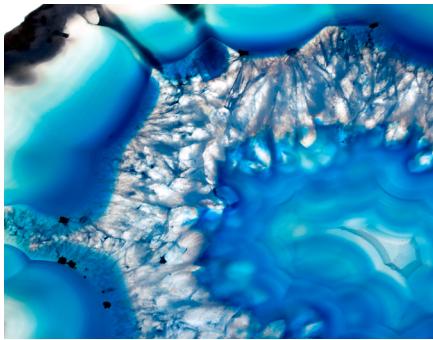
Issue 25 is a huge milestone for NUSci, which started as a midnight project more than five years ago. However, this accomplishment also begs an important question: where do we go from here? What do we want Issue 50 to look like, and how do we work towards that goal? Stick with us and you're bound to find out.

Sincerely,

Gwendolyn Schanker
Editor in Chief
Journalism and Biology 2018

Data Visualization

Diana Morel



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PHOTOGRAPHY BY NAOMI STAPLETON

this month in science history

King Tutankhamun of Egypt's tomb is discovered by an expedition led by Howard Carter and Lord Carnarvon. This tomb is one of the few that have been found entirely intact, perhaps because King Tutankhamun died at a young age and was buried in a tomb that was designed for a high official instead of one designed for a king.

• • • NOV 4, 1922

The "Morris Worm," one of the world's first computer viruses, is released to the internet by Robert T. Morris, a graduate student at MIT. Morris was eventually convicted of violating the Computer Fraud and Abuse Act.

• • • NOV 2, 1988

United States tests the world's first hydrogen bomb at Eniwetok Atoll in the South Pacific.

• • • NOV 1, 1952

U.S. adopts four standardized time zones because the American Railway Association wanted to standardize departure and arrival times. Prior to this, time was determined differently in each town in the U.S., by the sun, a local clock, or other local preference.

• • • NOV 18, 1883

The Mariner-9 becomes the first unmanned craft to enter Martian airspace. It took some of the most distinctive pictures of Mars' surface, including volcanoes, canyons and riverbeds.

• • • NOV 13, 1971

X-rays are first observed by Wilhelm Röntgen. His first x-ray was of his wife's hand, complete with her wedding ring.

• • • NOV 18, 1955

Richard Byrd and company conduct the first flyover of the South Pole. They dropped an American flag on the pole itself, weighted with a stone from the grave of Floyd Bennett, a close personal friend of Byrd who died before they could fly over the South Pole together.

• • • NOV 29, 1929

The first edition of *On the Origin of Species* by Charles Darwin is published. At least one store sold out of copies the day it was released. This book discussed the theory of evolution by natural selection, which challenged the belief in the superiority of humans as a species.

• • • NOV 24, 1859

The patent for the first pencil sharpener is filed by John Lee Love, who said in the patent description that the pencil sharpener's purpose was "to provide an improved device of this class which is simple in construction and operation and which is also adapted to serve as a paperweight, desk ornament, and for other and similar purposes."

• • • • • • • • • NOV 23, 1897

"Well, Celsius would probably have heat-powers, so he'd be able to boil his opponent alive, but Doppler could blow out your eardrums. I think it would be a tie."

- Professor Mark Patterson

**WHO WOULD
WIN IN A
SCIENCE
FIGHT?**

**ANDERS
CELSIUS**

Born November 27, 1701
Defined the Celsius temperature scale

Born November 29, 1803
Defined the Doppler Effect

**CHRISTIAN
DOPPLER**

"Christian Doppler, I think. That's more of a scientific advancement."
-Professor Steven Scyphers

• • • • • NOV 12

- Action Club Speaker:
Dr. Eugene Tunik
- Hear the Director of the Laboratory for Movement Neuroscience at Rutgers University speak in the Egan Research Center from 5:00 – 6:30 PM.

events at Northeastern

• • • • ONGOING

- Biology & Chemistry Colloquia
- Ongoing series of lectures: northeastern.edu/cos/event/.

• • • • NOV 8

- Biochemistry Club Speaker & Posters
- Keynote speaker Dr. Kornelia Polyak (Professor of Medicine at Harvard Medical School and Dana-Farber Cancer Institute) in 201 Mugar at 4:00 PM followed by a posters session in the Curry Center Ballroom until 8:00 PM.

upcoming

events in Boston

- Girls Day at the MIT Museum

- “It’s Not Magic, It’s Science” from 11:00 – 4:00 PM.

• • • NOV 7

- Demand Response: Architecture, Strategies and Theories.”

- with P. R. Kumar (CISE resident scholar at Texas A&M University) at Boston University, 15 St. Mary’s Street, Room 105, 2:00 - 3:00 PM

• • • NOV 23

- “Control of Gene Expression Programs”

- with Rick Young (Professor of Biology) at Cannon Room at Harvard Medical School, from 12:30 – 1:30 PM.

• • • • DEC 3

- “World Wide Views on Climate and Energy – Add Your Voice”

- at the Museum of Science from 7:00 – 9:00 PM.

• • • • NOV 12

- “Ocean Exploration Technologies: Past, Present and Future”
- with Robert D. Ballard (Founder and Director of the Center for Ocean Exploration) at the Harvard Museum of Natural History at 6:00 PM.

• • • • NOV 18

“Marie Curie! She’s a woman, and you know that being a female scientist is tough.”-Laura Evangelista

MARIE CURIE
Born November 7, 1867
Worked on radioactivity

Born November 1, 1880
Advocated theory of continental drift

ALFRED WEGENER

“Marie Curie, definitely. She probably has radioactive powers.”
-Professor Mark Patterson

“Bill Nye. He’d have all the modern technology at his disposal. What would Halley have – paper and pencil?”
- Professor Mark Patterson

BILL NYE
Born November 8, 1955,
Computed Halley’s Comet’s orbit

EDMOND HALLEY

Born November 27, 1955,
Well-known “Science Guy”

“Edmond Halley. Does Bill Nye do science?”
-Professor Steven Scyphers

DESSERT FIRST : TESLA'S GAMBLE OF THE DECADE

BY RAFI RAZZAQUE, PHARMACY, 2019

**"Eat your veggies first," they said.
"It'll be good for you," they said.**

Elon Musk, CEO of Tesla Motors, clearly disagrees. Since its introduction in 2003, Tesla Motors has revolutionized the automotive market with viable electric-powered vehicles. Their runaway success with producing cars hell-bent on rivaling traditional, gasoline-burning vehicles have brought light to the quirky nature of Tesla cars. However, quirks such as a volume control button that turns to eleven and a 'ludicrous speed' mode for maximum acceleration pale in comparison to Tesla's quirky business strategy and potential gamble of the decade.

Totally backwards from the practiced norm, Tesla's sales model involves initially producing low-volume, high-priced vehicles before selling cheaper cars in larger quantities. Their serve-dessert-first business strategy introduced the limited-production Tesla Roadster sports car in 2008. Roadster sales funded the development of the just-released Model X SUV and less-expensive Model S sedan, which has been on sale since 2012. Over 75,000 Model S have been sold, compared to only 2,600 Roadster sales.

The Roadster, Model S and Model X are luxury vehicles well out of reach of most consumers, although they serve as great halo cars, which underline the brand's emergence as a technological tour de force. To cater to the average American, Musk has promised an entry-level Tesla--the Model 3 sedan and crossover. With the median price for a new car set at \$33,560 in the US, Musk's car is set to cost \$35,000 (before state and federal rebates). This would offer Tesla an entry-level luxury car financially competitive against luxury cars and

production runs to minimize defects and potential recalls in mass-volume production runs. Finally, the valuable testing miles and feedback from customers may help perfect the future products to come, especially ahead of a large-scale launch like that of the future Model 3.

The flipside of Tesla leaving their vegetables for last is that their financial stability requires the mass production of Model 3s, produced on-time and defect-free. With Tesla's history of delayed models and unknown quality control, many question marks remain over its future viability as a major passenger brand. Increased competition from other automotive brands selling electric vehicles--BMW, Nissan, and GM, to name a few--will also challenge Musk's intentions of selling 500,000 Teslas a year. Its infrastructure of supercharging stations--charging stations that can quickly charge the in-car battery--must be expanded to soothe first-time owners making the jump to an electric vehicle. Likewise, the battery range of future Teslas must be improved through motor and battery developments. With Tesla's future up in arms, the business strategy of deferring production of the people's Tesla will make or break the company.

Tesla's dessert-first approach just may work out in the company's favor. With Tesla coming into huge public attention and demand, its attempt at creating a high-production car for the masses must be a hit for the future viability of the company beyond a millennial tech fad. By leaving their most daunting challenge for last, Tesla challenges not only the industry but itself. But boy, oh, boy, they'll have everyone lining up around the block for an affordable Tesla.

non-luxury cars. The Model 3 would be responsible for the vast majority of Tesla sales, making up the most of the 500,000 cars a year Musk hopes to move by 2020 in order to maintain a profit margin.

Tesla's dessert-first gamble provides them experience working with customer service in lower numbers ahead of larger-scale production runs. Staff and personnel can be gradually increased, while charging stations, dealerships and infrastructure can be erected worldwide to support Tesla vehicles. Production methods can be refined and perfected in smaller

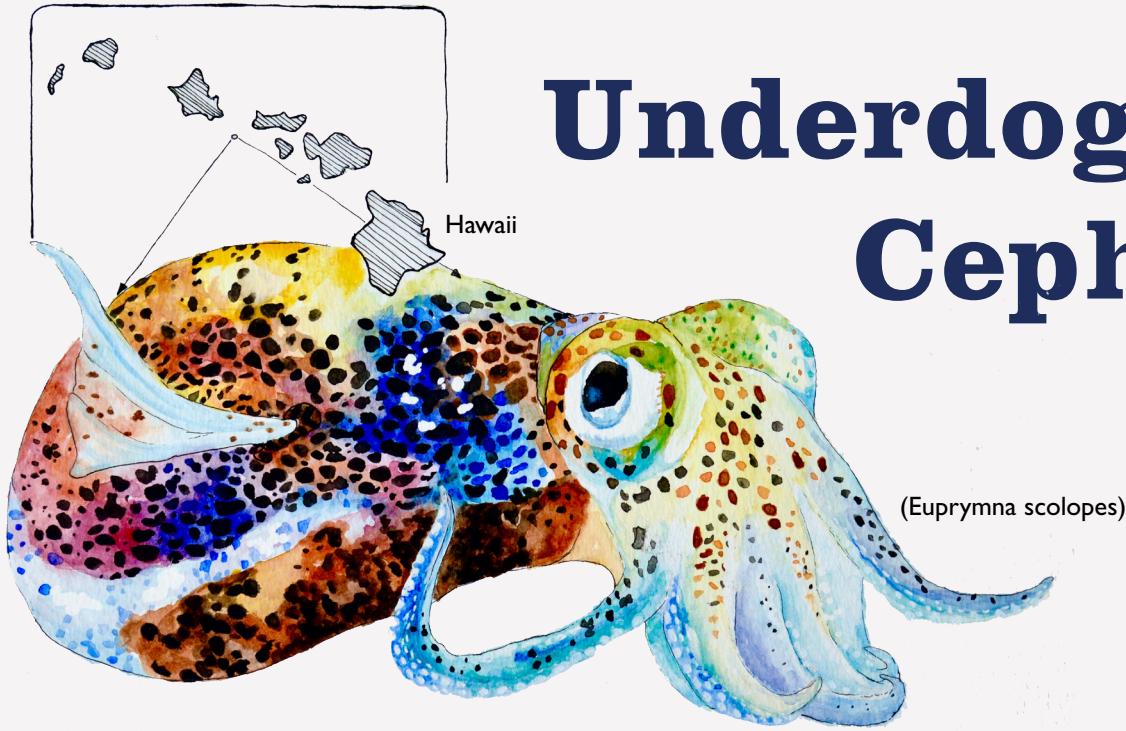


ILLUSTRATION AND ARTICLE BY ALEXIS STEFANO, BEHAVIORAL NEUROSCIENCE, 2017

At just a few inches long, the Hawaiian bobtail squid (*Euprymna scolopes*) has a lot of personality for such a small cephalopod. The sneaky squid has devised several survival strategies that help it evade predators and ensure the successful development of its offspring. However, it cannot manage all of this on its own. The Hawaiian bobtail squid has recruited an abundance of microscopic friends for help.

Most cephalopods are well adapted for easy camouflage within their respective environments, but the Hawaiian bobtail squid has taken this skill to a whole other level. Because the squid is mainly nocturnal, it has evolved to have a “light organ” dedicated to bioluminescence, the ability to naturally produce light using a biochemical reaction.

The crucial organ sits on the underside of the squid and consists of a specially designed pocket for friendly bacteria, known as *Vibrio fischeri*, which do all the hard work of actually producing the light. The squid’s contribution is surrounding this bacterial pocket with a thick layer of reflective platelets. These specialized platelets contain proteins known as reflectins, which can act as a perfect mirror to focus the light. The use of proteins to amplify and direct light is unique to the Hawaiian bobtail

Underdog of the Cephaloids

squid, as other bioluminescent sea creatures utilize layers of purine crystals instead. The overall advantage for the squid is that the light show on its belly disguises it at night. Usually, marine nocturnal predators identify potential food by looking for small shadows swimming above them. However, any predators swimming below the squid will look up to see just what looks like another star shining down on the ocean surface.

So far, the bobtail squid seems to be the life of the party with its own portable light show, but how does it compete in reproduction? Until recently, scientists believed that the female squid would simply deposit her eggs unprotected on the coral reef without any defense mechanisms. However, it seemed unlikely that the eggs were surviving the risks of infection and degradation for the entire 3-week development period all on their own. A mysterious gland housed in the reproductive system of the female may hold the answer to this question.

It turns out that the Hawaiian bobtail squid has once again called upon symbiotic bacteria to achieve a greater chance of survival. The gland contains a variety of bacteria from the Roseobacter family. When the female is producing eggs to be laid, the bacteria from the gland are deposited in

the gelatinous shell that protects the eggs.

In a recent study, scientists isolated the genomes of the bacteria present in the gland and found that many produced antimicrobial and antifungal compounds. When the eggs were grown in the lab and treated with antibiotics to kill off the symbiotic bacteria, the eggs became covered with fungus in just over a week. This indicates that the bacteria in the jelly coating are protecting the eggs from commonly occurring fungal infections throughout their development.

Although the Hawaiian bobtail squid may seem like the underdog of the coral reef, it has evolved to be a mastermind of deception with a little bit of help. This tiny cephalopod may have even given scientists some hints on how to further develop human technologies and medicines. Researchers are now investigating how reflectin proteins might be used to engineer more efficient biomaterials, molecular devices, or biosensors. There is also interest in further studies the antifungal properties of the Roseobacter family to potentially find new antifungal compounds that could help humans.

Frontiers in Microbiology (2015).
DOI: 10.3389/fmicb.2015.00123.

THE FREE, DIGITAL FUTURE OF SCIENTIFIC JOURNALS



BY JAMESON O'REILLY, PHYSICS & MATH, 2019

In the late 17th century, Isaac Newton was hit on the head by a falling apple and developed his theory of universal gravitation. Early in the 20th century, Albert Einstein, a lowly patent clerk, kept up with the cutting edge of physics research by reading journal articles, thus allowing him to make his own advancements in the field. And as recently as this year, Terrence Tao read a comment on one of his blog posts and realized how he could prove the Erdos conjecture, a problem in number theory that had been unsolved for over 80 years.

Science is a collaborative process, so the participants need to be able to communicate with each other quickly and effectively. However, the content of this communication also needs to be vetted to ensure that nobody is misleading the rest of the community with faulty or exaggerated results. Since the days of Issac Newton, most of this burden was carried by peer-reviewed journals run by third-party publishing companies. In return for performing these important services, the publishing companies have charged subscription fees, with more selective, and hence more prestigious, journals charging more.

Einstein was able to access these journals on a patent clerk's salary, but since then the growth of subscription fees has vastly outpaced inflation. Nowadays, university libraries and other research institutions dedicate a large part of their annual budgets to paying for access to these journals. Publishers, who do not participate in the research process themselves, make huge profits off of this endeavor. Meanwhile, working scientists do the peer review work for the publishers without compensation. Given that peer review is one of the most critical roles that the journals play in the scientific process, this set up is questionable at best.

The oldest and most prestigious journals like Nature and Elsevier have made claims that these costs are justified for the services that they provide to the scientific community, and these claims are not completely dismissible. More expensive journals also tend to be more exclusive in terms of what they publish, ergo implying that they contain the best and most important information. Having a well-known name behind certain papers helps tell people what they should be paying attention to. It makes sense to pay more for better content, and printing, paper, and ink are

not free. However, these arguments are only valid to a certain extent. Given the burden that this system places on the research community and the general population who might want access to this knowledge, alternatives must be carefully considered and thoroughly examined. This situation is especially worrying because much of this research is funded by public money.

The biggest factor disrupting this system is the invention and widespread access to the internet. This "information superhighway" allows for much cheaper publication because there is no need to print thousands of copies which must be bound and distributed. Despite this, publishers continue to charge thousands of dollars for access to articles. Thankfully, researchers tend to excel at problem solving, and the internet has allowed for the development of many new, open-access journals that are free for readers but still manage to do peer review.

They fund their much lower production costs by charging authors for publication and getting grants from institutions.

It has also led to the rise of pre- and post-print sites, such as arXiv, where researchers can post their manuscripts for feedback from the community, allowing them to disseminate information more freely. When Terrence Tao

recently proved the Erdos conjecture, he posted the paper to Discrete Analysis, the first arXiv-overlay journal. The journal does peer review and everything else that a normal journal does, except that it uses arXiv as its publishing platform. All of its articles are vetted and reviewed, but they are also completely free and public.

This method is cheap, convenient, and open. It could be the future of science, but only if the scientific community allows it to be. Currently, researchers need to get published in the most prestigious, expensive journals to advance their careers and earn respect, and large organizations with a lot of money are fighting to keep it that way. It will take a huge group effort to shift scientific publishing to a more open platform. It is our responsibility to stop research from getting even more exclusive. We must fight for an open exchange of ideas and information. It would be a massive loss for humanity if the next Einstein is prevented from making a breakthrough because of something as banal as a payroll.

“
It is our responsibility to stop research from getting even more exclusive.”



STICKING THE LANDING

Strategies for Working Through Fear in Gymnastics



BY GWENDOLYN SCHANKER, JOURNALISM AND BIOLOGY, 2018

Put yourself in the mind of an artistic gymnast.

You're standing on the balance beam, ready to launch into your most difficult move: a back handspring followed by a back layout. You just learned this sequence a few weeks ago, but already you feel quite at home performing it on the high beam – for those who don't know, that's a four-inch wide board suspended four feet off the ground. You take a deep breath, bring your arms up to your ears, and prepare to jump.

Then, suddenly, you freeze. Not because you don't know what you're doing, and not because you're not ready to perform the move but because you're scared. This type of anxiety, which one 2006 study referred to as "Lost Move Syndrome," is something that occurs often in gymnastics and other dynamic individual sports. The question for sports psychologists, gymnasts and coaches around the world isn't how to prevent the fear from happening – it's determining where it came from and what the best strategies are for working through it.

The best way to answer these questions is to go straight to the source. Many studies that address this issue collect data by conducting interviews with a group of gymnasts, asking them to assess the sources of their fears and what strategies they use to get past them. The root causes these studies identify aren't surprising: one of the most frequently mentioned is fear of injury, a risk gymnasts face every day as they push their bodies to the limits. Elite gymnasts often practice 30-40 hours every week, a level of biomechanical demand that increases both mental and physical strain. Not far behind is gymnasts' concern that they will let others down, whether that be their coach, family or teammates. This fear may be propagated by the fact that gymnasts are in close contact with these significant others daily, and consistently face a confusing mix of praise, frustration and constructive criticism.

Fear in gymnastics has nothing to do with talent. In fact, one study mentioned that athletes who experience blocking are often some of the smartest gymnasts and fastest learners. However, the situation can get out of hand quickly as anxiety increases parallel to the gymnast's humiliation. Eventually, the shame of not being able to perform the skill becomes associated with the move itself, making the block even more difficult to overcome. When coaches' and parents' initial understanding turns to impatience, things can go from bad to worse as one of the gymnast's fears is further realized.

When the gymnast's anxiety reaches this point – or hopefully before then – it's important to address the problem through

some kind of psychological strategy. Again, researchers turn to the athletes themselves for answers, and the results are as varied as the skills the gymnasts perform. Among the most widely discussed strategies for working through fear is the concept of self-efficacy. Simply put, self-efficacy is the belief in one's own success, the confidence developed from the simple statement of "I can do this." This statement is very powerful in almost every situation, but is especially relevant in gymnastics, when the knee-jerk response to the fear of a skill is to blurt out "I can't."

According to theory, gymnasts who believe in self-efficacy will be more motivated to overcome their fears, and also may seek out other problem-solving techniques. These additional strategies include thought-stopping – a practice where athletes block out negative thoughts in favor of the simple statement, "just go for it" – or relaxation, where gymnasts calm both their emotional and physical state prior to performing the skill they are afraid of, either in practice or competition.

Whatever strategy a gymnast may employ to conquer his or her fear, it's important that the coach plays an integral role. Cultivating a trusting athlete-coach relationship is very important in gymnastics since gymnasts and their instructors spend so much time together. One 2013 study recommends that coaches, with the help of sports psychologists, create training programs specifically designed to overcome mental blocking, and another paper identified verbal encouragement from the coach as a key motivator for gymnasts' self-efficacy. Gymnastics may be an individual sport, but healthy relationships with coaches, teammates and families are just as important as athletic talent.

Put yourself back in the mind of that gymnast, standing there on the beam with her arms raised, afraid to jump and wanting desperately to shout, "I can't." Now, remember that the way you feel is normal. Take a moment to dismount and collect yourself. Relax your muscles and remind yourself that you actually can do it. Turn to your coach for some advice, and let their trust in you increase your belief in yourself. These techniques may seem simple, but they're key to your ability to move forward. Gymnastics is scary, but working through the fear is worth it.

Journal of Applied Sports Psychology (2006).
DOI: 10.1080/10413200600653782.



MAD GENIUS



THE BRILLIANT AND TROUBLED MIND OF JOHN NASH

John Nash Jr. is often considered one of the greatest mathematicians of the 20th century.

BY JORDYN HANOVER, BEHAVIORAL NEUROSCIENCE, 2017

His contributions to game theory, Euclidian geometry, and algebraic geometry are considered some of the most important proofs and analyses within the field of mathematics. His colleagues and professors at universities like Princeton and MIT included Albert Einstein and John von Neumann. The presence of such accomplished mathematicians pushed Nash to make an equally distinguished name for himself. He was known around campus for being eccentric and childish in personality, as well as fiercely competitive. While many aspiring mathematicians chose to follow certain professors, Nash did his best to remain separate from such an association, craving recognition for theories and proofs of his own.

In 1994, Nash won the Nobel Prize in Economics for his contributions to game theory, which branched off of early ideas by prominent game theorists like John von Neumann. Game theory focuses on decision-making and the strategies behind how those decisions are made. The minimax theorem, developed by Emile Borel and proven by John von Neumann, shows that in cooperative games, players will minimize the levels of (maximum) loss given the uncertainty of the other players. The Minimax paper defined many of the earliest thoughts and discussions regarding game theory, and has been expanded upon as research has continued throughout the years. When Nash published his Non-cooperative games paper, it introduced an aspect to game theory that many hadn't considered, and von Neumann had previously dismissed. These new concepts added many layers to

game theory and expanded its applications, many of which are still relevant today.

Some of Nash's most significant contributions to game theory emerged during his time at the RAND (Research and Development) Corporation in 1950. The corporation emerged out of the Cold War arms race, and was highly focused on nuclear warfare and strategy. He was able to demonstrate that non-cooperative games, or games where the players acted independently and did not have to commit to one single strategy, had firm solutions – the players would continue to make the choices that would improve their situation. The paper, published in *The Annals of Mathematics*, proved that every game with a conclusive end, where players are expected to act in their own best interest, has an equilibrium point, or a constant solution.

The most famous example of this is a strategy called the Prisoner's Dilemma, particularly relevant during the Cold War era. The theory essentially states that in a situation where two suspects of a crime are questioned separately, each individual suspect is more likely to confess than keep quiet. Each individual is presented with the same situation: if neither person confesses, they will receive minimal punishment. If one person confesses and the other stays silent, the implicated individual will receive the maximum punishment

“

While many aspiring mathematicians chose to follow certain professors, Nash did his best to avoid such associations.”

while the confessor is absolved of punishment. However, if both individuals confess, they will each receive a medium punishment. The theory states that it is most beneficial to each individual that they confess – if their partner does not confess, they have no punishment, but if their partner has confessed, they will receive a medium punishment instead of the maximum punishment given if they stay silent. This concept can be applied in a number of situations, and essentially suggests that each suspect will play the hand that benefits them the most – in this case, both will confess, and ultimately receive the medium punishment.

The Cold War arms race was a perfect application of the Prisoner's Dilemma, which enhanced the theory's relevance in politics as well as economics. Both sides of the Cold War participated in the arms race – if one side had chosen to arm and the other had not, one side would have a significant advantage in any future conflicts. Thus, both sides fell prey to the Dilemma and participated in a costly arms race for many years. This theory is applicable in modern day negotiations – for example, Professor Rory Smead at Northeastern University has studied the global climate agreement between China and the United States about emissions reduction. According to Smead, recent developments in the field have “turned out to be rich and fruitful, enabling us to understand things like cooperation, communication, strategic thinking and social behaviors in a much more detailed and nuanced way.”

It is important to note that alongside his non-cooperative games theory, Nash developed another theory in The Bargaining Problem. In this paper, Nash sets up a situation where two people are bargaining, and the actions taken by one individual will affect the compromise given a series of four specific requirements. When the conditions for this situation are met, then the solution is that the outcome will maximize the product of the players' services. In this situation, the two players are dividing resources at risk to both of them but one player's loss is the other player's gain. Nash's negotiation theory is used frequently in business today. This bargaining theory was published in an economics journal, even though Nash only ever took one economics course.

Despite his brilliant mind, John Nash's personal life was difficult and scattered. He was an elitist and very focused on gaining recognition and winning prizes, but often displayed strange behaviors and odd mannerisms. Nash was known to concoct elaborate private jokes and experiments in his social

interactions and as a result his initial nervous breakdown – today widely considered a schizophrenic episode – was not immediately acknowledged as such. He believed that he was receiving messages from outer space, and began attempting to form a world government, but the manner in which he communicated this to the people around him was unclear. Colleagues who were aware of his eccentricities initially believed he was playing an elaborate prank. Eventually Nash grew more agitated and it became clear that he was ill, particularly after he tried to deliver coded messages to important figures in the Washington D.C. area. This led to him being committed to a psychiatric hospital by his wife Alicia Nash.

The next several years saw Nash in and out of psychiatric hospitals. He traveled with his family to Europe where he continued to deteriorate. Nash decided that he wanted to transfer his nationality and renounce his American citizenship, going so far as to destroy his passport. Nash's delusions included his membership in a secret society comprised of top government officials, and he constantly attempted to contact them and form a separate, elite government. Eventually, Alicia had to force her husband back to the United States, where he was sent to a psychiatric hospital near Princeton University. After being released for several months, he was sent to another hospital in New Jersey. This cycle continued as his delusions progressed, with Nash constantly viewing himself as a powerful scholar determining the answers to complex theories and problems.

Between 1970 and 1990, Nash remained fairly stable and quiet despite receiving significant recognition from the economic community for some of his earlier works. In the early eighties he began slowly recovering from his schizophrenia. According to Harold Kuhn, a mathematician at Princeton, Nash maintained that he could still hear voices even after his apparent remission. However, he told others that he was able to become aware of his delusional thoughts through extensive rationalization and thus reject such thoughts.

Although his contributions to economics via game theory had stalled several decades earlier, Nash's name came up multiple times in the Nobel committee. His work in the field led him to become a Nobel Prize winner in 1994, and the Nash equilibrium point is widely regarded as the starting point for the majority of current applications of game theory.

“

He believed he was receiving messages from outer space.”

More recent studies have focused on the ways that responses change over time to a Prisoner's Dilemma situation.

According to Northeastern University Professor Rory Smead, "Some of the most important recent contributions to game theory are those involving some kind of dynamics: the studies that consider players, groups or situations that change over time." This outlook is extremely positive for the theory retaining relevance over the years, and recent research has been similarly focused on more flexible situations that change over time.

The applications of game theory are abundant – from philosophy and economics to artificial intelligence and international negotiations on climate policy, which is Dr. Smead's specialty. It is clear that the versatility of the theory will only increase. Smead questions the future of the field in broader terms: How will the games themselves change over time? How can players actively alter such games from within? These enquiries are both relevant and astute. Examples of these situations are abundant in popular

culture, and intellectuals are constantly challenged to find a strategy to change the game as opposed to playing within the rules of the game. Although Nash dealt with many personal struggles, his contributions to game theory and the field of economics are incomparable. His theories of participant interaction in games have propelled the field forward, and broadened the applications significantly, which will continue to grow as the theory develops.

Journal of Economic Theory (1994). doi: 10.1006/jeth.1996.0042.

Proof: First we note that

$s_{j_0} = \sum_i \pi_i s_i$ has the property $(s_{j_0})^\phi = s_{j_0}$ where
 $j = i^{\psi}$, so that the n-tuple $\alpha_0 = (s_{j_0}, s_{j_0}, \dots, s_{j_0})$ is
 fixed under any χ ; hence any game has at least one symmetric n-tuple.

If $\alpha = (s_1, \dots, s_n)$ and $\tau = (t_1, \dots, t_n)$ are symmetric then $\frac{\alpha + \tau}{2} = \left(\frac{s_1 + t_1}{2}, \dots, \frac{s_n + t_n}{2}\right)$ is so
 too because $\alpha^\chi = \alpha \Leftrightarrow s_j = (s_i)^\phi$ where $j = i^{\psi}$, hence
 $\frac{s_j + t_j}{2} = \frac{(s_i)^\phi + (t_i)^\phi}{2} = \left(\frac{s_i + t_i}{2}\right)^\phi$, hence $\left(\frac{\alpha + \tau}{2}\right)^\chi = \frac{\alpha + \tau}{2}$.

Co-Op Spotlight: New England Aquarium

BY MATT TYLER, MARINE BIOLOGY AND ENVIRONMENTAL SCIENCE, 2017

“**The job is demanding yet very rewarding on both physical and mental levels.”**

One of Northeastern's most lauded “draws” for prospective students is our co-op program.

Apparently the idea of getting paid for a full-time job, at least for a while, padding one's resume with real world experience, and building a professional network is appealing to forward-thinking teenagers. While as a junior, I'm starting a bit later than most Northeastern students, I am on my first co-op at the New England Aquarium here in Boston. The aquarium actually offers three co-ops per semester: two in penguin husbandry, and mine, the Giant Ocean Tank aquarist position.

The job is demanding yet very rewarding on both physical and mental levels. One of the biggest and most visible aspects of the position is SCUBA diving: the GOT/Dive department has at least five dives daily in the 200,000 gallon, 23-foot deep centerpiece of the aquarium, and the co-op will usually be on at least three of them. Many days, I've found myself doing all five dives. It's often tiring, but always worth it, whether I'm feeding our two loggerhead sea turtles their breakfast at the bottom of the tank, or cleaning the windows and posing for a dozen selfies. Trying to find ourselves in Instagram posts is a common pastime during lunch!

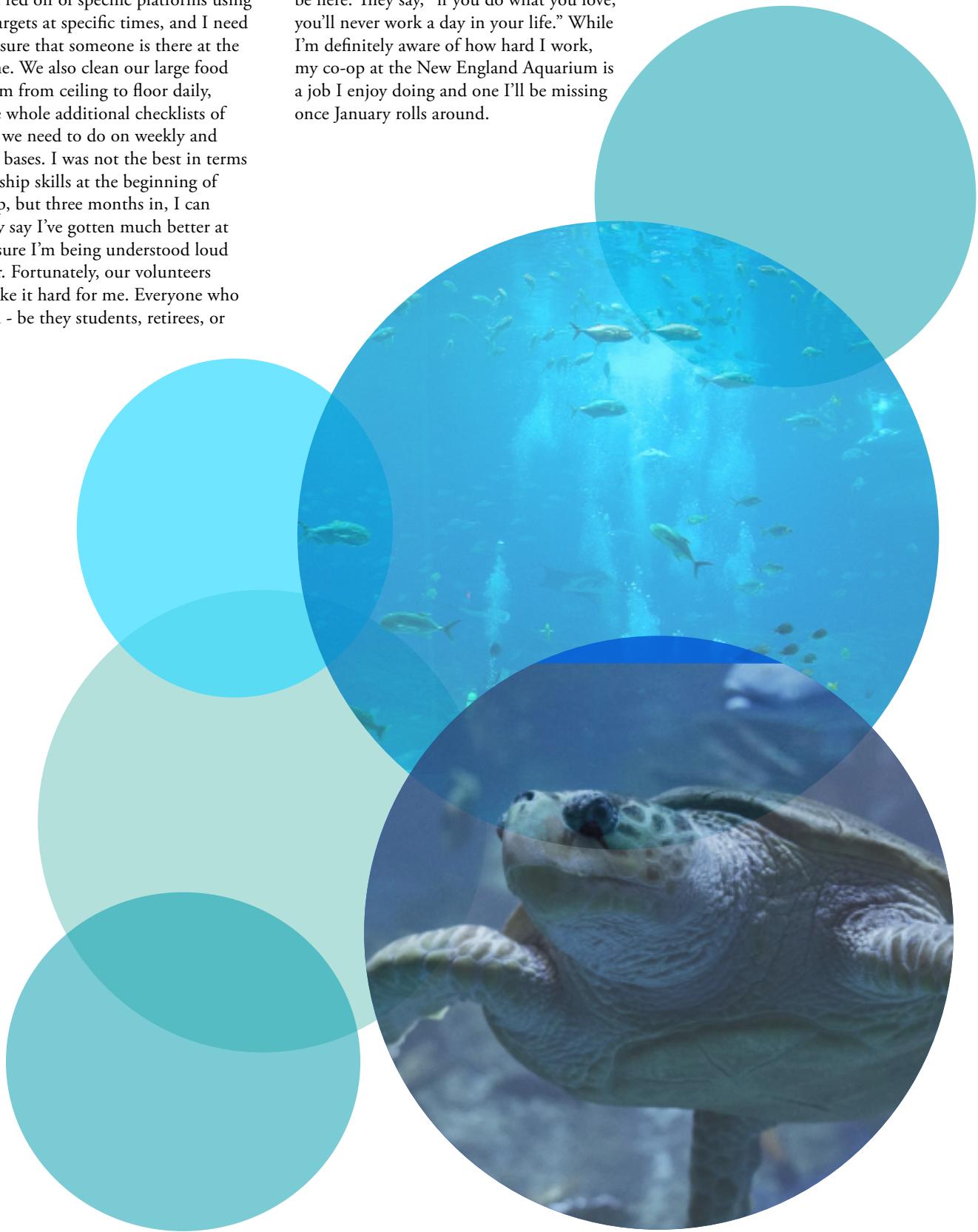
There are 130 or so species of fish in the tank, and 1,600 individuals. I was fortunate enough to pick up a lot of fish identification experience while in Panama on the Three Seas Program, but we keep flashcards and quizlet quizzes aplenty. Some of our more devoted volunteers spend parts of their lunch hours walking up and down the spiral outside of the tank, trying to identify as many fish as they can. It's important to know who is who and what is what in there, because a lot of feedings are tailored to specific fishes, and if a fish is sick or injured, it's important for the aquarists and the medical staff to know which kind. There's also plenty of interaction with the public: when I'm not diving, I'm often on one of our surface platforms doing a targeted feeding, and many inquisitive guests like to know what they're looking at too.

There is a ton that goes on outside of the tank to keep things running smoothly on a day-to-day and long-term basis. I'm the intermediary between our many volunteers and our permanent aquarists, and I'm also the only aquarist who works through the whole weekend (yes, I work Saturdays and Sundays, and get Wednesdays and Thursdays off), which means I am a major force in making sure everyone is up to date on everything. And there is a lot to keep people updated on: we are constantly tweaking our fishes' diets, training them to go to certain targets for feeding, keeping an eye on sick or injured looking fish, coordinating with the aquarium's medical center (conveniently right down the hall from us) for checkups, and adding, acclimating, and releasing new fish.

When it comes to our volunteers, I am not just an intermediary. I am the person directly in charge in most cases. We have 1,600 fish and three sea turtles, so we prepare almost 40 pounds of food every morning, split into many different

containers to accommodate their varied diets. While many are fed by the divers, some get fed off of specific platforms using special targets at specific times, and I need to make sure that someone is there at the right time. We also clean our large food prep room from ceiling to floor daily, and have whole additional checklists of cleaning we need to do on weekly and monthly bases. I was not the best in terms of leadership skills at the beginning of my co-op, but three months in, I can definitely say I've gotten much better at making sure I'm being understood loud and clear. Fortunately, our volunteers don't make it hard for me. Everyone who comes in - be they students, retirees, or

people with full-time jobs - spends a full day here every week because they want to be here. They say, "if you do what you love, you'll never work a day in your life." While I'm definitely aware of how hard I work, my co-op at the New England Aquarium is a job I enjoy doing and one I'll be missing once January rolls around.



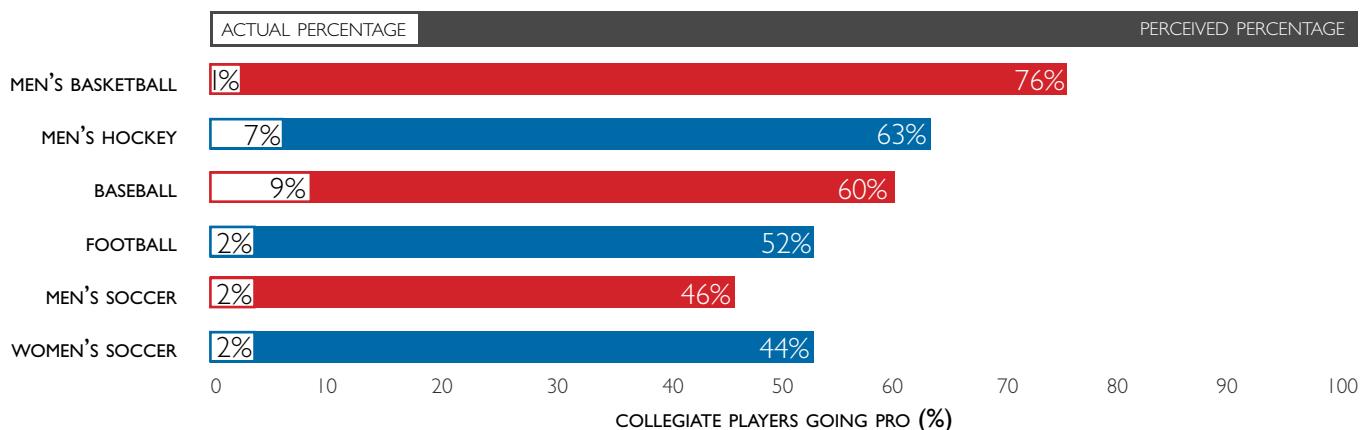
PHOTOGRAPHY BY VLAD MARTIN

The Challenge of AMERICAN SPORTS

Sports and human culture are inextricably linked. Cave paintings 17 millennia old show human figures sprinting and wrestling while in modern times professional sports garner ego, viewership, and profit in equal measure. Due in large part to its consistent appeal, the American sports industry is worth a combined \$498 Billion. The charts below compare American sports from the perspective of aspiring American athletes, moving up the rungs of competitive sports.

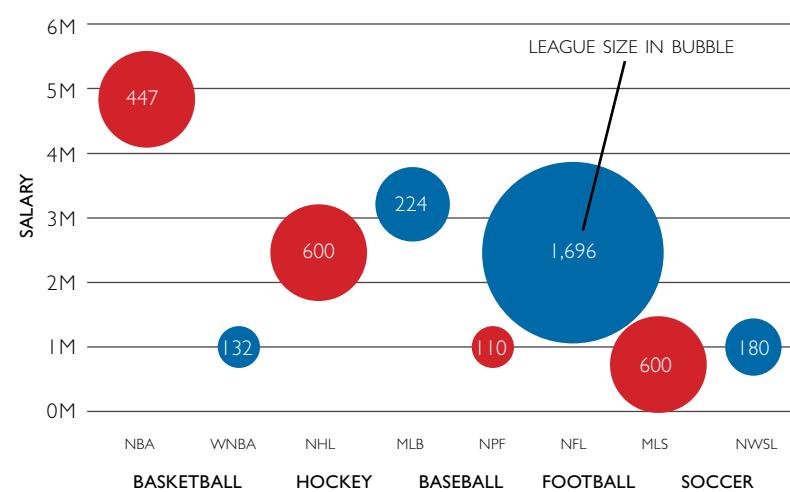
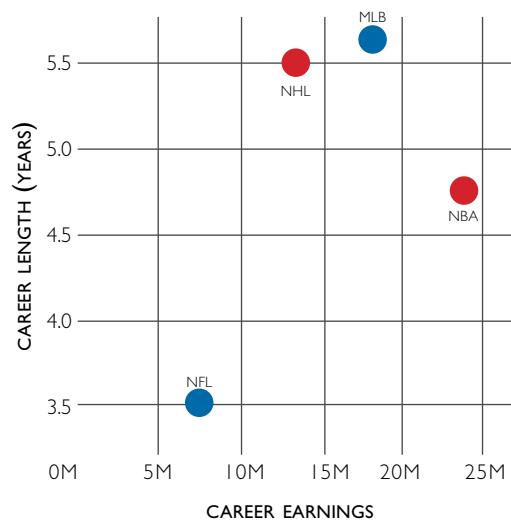
DATA AND VIZUALIZATION BY DIANA MOREL

CONFIDENCE EXTERNAL REALITY VS INTERNAL BELIEFS



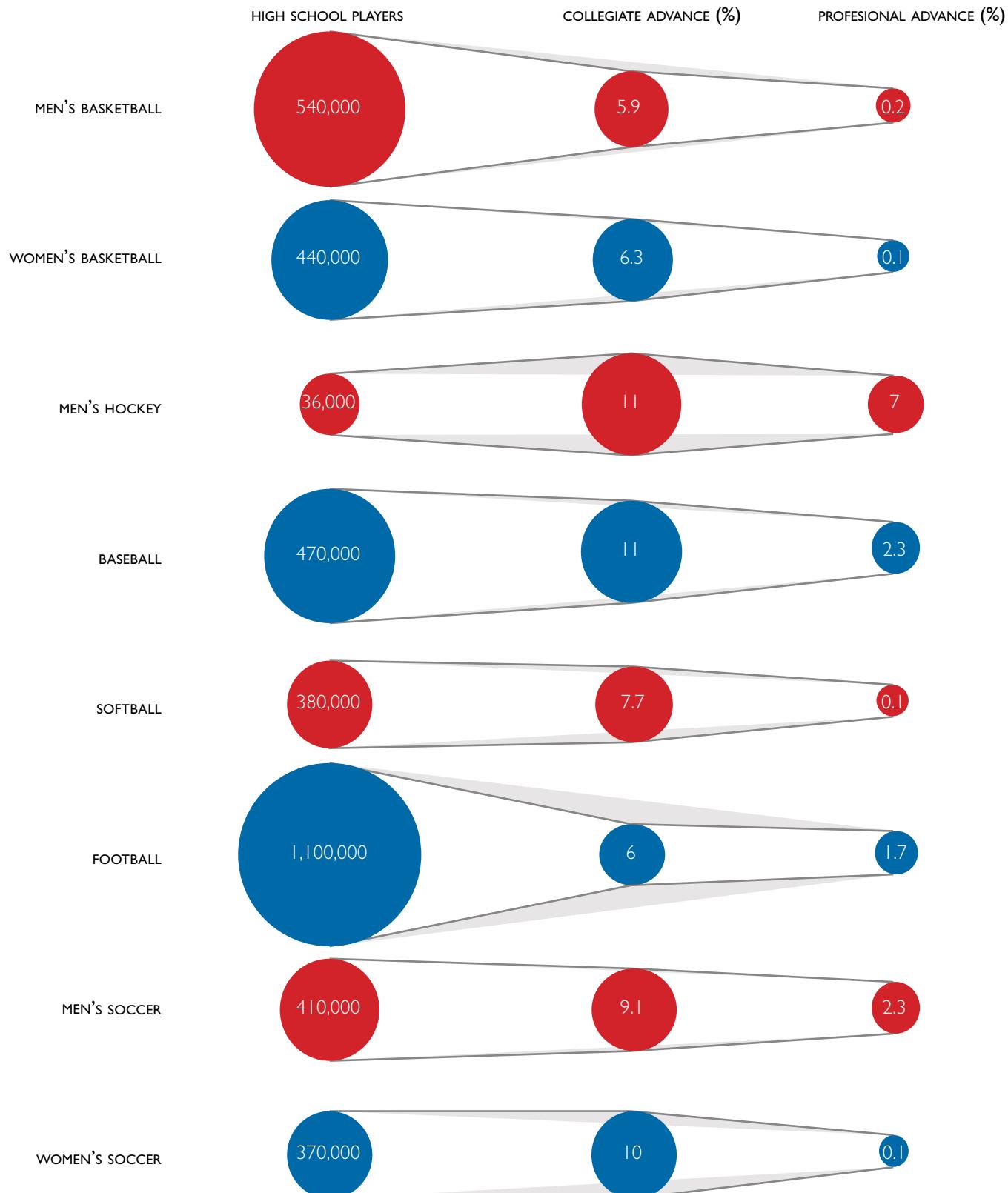
Surprisingly, despite the intense competition between large numbers of athletes, the majority of American collegiate athletes in men's basketball, hockey, baseball, and football answer surveys indicating that they are likely to one day play professionally.

WINNERS' CIRCLES SPORTS AT THE PRO LEVEL



The career outlooks for the small minority of athletes that manage to make it pro are different from sport and sport, and particularly between gender. The graph on the left compares career length vs. career earnings while the graph on the right shows median salary along with league size in the bubble.

ONE LEVEL TO THE NEXT RATES OF PROGRESSION



No two sports are the same, and the differences transcend rules. The graph below compares a selection of American sports. In some sports, like men's hockey and baseball, it's easier by comparison, to "advance" to the next level of competition (high school to college, college to professional).

Men's basketball, and women's sports are (among these sports), the most difficult to advance within. The circles of the first column on the left compare total sport populations while in the right two "advance" columns, the size of the circles are adjusted relative to the highest value of that row.





BY ANDREW BLOY, BIOLOGY, 2015

Two young brothers living in stone-age Mongolia wrestle with each other for control of a prized stone. A few thousand miles and a few thousand years later, Greek children push hoops down the street with a stick to pass time after their lessons. Hop across the Atlantic and fast forward around 2500 years to Boston, Massachusetts in the year 2015, where a group of five-year-olds frantically chase a soccer ball as part of their first experience in team sports. The common thread that unites these people scattered all across the globe and throughout humanity's history is one fundamental human behavior: play.

Virtually every human that has walked the Earth has exhibited play as a behavior. Play, however, is not an exclusively human behavior; a variety of mammals across a huge range of habitats including cats, dogs, gorillas, and elephants exhibit this behavior. Even animals that would not typically be expected to get along have been observed playing with each other. These cases include a dog and his orangutan and a cat that befriended an owl. However, animals playing is a well-documented phenomenon that does not surprise anyone.

Nevertheless, there are questions that need to be asked. What is the point of play? What benefits does play provide? Since play as a behavior can be observed in all mammals, that would indicate that every animal that plays most likely evolved from a common ancestor. To find a common ancestor for animals ranging from chimpanzees from the Congo to polar bears found in the Canadian Arctic, one would have to look back 100 to 200 million years ago. This means the first animals that played walked the Earth during the Jurassic period alongside the dinosaurs. For this behavior to persist for such a long period of time, notwithstanding mass extinctions and climate change events, it must have given animals that play a slight edge over their competitors. But the question is, what exactly is that edge?

German researchers Andreas Berghänel, Oliver Schülke, and Julia Ostner working at the University of Göttingen have been researching this particular edge. According to them, “energy-intensive behavior, such as play, can only evolve if there are considerable benefits.” To test this, they studied the behavior of Assamese macaques, a species of monkeys native to Southeast Asia. These monkeys actively participate in various forms of locomotor play, including the playground classics: tag, chasing, hide and seek, as well as tree and rock climbing for pleasure. Playing any of these games can be exhausting, a cause for concern if finding enough food is a daily struggle. So why do these monkeys spend all this time and effort chasing each other around? The answer to this question bears striking similarity to the reason that most college kids leave their warm beds to go to class: it is an investment in the future. Playing hide and seek or tag helps Assamese macaques develop their motor skills, an important adaptation for life among the treetops.

However, in addition to play's benefits in Assamese macaques, there were some negative consequences. The energy these monkeys devoted to play was not spare energy; it had to be taken from another function: growth. The more a particular monkey played, the less the monkey grew. This emphasizes how important play is to the organism because it would not be evolutionarily advantageous to sacrifice growth potential unless the benefit was overwhelmingly positive. Assamese macaques and their precursors survived partially due to the fact that they chose to invest their energy in play.

While this benefit is clearly seen in Assamese macaques, does it translate to humans? Researchers at Oregon State University studied a type of locomotor play practiced exclusively by humans - youth sports. In the study, 14 to 19 year old students that played a sport at their school and participated in gym class were compared to students that only participated in gym class.

Unsurprisingly, the student athletes showed more aptitude for skills typically associated with sports such as throwing, kicking, and jumping as well as more intangible physical attributes such as agility, coordination, strength and speed. Continuing along the same lines, the student athletes also had better heart, lung and muscular function. These athletes were also far better at maintaining a healthy weight and had a lower risk for developing problematic medical conditions later in life, such as obesity, diabetes, and heart disease. However, unlike the Assamese macaques, there were no clear trade-offs for these benefits. While the monkeys sacrificed physical growth for motor skill development, humans appear to sacrifice virtually nothing for these positive health effects. The only input required to observe these benefits is simple energy.

While the physical benefits in mammals are clear, play holds a special significance for humans. As social animals, play holds a key role in human social and psychological development. During childhood, children at play will mimic adults as a dress rehearsal for later events in life, including conflict, socialization, workplace mannerisms, and even romantic encounters. Without proper exposure to play, abnormalities can arise.

Charles Whitman, better known as the Texas Tower Shooter, was a mass murderer who shot and killed 16 people at the University of Texas in 1966. Whitman is a well-documented case of the potentially catastrophic effect play deprivation can have. Doctor Stuart Brown, a psychiatrist and researcher at the National Institute for Play, links Whitman's psychological disturbance to play deprivation and suppression of play normal for adolescents. These alienating factors contributed to his psychological instability and ultimately led to his demise at the hands of the police. This demonstrates that play is a positive evolutionary behavior that contributes to normal, healthy psychosocial development.

The social and psychological benefits of play are important contributors to humans as a species and their overwhelming success. Social norms developed through play make it easier for human beings to cooperate with one another and work towards greater goals. The social skills developed through play made it possible for larger numbers of humans to live together and interact. Children growing up



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in the Stone Age and the Bronze Age learned how to interact with each other through play. This standard set of interactions that all children in an area would go through allowed social norms to develop. Without these social norms, it would have been nearly impossible for innovations that require a large number of people to work together, like organized agriculture or city building, to occur. Play provided the human species with the tools they needed to move forward and to thrive.

Play is present in almost all aspects of our day-to-day life. The coordination required to tie shoes, the way classmates interact with each other and the way we think about our life are all shaped by play. And it doesn't stop at humans. Assamese macaques play to develop their motor skills, even at the tremendous cost of reduced growth. Humans, monkeys, cats,

elephants, etc. all play to aid their development. Play is a time-honored evolutionary tradition dating back to early mammals that walked the Earth with dinosaurs. So next time there is a group of kids playing in a sandbox, a dog and its master playing fetch or a baby stacking blocks, do not think about how banal these activities are. Think how they are shaping the future of the player, and the countless players that will come after them.

Science Advances (2015) DOI: 10.1126/sciadv.1500451.

PHOTOGRAPHY BY NAOMI STAPLETON



ON THE BRIGHT SIDE

The Solar Energy Boom Leads an Energy Revolution

BY CAYMAN SOMERVILLE, ENVIRONMENTAL SCIENCE 2017

The issue of energy is not only a scientific question, but also a political, social, and economic discussion.

The cornerstone themes of environmental science – addressing global climate change and advancing sustainable energy solutions – compel interdisciplinary approaches, where scientists must inform policy-makers and companies. According to the Union of Concerned Scientists (UCS), power generation is the “single largest source of U.S. global warming emissions.” The UCS, a group that has played a key role in establishing milestone emissions, fuel efficiency and clean energy standards, uses scientific evidence to stress the detrimental impacts of global climate change on humans and the environment and to outline the necessity in transitioning to a cleaner, healthier energy future. While more than five years ago, 97 percent of climate scientists in the United States reached a consensus that human activities “very likely” impacted climate-warming trends throughout the last century, it was only in the last year that serious political action was implemented, according to a National Aeronautics and Space Administration study conducted in 2010.

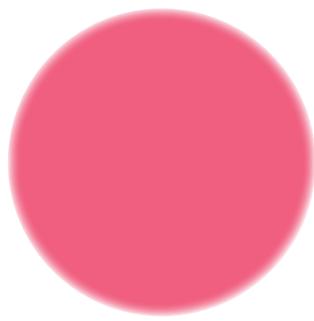
On August 3rd, President Barack Obama unveiled his Climate Change Plan (CCP), widely praised for its ambitious climate regulations and deemed the “most important action any president has taken to address the climate crisis” by The New York Times. Additionally, the majority of Republicans, though a mere 54 percent, also recently acknowledged that humankind is playing a role in the world’s changing climate. The CCP arguably encouraged action from India – the third largest polluter in the world— who announced a plan to reduce greenhouse gas emissions and to establish sustainable energy sources a month later. According to The Washington Post, the CCP could also potentially lead to the decommissioning of hundreds of polluting coal-fired power plants (responsible for nearly 80 percent of all power plant carbon emissions) and to an “explosion in production of wind and solar energy” as a result of the expanded Clean Energy Incentive Program.

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Currently, the most cost-effective non-polluting source of energy is solar power.”

Currently, the most cost-effective non-polluting source of energy is solar power, which is an increasingly attractive investment for homeowners and will be a crucial component for utilities’ survival. In the first quarter (Q1) of 2015, the Solar Energy Industry Association (SEIA) reported that “the amount of installed solar power in the U.S. grew by 76 percent as compared to [Q1 2014].” In Q2 2015, the U.S. installed 1,393 megawatts (MW) of solar photovoltaics (PV) – an amount equivalent to the power needed to run 4.6 million American homes. Furthermore, in the last quarter of 2015, the amount of homeowners going solar grew 70 percent year-over-year, while natural gas generation increased by only 19 percent. According to SEIA’s latest U.S. Solar Market Insight, solar capacity is projected to continue on this “record-breaking trajectory,” increasing utility-scale solar by more than 100 percent between 2014 and 2016. Their projections end on December 31, 2016, which is when the solar Investment Tax Credit (ITC) is expected to expire, causing a degree of uncertainty on the solar industry’s future. Nevertheless, these figures establish aggressive growth in installed solar energy during Obama’s administration and predict that growth will continue long after his term ends.

In addition to political pressure, support from powerful companies like Tesla and Google has contributed significantly to the solar energy revolution. Last May, Tesla launched Tesla Energy, a new line of two battery products: the Powerwall, a lithium-ion (li-ion) battery for residential solar energy systems, and the Powerpack, an energy storage unit for utility and industry applications. The revolutionary products were designed to “fundamentally change the way the world uses energy at the extreme scale,” stated CEO Elon Musk. In addition, Tesla announced the creation of the Gigafactory in Nevada, where these li-ion batteries will be produced as fast as possible and will drive battery costs by 70 percent once at peak production. This summer, Google also entered the solar industry through Project Sunroof, a tool that uses Google Earth aerial photos, mapping data and weather data to estimate homeowners’ savings if they

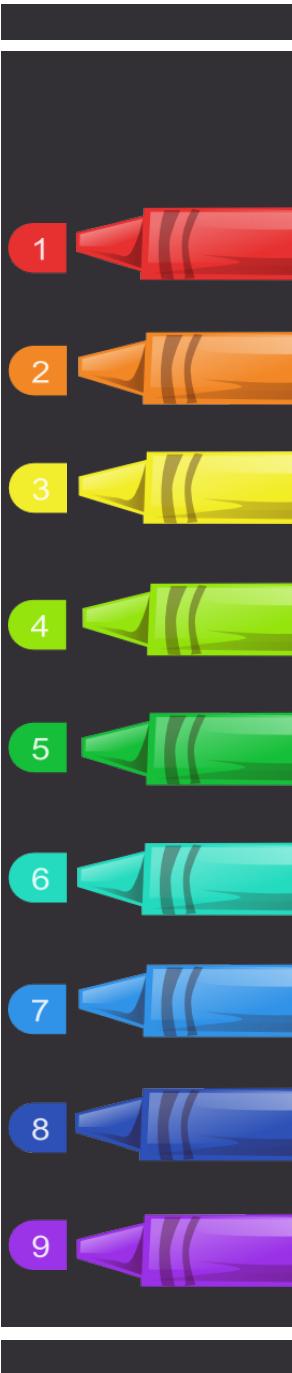


went solar and suggests installers in their areas. However, The Huffington Post reported that Google's new feature is not the first online solar power tool, highlighting EnergySage as a startup that is already carrying out these services in over 30 states, in contrast to Google's three pilot cities: San Francisco, CA, Fresno, CA, and Boston, MA. All of these industry titans themselves fueled the start of the solar tech and energy revolution.

Many politicians, climate scientists, businesses and economists all view the current solar boom as a favorable event – especially as the industry reduces carbon emissions by 20 million metric tons a year, drives enormous job growth and lowers electricity costs

for homeowners. The exciting addition of the first affordable energy storage solution highlights what will someday be the standard for the solar-powered home. While the future looks bright for the solar industry, Obama's aggressive climate plan will not be fully implemented until 2022 and is also expected to face "legal challenges," according to The Washington Post. Regardless, the scientific debate on anthropogenic-caused climate change appears to be closed, while specialists of all disciplines discuss ways to not only directly combat climate change, but also to change the way we use energy.





SENSES TO THE RESCUE!



**Our senses may be more connected than we realize.
Could this be the key to healthier, tastier, sustainable foods?**

BY SAGE WESENBERG, BIOCHEMISTRY AND JOURNALISM, 2019

When you sit down for dinner, what do you notice? There are the sounds: the sizzle in the pan, the fork and knife clacking against the plate, the crunch of food in your mouth. Then there is the cacophony of smells wafting up from your plate or spraying out from the cracked pepper. You probably first take in what your food looks like: greens, whites, reds, all shapes and sizes. Some seem rough, while others appear soft. The textures are visible and can also be felt against your tongue as you take the first bite. Immediately, you start breaking down the tastes in your mouth; perhaps salty, sweet, or even sour. Every bite you take might be a little bit different and all of your senses work together as you interpret the whole meal to be delicious or bland, healthy or fattening, dinner or dessert.

All of these senses are crucial to make food what it is, and a lot of times, it happens without us even really thinking about it.

While our senses are always in action, sometimes it is in ways that are more unusual. For example, what if when you heard a noise, it made you taste fresh chocolate chip cookies in your mouth or smell burgers on the grill? Is that even possible?

For about every 1 in 2,000 people, it is. These people are experiencing synesthesia; a neurological occurrence that happens when one pathway in your brain is stimulated by something like a sound or a word, and in turn, there is an automatic response in another pathway, usually another sensory response. Basically what this is saying is that senses are cross-connected in the brain. It is a phenomenon that has been happening to people, known as synesthetes, since they were young. It is a part of their life that they are

completely used to even though it happens involuntarily. Synesthesia is also thought to have some relationship to genetics, as there are twice as many female synesthetes than males, and many synesthetes also have synesthetic family members.

But for someone who cannot experience this, it seems very strange and difficult to comprehend.

“Often, synesthetes are prone to be more artistic and creative...”

Synesthesia has a few different types of pathway associations, the most common being color-graphemic synesthesia where letters and numbers are each connected with different colors. When someone with synesthesia sees a certain number, the color red may appear in front of them or somewhere in their mind. Another common form of synesthesia occurs when a certain sound or word leads to tasting some flavor. However, within each different type, every person experiences synesthesia differently. And, they've each been experiencing it this way since they were about two. Doctor Veronica Gross, an expert in neuroscience and synesthesia at Boston University, reported that synesthetes will have the same associations 70-100 percent of the time when tested on their synesthesia over a period of weeks or even years.

However, it is often hard for researchers to get exact statistics on this phenomenon. While it is a neurological condition, nothing is fundamentally “wrong.”

and many people don't recognize it as anything out of the ordinary. There are also others who feel misunderstood and keep quiet about what they see or feel because they feel outcast and different. But people with synesthesia function no differently than anyone else, and they are accustomed to experiencing those senses in their mind quite often throughout the day. Often, synesthetes are prone to be more artistic and creative, as many of them visualize things in unique ways.

But back to the important thing in life: food.

English Chef Jozef Youssef and Oxford Professor Charles Spence, known together as "The Chef and The Scientist," have collaborated to take a neurological look at gastronomy and create a multisensory dining experience. They are using the concept of synesthesia, and the relationship between different senses, to not only make the dining process more pleasurable for every sense, but also hopefully to find creative strategies to solve health challenges worldwide.

When describing the goals of their work, Youssef and Spence said, "We believe humans can only make sense of life, interact and communicate using their senses – we have no other way of receiving information about the world around us – which forms our perspective and reality. Life therefore can be seen as a continuous series of multisensory experiences, which create our existence."

They perceive the definition of flavor to be a lot more complex than most may think. Flavor to them requires the use of all senses, including smell and temperature. Youssef and Spence have been researching how senses relate, interact and make sense of food in order to put it in context to create the ultimate dining experience. From February to June 2015, their group, Kitchen Theory, put on a dining event called "Synesthesia by Kitchen Theory,"

where seven modern courses with names like "The Sight and Sound of Flavor" and "Believe Nothing of What You Hear" were prepared and served with audio-visual aids to explore how the synesthete's mind works and to explore how this neurological phenomenon makes dining different.

Through this and their research with

"Life therefore can be seen as a continuous series of multisensory experiences, which create our existence."

food, Youssef and Spence have come to a few conclusions about eating with all the senses. People associate colors with tastes; for example, red is often seen as sweet, while green is usually sour or bitter. They've learned that the texture of food is important because the way it feels in our mouth makes us notice different tastes; rougher, crunchier food is usually saltier or bitter. The way the food appears on the plate changes a person's perception and enjoyment of the flavors they're eating. That flavor can also change based on the external aromas while eating. If a fishy smell was emitted while eating ice cream, evidently, our nose and taste buds would get confused and it would make the ice cream taste different. The sound food makes also changes what we expect it to taste like, as well as shape, color, and identity. If you go to eat green pistachio ice cream, you expect it to taste as such and not like green broccoli.

With all of this in mind, The Chef and The Scientist want to explore the idea of tackling problems like malnutrition and obesity by changing the way people perceive the food they are eating. Spence completed a study where diners ate the same exact red mousse twice: once off of a black plate, and once off of a white

plate. Although it was the same mousse, the mousse on the white plate was rated as 12 percent sweeter. The only difference was the color of the plate. Using this, the researchers believe that sugar could be reduced in food, but if it's packaged or presented in the right colors, consumers will believe that it tastes like the same or a higher amount of sugar. Another similar concept is that when eating foods with high levels of sodium, the saltiness is brought out by rougher textures, so theoretically, if you were able to eat with a textured spoon, you would have the satisfaction of the same amount of salt without eating as much. It is with ideas like these and other similar ideas that Youssef and Spence hope to help people eat healthier without necessarily changing the type of food they eat.

Similarly, they are trying to find resourceful ways to help third world countries fight malnutrition, where eating enough protein is a challenge. Because insects are actually a more sustainable source of protein than animal farming, the team is working on developing "worm butter." This is supposed to take away the negative, gross perception of eating bugs by taking the worms out of their natural form while still retaining high levels of protein. In tests of this new type of butter, people reacted positively and they ate more of it on their bread compared to the regular salted butter that sat right next to it.

You might not think you're ready to eat worms, but maybe you can have a new appreciation for every meal you eat when you use all your senses to absorb the experience. Synesthesia is unusual, unique, and still a bit of a mystery. However, the idea of connecting different senses poses a lot of potential for people like The Chef and The Scientist who want to use our own senses in new ways to make the world a better place.



TOPPLING THE TRUMP TREND

A Psychoanalysis of Trump's Political Campaign

BY KATIE HUDSON, MARINE BIOLOGY, 2017

He is the man many of us love to hate – billionaire, real-estate mogul, television star, and (at the time of writing) Republican Presidential candidate frontrunner Donald Trump. If you tune into Fox News or CNN any time between now and Election Day 2016, you will most likely hear Trump's name within ten minutes, either from the newscaster or from one of Trump's opponents.

Despite being the Republican frontrunner, Trump has no political experience. Instead, Trump owns several hotels, golf courses, and other large buildings with his name stamped on them in a similar fashion to the Avengers Tower. He makes billions of dollars each year and is easily one of the country's most talked about people. Fox News and CNN, however, are not discussing Trump's lack of political experience. They are covering his most recent radical comments. The comments in question range from building a wall along the Mexican border, to how we are losing to China, to about how successful Trump is - and almost always strike the nerve of at least one demographic, if not several.

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So how is an extremely conservative billionaire with no political experience who offends people every time he opens his mouth the frontrunner for the Republican nomination for president of the United States?

When you ask the people who stand in line for hours for the chance to see him, the answers are resoundingly similar. Trump's supporters say "he speaks the truth," and "he's not politically correct." This political "incorrectness," according to Doctor Melanie Tannenbaum, writer for Scientific American's PsySociety blog, is the key to Trump's success.

Trump's track record does not suggest that he is dependable. In the most recent debates, some have even gone as far as to speculate if he is really a Republican. It is not his track record that suggests that Trump may be a dependable politician; it is the fact that he is saying the things that his opponents avoid because they are not politically correct. Tannenbaum, who recently received her Ph.D. in social psychology from the University of Illinois, says that Trump's ability to speak his mind consistently, even if these thoughts are thought to be politically incorrect by some, makes him more believable and

dependable. Tannenbaum argues that since you do not expect a politician to say that he will deport all of the immigrants in the United States and build a giant wall on the Mexican border, you believe that Trump is a dependable man when he says things of this nature. Tannenbaum calls these type of statements "non-normative" statements, and says that people using these generally seem more authentic because they diverge from the audience's expectations. In other words, potential voters see Trump as authentic as a direct result of his political incorrectness.

Another candidate, some will argue, is using a very similar strategy. Bernie Sanders is currently one of the Vermont Senators, and has been present in Washington D.C. since 1991. Sanders is registered as an independent in the Senate, but is running against Hillary Clinton for the Democratic nomination. The Vermont Senator describes himself as a democratic socialist, and this has invoked a similar reaction to Trump's lack of political correctness – he, too, is not speaking words audiences expect from politicians. This has led voters to view Sanders as authentic in comparison to Clinton.

Still, it is not only Trump's political incorrectness that builds his appeal. Tannenbaum believes that another large part of Trump's appeal is the personality trait known as ambiguity intolerance. People who are ambiguity intolerant "feel uneasy or anxious in the presence of uncertainty," according to Tannenbaum. Research has shown that people with a high ambiguity intolerance will prefer a negative, yet certain, outcome over a positive and uncertain one, simply because they dislike being uncertain so severely. As a result, while Trump's ideas may be radical and offensive to some, people who are ambiguity intolerant will prefer him over a candidate with uncertain ideas and beliefs, even if that candidate may be better suited for the Oval Office. Similarly, Sanders has had a consistent voting record for the past 24 years. As a result, Sanders appeals to the ambiguity intolerant, democratic voters, unlike Clinton who lacks Sanders' reputation for consistency.

The results of these effects, whether subconscious or not, may make all the difference in the 2016 election.

**Potential voters see
Trump as authentic
because of his political
'incorrectness'."**

STRATEGIZING SOCIAL JUSTICE

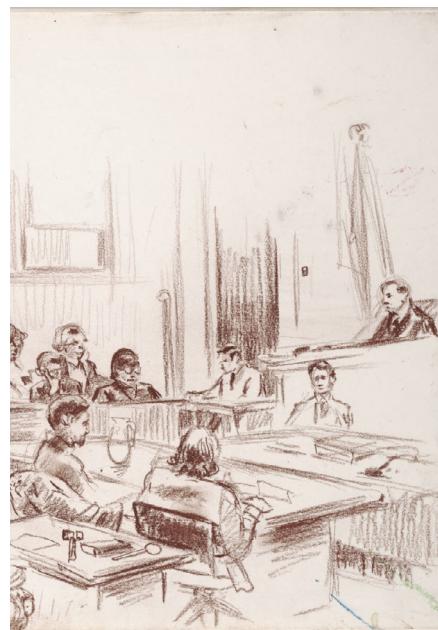
How the Brain Decides What is Blame and Punishment

BY: NATASHA MATHUR, BEHAVIORAL NEUROSCIENCE, 2018

Most people have spent several hours in a crowded courtroom, crossing their fingers and hoping that they won't be chosen to sit on a jury. But at some point in our lifetimes we will inevitably be placed on one and will have to make a decision that affects someone else's future. What many people forget is that juries represent social norms. Citizens who have never met before will use sound logic to make a case, using information from the trial such as a defendant's mental state, the severity of the crime, and other key points of evidence in order to come up with a verdict – guilty or not. In highly televised cases, this is often where chaos erupts. People all over will debate over the punishment – how long, how severe – often within minutes of hearing a verdict. Even in other cultures, there is always a group of people set to make decisions when one member of the society has committed a crime. So, how do individuals come up with these punishments and how are we able to differentiate the situations in which they are used?

In order to better understand the why and how we are able to make such important decisions, a recent study was conducted by researchers from Vanderbilt University. They targeted the dorsolateral prefrontal cortex (DLPFC) of the brain. For the non-neuroscience nerds, the prefrontal cortex is what makes humans more advanced than other species – amongst many helpful advantages, it allows us to think logically and make decisions. The DLPFC has been studied previously, and scientists believe that it has undergone expansion in size and connectivity, meaning that it has been increasingly useful to the extent that it has actually enlarged in

size throughout evolution. Although the DLPFC isn't the only region of the brain that is used in this type of situation, it is important because it is so crucial for "norm-enforcement." Norm-enforcement is critical for societies like ours, in which those who violate the rules need to be reprimanded accordingly. The main premise of this study was to understand whether the DLPFC was involved in assigning blame and assigning punishment.



In order to achieve this, researchers used functional magnetic resonance imaging (fMRI) scans to show that the DLPFC was active when participants were assigning blame and punishing someone in a hypothetical situation. Next, a set of 66 participants who did not undergo the fMRI scans were given hypothetical scenarios in which crimes were committed by someone. The situations varied in regards to the criminal's mental state (reflecting how

responsible he was for the crime) and the severity of the crime. Participants were asked how culpable the criminal was and what punishment was deserved. This was repeated when researchers inactivated the DLPFC via repetitive transcranial magnetic stimulation (rTMS), which decreases the excitation in cortical areas, resulting in the suppression of the area. The responses of the participants were then compared.

The results showed that participants were more likely to give a less severe punishment without changing the culpability, or how much they blamed the defendant, of the hypothetical criminal. This means that the DLPFC plays a role in processing and integrating the information we take in, and is necessary for us to logically make a decision. Although very informative, this study only looked at one region of the brain. There is a possibility that there are other areas involved in these punishment and blameworthiness judgements. Because the rTMS did not affect the blameworthiness judgement, researchers think that high-level thinking and reasoning processes that are important in norm-enforcement may have little to do with the DLPFC. Often, we don't think of why we decide things or how we decide. Many people are of the mentality "I just felt like that was right" and can't explain their choices more than that. But your brain does more than you give it credit for, including giving you the ability of sound logic. The logic of how severe a punishment to give a criminal is also a social norm, and without jurors and judges our societies would not function.

Neuron (2015). DOI: 10.1016/j.neuron.2015.08.023.

Ticket To Ride

BY EMILY ASHBOLT, BIOMEDICAL PHYSICS, 2017

My favorite game is about trains.

It sounds nerdy. It sounds lame. It sounds like something your 9-year-old cousin would be obsessed with to the point of alienating his family. And you know what? It might be nerdy. Your cousin may well be obsessed with it.

But it is a far, far cry from lame.

When Zug um Zug (literally, Step by Step) came out of Germany in 2004, it sparked a board game revolution. Renamed Ticket to Ride for the American audience, it tells the (fictional) story of a group of 5 friends who meet in America at the time of the steam train boom. The goal of the game is fairly simple: you and up to four others complete routes across a simple map of the US by collecting train cards of various colors. Route lengths are worth different point values, and the player with the most points when players start running out of trains wins.

It is a fairly simple game, but that simplicity does not translate to regular gameplay. Ticket to Ride, along with being a game from Germany, is also a “German-style game,” which, according to Wikipedia, means that it has “simple rules, short to medium playing times, indirect player interaction and abstract physical components.” These abstract physical components are what keep people coming back for more - you are never playing the same game twice.

Wikipedia goes on to explain that “such games emphasize strategy and downplay luck and conflict,” however, and on this point, Wikipedia and I must agree to disagree, because conflict is an essential, unavoidable part of all of my Ticket to Ride experiences.

As of 2014, over 3 million copies of the physical board game have been sold, and at least half of those are owned by people I know. A friend of mine brought it over one snow day, having learned about it

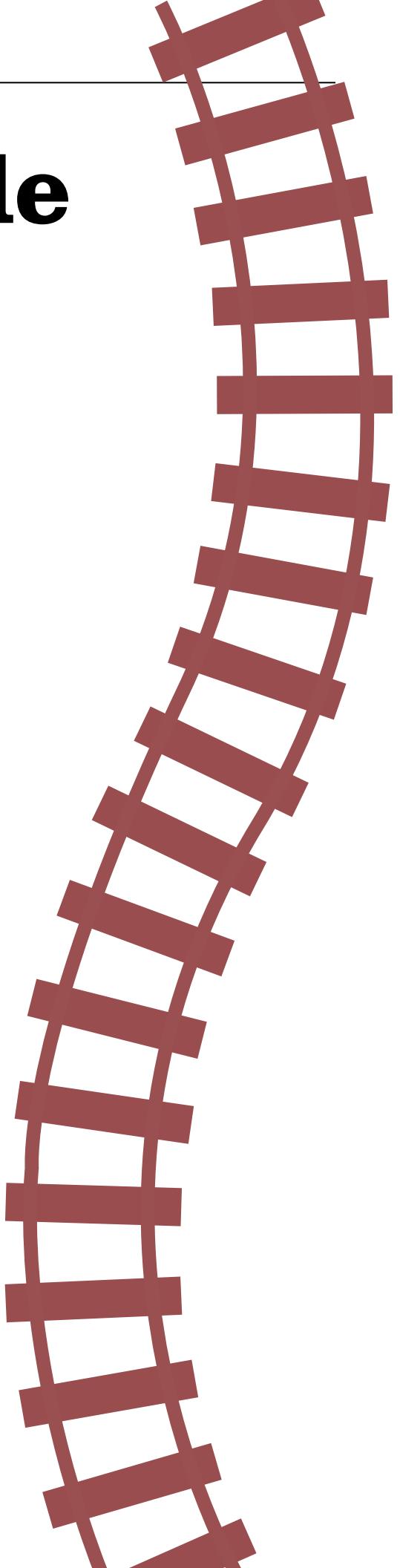
from her roommate, and I mentioned it to my boyfriend, who said he had a copy, and together the two of us introduced it to our mutual friends, two of whom ended up buying it themselves and introducing it to their own families. I then bought a copy for my father, and now I live with the girl who first introduced it to my friend.

With all those boards in my life, I have played a lot of rounds of this game, and every one has been peppered with the threat of ended friendships, borderline hysterical pleading, and, in some cases, tears. It may well be the best game of all time.

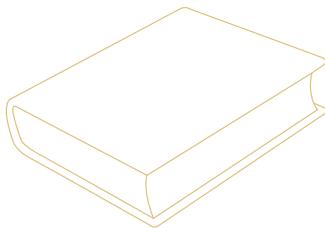
Multiple articles have been written crediting Ticket to Ride with breathing new life into tabletop gaming. It is popular across the globe, particular because of its various expansion packs, which allow gameplay across Europe, Africa, Asia, Scandinavia, and more. It has also been the winner of multiple awards, such as Game of the Year in multiple European and Asian countries, and various Best Family Game medals. It consistently heads any Reddit thread on the best board games, so you know it has to be good. It also teaches only slightly skewed American Geography to anyone who might need a refresher.

As far as board games go, it is probably the best I know. The strategy is just present enough to be enjoyable, and the cutthroatness need not be overwhelming unless you wish it to be. It is a beautiful game, also, featuring fantastic colors and loving illustrations of the most common train cars of the era. Although a little on the pricier side, the amount of entertainment available (particularly with the 1910 expansion pack) very quickly makes it worthwhile.

It is a great family game, as well as lending itself easily to raucous evenings with friends. I am also strongly of the belief that it would make a marvelous wedding gift, because train travel is romantic, right? So what are you waiting for? Climb aboard!



PHOTOGRAPHY COURTESY OF TUMBLR



BONK

The Curious Coupling of Science and Sex

BY MIKA WHITE, HEALTH SCIENCE, 2018

First and foremost, this is not a how-to book.

In a world where the taboo surrounding the activity of sex leads us to awkward birds-and-bees talks with our parents, Bonk is a refreshing, giggle-inducing read. Author Mary Roach manages to bring cohesiveness to the complexity and physiology of sexual arousal and orgasm while answering questions that we would only be comfortable Googling with the history-erasing option on our browser. Although it doesn't explicitly give tips on how to have better sex, it does discuss the ins and outs of what may improve or worsen intercourse, which, in a sense, is what sex research is all about.

Roach is a quirky writer. Her investigation into the world of sex research led her to interview workers in unconventional places including pig farms, sex-toy labs, and brothels. Immersing herself full on in her

research, she flew to London to have sex with her husband in an MRI machine to provide a medical physics researcher with a real-time image of human intercourse.

Originally a journalist, Roach writes in a concise and eccentric manner. In Bonk, she is not afraid to ask embarrassing questions that might cross the curious (or the uncurious) mind. Does orgasm increase the chance of conception? Does Viagra work on women? She also analyzes the different approaches toward sex between men and women. In one section where she writes about her research into a rat lab, she quotes, "Cheese crumbs spread in front of a copulating pair of rats may distract the female, but not the male."

If the idea of reading about erections, sex hormones, pig insemination, and dildos doesn't intrigue you, I don't know what will.

An Interview with Professor Randall Colvin



Professor Randall Colvin teaches the personality lab course, an undergraduate seminar in mental health, and a seminar for incoming graduate students. His research is primarily concerned with personality and the accuracy with which one can judge his or her own personality as well as someone else's disposition.

BY MEGAN PINAIRE, PSYCHOLOGY, 2018

How did you get started in psychology?

When I was in high school, my high school offered a course on marriage and family and it was really about psychology. I noticed along that course that I played that role with friends - the person who listened and offered suggestions. I'm not sure why, but I started college as a math and engineering major, failed at that miserably, and then switched to psychology and found my true calling at [California State University Long Beach]. There was one professor there who got me really excited about psychology, a guy by the name of Victor Benassi who is now a professor at University of New Hampshire.

How did you go from majoring in psychology to a career in higher education?

So I got my bachelor's degree [at California State Long Beach] and started my master's, but I couldn't decide whether to go into clinical or into research. So I quit the master's program. I ended up working for a phone company in California in information systems. I hated computers, but I had on my resume that I had taken two computer courses as a psych major, so I did that for three years. It took three years for me to figure out that big corporations weren't for me. So I made the decision to go back to school. I went back to where I quit, finished my master's, and then went to University of Illinois where I got my Ph.D. After that I went to University of California, Berkeley and did my post doctorate. [Northeastern] was my first academic job, and I've been here for about 20 years now

What led you to combine video games with personality?

To start off with, I wasn't necessarily thinking about video games. As a personality psychologist, our data typically consists of ratings where [participants] rate themselves or where someone watching a video of the person and rates his or her behavior. While those methods have unique strengths and weaknesses, the issue is that they're all being done by a human observer. There are certain errors that humans make that limit data. So I thought, wouldn't it be great if there was some sort of gold standard to measure personality? Some objective measure of personality that is not biased?

So where do video games come in?

Well, as I was doing a different study to begin finding the objective measure of personality, two colleagues from video game design asked if we could use video games to determine someone's personality. It became a two-part study. We had people play a modified video game for an hour. We collected data throughout gameplay and [afterwards] we brought them into the personality lab. We videotaped a man and woman on a couch, told them to "talk about whatever you want" and walked out the door. After five minutes we came back in and they rated the interaction. Another hour and a half was spent completing questionnaires.

With all that data, we look at the video game behavior that people engaged in. [For example], people could talk to non-player characters (NPCs), or they could go directly to the goal. We look at the differences in how people played the game and whether these patterns connect to what people are really like [according to how we] assessed them in the personality lab. So, if people talked to the NPCs and were helpful to others in the game, does that translate to [whether they are] more friendly and agreeable in the real world?

What findings do you have so far?

We have preliminary evidence from a smaller study that there are connections between how people behave in the game and their personality. This [current] study is the bigger, better version that has funding and establishes if there are clear relationships. It is currently in progress.

Some people might think that people can be whoever they want to be when playing a video game. That might happen for some people, but the idea is that after the novelty wears off of trying out different personalities, you go back and act the way you normally do. We are hoping this is the case and that we will be able to assess people's personalities in game-like environments.



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