The Synapse: Intercollegiate science magazine

Volume 8 | Issue 1 Article 2

2016

Issue 8

The Synapse

Oberlin College Science Magazine

Volume 4 Issue 3

April 2016

Staff

Editor-in-Chief Gabriel Hitchcock
Managing Editor Nate Bohm-Levine
Chief Layout Editor Rachel Dan
Art Coordinator Peyton Boughton
Interview Coordinator Willa Kerkhoff
Outreach Coordinatior Victoria Albacete
Treasurer Rebecca Posner
Liaison Hillary Pan
Web Design Derek Palinski
Cover Art Claire Kotarski

Writers

Alyssa Altheimer
Ilana Ascher
Emma Hahn
Gabriel Hitchcock
Sarah Hughes
Nandita Krishna
Oluwadamilare Ogunjimi
Brooke Ortel
Lauren Rhodes
Jane Sedlak
Anah Soble
Jacob Turner
Joy Udoh

Copy Editors

Victoria Albacete
Alyssa Altheimer
Luke Burrows
Jamie Hawkins
Caroline Lawlor
Sophie Lewandowski
Nora Newcomb
Emma Parkins
Gabe Seidman
Anah Soble

Layout Editors

Rachel Dan
Dayna Gallagher
Ashley Grauman
Matana Moran
Kate Van Pelt

Artists

Eva Bednarski
Sydney Bernal
Rachel Dan
Caroline Edwards
Linnea Fraser
Elena Hartley
Mikaila Hoffman
Adina Johnson
Megan Lee
Lydia Newman-Heggie
Oluwadamilare Ogunjimi
Beatrix Parola
Jane Sedlak
Zimeng Xiang

Content Editors

Victoria Albacete
Alyssa Altheimer
Luke Burrows
Isabel Canfield
Madison Clapp
Chloe Deshusses
Dayna Gallagher
Caila Glickman
Gabe Hitchcock
Sophie Lewandowski
Nora Newcomb
Brendan Nuse
Emma Parkins
Gabe Seidman

Photographers

Yinuo Zhang

Interested in joining our team?
Email: *synapse@oberlin.edu*
Visit: *thesynapsemagazine.org*

The investigation of our physical world and the ever broadening culture surrounding art are realms of human exploration that cannot be limited by national boundaries. Science and art are products of humanity that all people are invited to not only participate in, but to actively appreciate. In the same way that artists continue to expand on and defy conventionality, so too does science continue to reveal greater and more impactful truths. Yet, despite this, there persists a perception of science as being a wholly inaccessible entity, available only to those with the proper faculties and training. A perception that science, like the physical properties it defines, is a static and unalterable entity. But science, like artistic expression, does not occur in a vacuum. It is a vibrant and living discipline influenced by societal currents as much as by recent discoveries. It can be accessed from multiple angles and does not discriminate against whom it reveals its truths. All it takes is the right communicator to render it accessible.

With science media coverage dominated by sensationalized stories of cancer cures and wonder drugs, and mainstream media consumed by the polemical politics of our least favorite, wispy-haired businessman, *The Synapse* strives to cut through the usual rhetoric by providing clear and insightful science journalism to its readers.

In this issue, we have combined the journalism of new and returning writers to offer a breadth of topics. I invite you to journey with Lauren Rhodes as she take us from seed to dinner plate with her article *The Journey of a Modern Vegetable*, to take take a ride in a self-driving car with Nandita Krishna in *The Economy of Autonomy*, and to consider the fundamentals of existence itself with Jacob Turner in *Nature's Elusive Particle*.

Furthermore, I am thrilled to introduce the work of Zoe Cohen, whose reductive, limbless depiction of the human body for *Diabetes in Antiquity* draws attention to a life-defining disorder. Finally, as always a nod to our cover artist *Zimeng Xiang*, whose geometric abstractionist work entreats the reader to delve into this latest issue of *The Synapse*.

Enjoy.

Gabriel Hitchcock
Editor-in-Chief

Featured Contributors

Victoria Albacete is the quintessential *Synapse* staff member. While pursuing degrees in both Biology and English, Albacete has worked with the magazine as an editor since the fall of 2015, shortly thereafter becoming our Outreach Coordinator. Albacete has also been involved with our intercollegiate efforts. In addition to her work with *The Synapse*, Albacete works as a production editor for the Oberlin student newspaper, *The Oberlin Review*, and staff writer for the literary and arts magazine, *The Plum Creek Review*. As if that were not enough, Albacete is also a writing associate at the OberlinWriting Center, a member of student dance troupe *Movimiento,* and Latino/a organization *La Alianza Latina*.

Zimeng Xiang has always been inspired by the beauty she finds in the natural sciences. Having worked with the magazine since the fall of this year, Xiang has contributed artwork for each issue to date. Now, for this newest issue, Xiang has created a stormy seascape strewn with dark clouds and chaotic geometrics. Speaking on her artwork, Xiang says that she creates artwork that reflects her imagining "of a magnified world where every tiny particle and their subtle motions could be seen with our eyes." Originally from Shanghai, China, Xiang is a sophomore, double Art History and Studio Art major, with a minor in Physics. After Oberlin, Xiang is considering pursuing graduate work in modern Chinese art history.

Tara Santora is a first year, intended Biology and Neuroscience double major from Abington, Pennsylvania. Santora began working with *The Synapse* in the fall of this past year. As a writer, Santora first wrote about the extraordinary planned mission to Mars, Mars One. Oxford physicist and Mars One candidate Ryan MacDonald congratulated Santora on her original piece, calling it "excellent true journalism . . . that avoided many of the common pitfalls that even major news outlets have made." Now, after a one issue break to write about antibiotic-resistant bacteria and the threat they pose to mankind, Santora returns to the topic of a human mission to Mars through an interview with MacDonald. Read more in *Interview with a Martian.*

Rebecca Posner is one of the few members to have been involved with *The Synapse* before its reemergence in the spring of 2015. Posner became the treasurer in the fall of 2014, six months before the now editor-in-chief became involved. Beginning as a Biology major, Posner quickly switched to become an Art History major, a discipline which she may decide to pursue in graduate school. Posner says that, despite her change of major, she has continued with *The Synapse* because she "wanted to maintain [her] connection to science at Oberlin. It feels good to contribute to an organization that showcases such interesting and important topics." Posner also works with the Oberlin Heritage Center, where she gives presentations on local history and tours of historic sites.

Contents

The Cosmos

4 Nature's Most Elusive Particle

Biology

6 The Journey of a Modern Vegetable

8 Carl Linnaeus

The Brain

9 The Complement System and Schizophrenia

10 Schizophrenia

12 No Amygdala, No Worries

14 A Crash Course on Migraines

Medicine

16 Vitamin MisconCeption

17 A Brief History of Diabetes

Big Ideas

18 Climage Change in the Media

20 The Economy of Autonomy

22 The Science of Superpowers

24 BPA Here, There, Everywhere

Interviews

25 Elizabeth Kolbert

26 Ryan MacDonald

Features

28 Honors Research

31 Crossword Corner

Nature's Most Elusive Particle

What Can Neutrinos Tell Us About Our Universe?

By Jacob Turner

Artwork By Elena Hartley

Did you feel that? Every second, you are being bombarded by millions of particles. And yet, you can't feel a thing. They pass right through you with virtually no interaction. Forget the stories about ghosts from your childhood; these ghosts are real. They are also incredibly old, serving as fossils from older periods in the universe and providing clues to what those periods in the universe were like. These are the particles known as neutrinos.

Neutrinos are relativistic (always traveling at a large fraction of the speed of light), high-energy particles that are almost massless. For many decades they were believed to have no mass at all, requiring that they must always travel at the speed of light. It wasn't until the beginning of the 21st century that it was established that neutrinos oscillate. This process "mixes" the various mass and flavor states of the neutrino, giving it mass. Even with this tiny amount of mass, these particles are constantly travelling at 99.9999 percent the speed of light. Because the difference between these speeds is so miniscule, even the most rigorous experiments still measure speeds at or faster than light within their margins of error.

Produced mainly in high energy interactions, such as nuclear fusion in the sun or in the collapse of a star going supernova, neutrinos rarely interact with their surroundings, and many travel halfway across the universe without interacting with anything. The best neutrino detectors in the world are built more than a kilometer underground to prevent them from interacting with particles other than neutrinos. These massive underground detectors are considered a success if they can detect around 10 or 20 neutrinos per month. In the rare event that a neutrino does strike a detector, what we measure isn't the neutrino itself, but rather the particles that result from the neutrino's decay. As of right now, this decay chain is as close as we can get to inferring their existence, but the reactions are explained so well that it is very easy to infer.

Despite this particle's elusiveness, we are able to use it to predict, observe, and better understand a variety of important astrophysical phenomena. A particularly significant example of this took place in 1987, when three neutrino detectors detected the signals from more than 20 neutrinos in a span of about 10 seconds. About two hours later, telescopes observed a massive supernova that was determined to be in the same location on the sky from which the neutrinos originated. The neutrinos had allowed us to predict an impending supernova hours before its light had reached us.

> Even with this tiny amount of mass, these particles are constantly travelling at 99.9999 percent the speed of light.

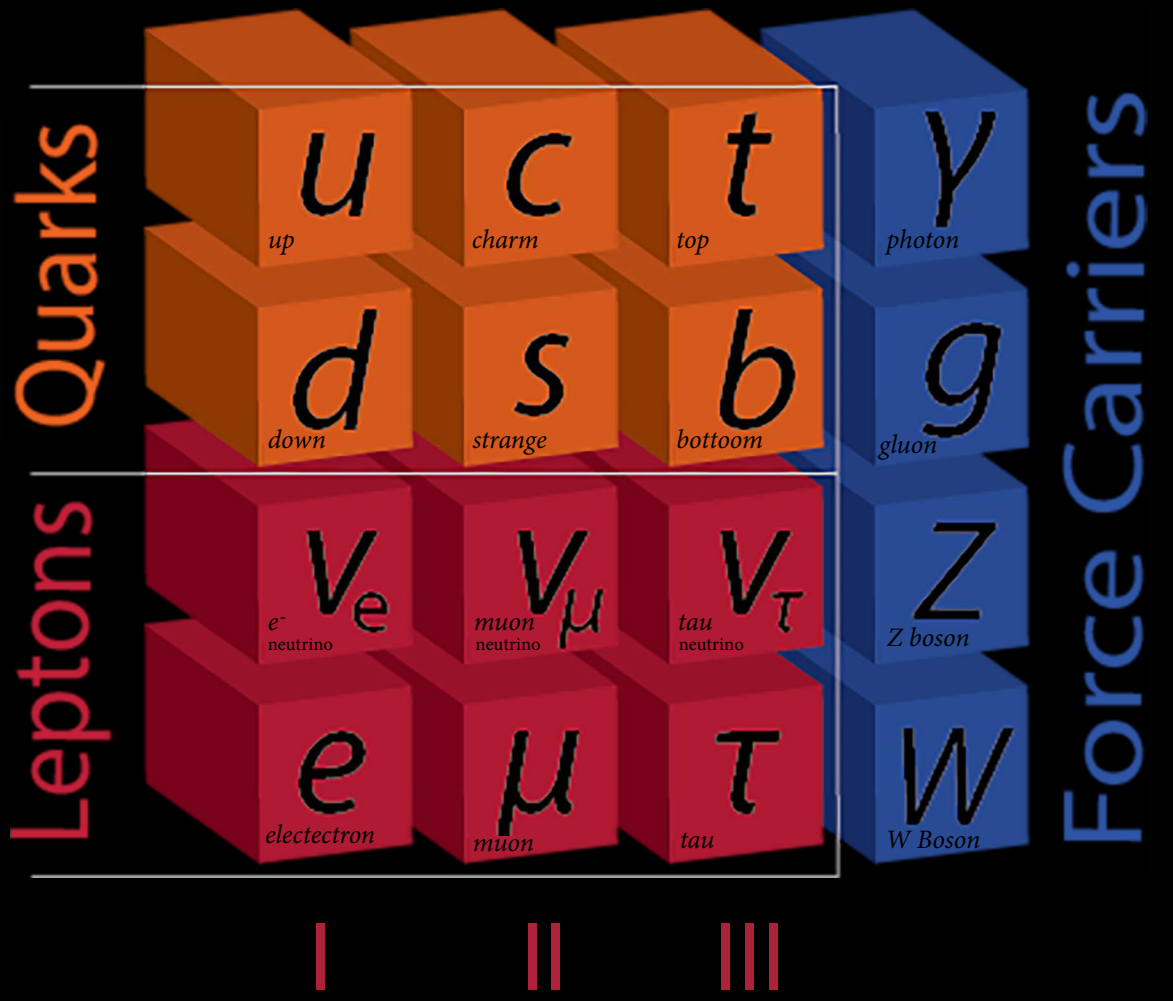
If you're following along, that last sentence might seem strange, or even counterintuitive. The light from the supernova was detected after the neutrinos were. Light travels at the cosmic speed limit because its particles have no intrinsic rest mass; however, neutrinos do have mass (however little it may be), so they clearly must travel slower than the photons. What's going on here?

Surprisingly, there are no physical laws being broken. The photons and neutrinos are still travelling at their own speeds, but neutrinos have an advantage that allows them to beat the photons to our detectors: they hardly interact with anything. When a star initially

collapses, it acts like a massive particle accelerator, smashing together billions of trillions of particles and spewing them out into space. Among these particles, flurries of neutrinos are created and are able to escape the star virtually uninhibited. The photons, however, interact with so many particles that they take long, random walks within the star before they are able to escape. If you imagine a large traffic jam, the photons would be cars trying to get through the backup and make it onto the open highway. The neutrinos are like scooters that can maneuver around the other cars and make it onto the highway without much incident.

The neutrinos are like scooters that can maneuver around the other cars and make it onto the highway without much incident.

Another, more recent application of neutrino detection came about in the past 10 years. Researchers using detectors deep under Antarctic ice have been able to detect signals from cosmic neutrinos with origins far outside the reaches of our galaxy. These neutrinos form in high energy events, such as the collapse of stars going supernova or black holes drawing in mass. Many of these events happen hundreds of millions of light years away, which would indicate that they happened back in the early universe. Since we believe the universe was originally compressed into a point smaller than the width of a proton, the early universe was much smaller than it is today. This meant that everything was more densely packed, meaning that violent events would occur at a higher frequency. The neutrinos produced in these events have energies that may be hundreds to thousands times those of particles produced in CERN's Large Hadron Collider, and their negligible interactions have allowed them to maintain almost all of this energy, even by the time they reach us hundreds of millions of years after their birth. As a result, these particle fossils can provide clues about the nature of the early universe, such as properties of particle physics or the origins of dark matter. In the end, it may be that nature's most elusive particle will open the largest doors into our understanding of the universe.



The three types of neutrinos show in relation to the other known elementary particles

The Journey of a

An Exploration of the Agricultural Industry, From Seed to Core

By Lauren Rhodes
Artwork by Rachel Dan

Large amounts of pesticides can be detrimental to an ecosystem

Many pesticides are neurotoxins. Pesticides - essentially biocides - are not discriminatory in who they effect.

When you look at your plate, what do you see? The sources and energy behind our food are often invisible. I know that when I sit down to a salad or pasta, I don't usually think about the story behind the greens in the salad and how much water they took to grow, or where the wheat came from and who runs the field in which it grew. There is so much more behind the farming industry than we see on our plates. When you eat a piece of kale, you are eating something that was once a seed, an organism, and sunlight, and it took a certain amount of labor and carbon to get this one piece of kale to you.

I associate seeds with growth, ideas, and new plants. In the modern large-scale farming industry, they also come with coatings and genetic modification. GMOs, or genetically modified organisms, have become common practice in a lot of processed foods, but they start with the original seed, which can be modified for herbicide tolerance and insect resistance. The organic foods movement is partly related to GMOs, as no foods labeled as organic can have GMOs in them. According to the USDA, many seeds are also coated or treated by different procedures to protect them from pests that are the most prevalent when the seed has not yet grown into a small plant, but is still in the ground. The decision of whether or not to use GMOs or seed coating is a tough area to work with, because in order to feed the population, we need to grow a lot of food. Getting past the seed stage of a plant is a crucial step, and having certain strains of a plant can help protect it throughout its lifetime. Using a small amount of chemical coating can also protect many vegetables or fruits.

However, using a large amount of pesticides can be completely detrimental to an ecosystem. The little seeds are sometimes coated or modified, and then grow into plants. The plants are also commonly sprayed by pesticides, which cover whole fields, leading to a host of problems. Many pesticides are neurotoxins, which means that they affect the nervous system of an organism. This is how they kill "pests." But pesticides–essentially biocides–are not discriminatory in who they effect, and they are also marketed in a very user-friendly way. For example, cypermethrin, a pesticide used in agriculture, is toxic to different organisms and has a stronger effect the longer that an organism is in contact with it, according to a paper by Cömelekoglu. This means that people or organisms who are around the plants and pesticides the most are often more likely to experience negative effects from the biocides. Pesticides can also have long-term effects on ecosystems. Again, pesticides protect future food from destruction, thus providing more people with more food. But there are alternatives out there, including integrated pest management, which is a multi-faceted approach designed to minimize the impact on organisms and the environment from protecting plants from pests.

Once the plants have grown, they need to be harvested. The Fair Labor Standards Act from the U.S. Department of Labor specifies that the minimum age to work in the agribusiness is sixteen, but there are multiple exemptions that allow for children as young as twelve and even younger to work with their parents' permission. This can lead to young children being overworked. This life leads to health problems, less likely access to education, and leads a cycle from poverty to poverty. A number of people are trying to bring this issue to light through various projects, including the film

Modern Vegetable

One way to mitigate environmental costs is to buy locally.

For every 10 fruits in a gorcery store, 1 will end up in a landfill.

from 2011 "The Harvest [La Cosecha]," which documents children who work on farms picking produce like onions, apples, and tomatoes. Many groups are working to make this sector of the industry better, but this is a huge problem, especially because after the food is harvested it does not always even get eaten.

The fruits and veggies have now been harvested, and they need to travel around the world in order to get to their future consumers. The United States Department of Agriculture Economic Research Service did a study in 2013 of the effects of transportation on the costs of fresh produce. They found that the price of fuel, especially in truck transport of produce, had an effect on the food that consumers bought. The amount of fuel used also goes up as the transportation distance is higher. Therefore, the amount of fossil fuels and carbon emissions are going up as well, since trucking is a common method of produce transport. One way to mitigate these monetary and environmental costs as a consumer is to buy locally if possible. There are a lot of campaigns aimed at buying local foods, and here in Oberlin, the Oberlin Project is working on a local food network.

Consumers may find their produce locally at farmer's markets, but a lot of produce is sold in grocery stores, where the amount of food wasted is astounding. The USDA Economic Research Service also did a bulletin in March 2009 covering the amount of food wasted by supermarkets, which is quite illuminating. Over half of the fruit types surveyed had over a 10% loss rate, which is quite high. That means that for every 10 fruits in a grocery store, one will probably end up in a landfill instead of feeding a person who needs it. The loss estimates for vegetables were also very high, topped by mustard greens at a whopping 63.6%. There must be a better way to save these foods and share them with people who really need them, potentially through policy. Some grocery stores are now zero-waste as a way to combat this problem. One store in Berlin, Original Unverpackt, sells bulk food without packaging as a way of reducing waste. This mostly works for dry goods, but it only works to reduce some kinds of waste. Surprisingly, the USDA also has a gleaning program where they collect leftover fresh produce from farms and produce sources. So many measures, from genetic modification to pesticides, are currently used to try and maximize return from produce, but grocery stores still end up wasting an inexcusable amount of food.

The fruits and veggies have now been consumed. From seeds to waste patterns, and from human labor to carbon emissions, the agribusiness has its flaws, but a lot of people are working on growing and distributing food more equitably and sustainably. There are also a lot of up and coming alternative farming methods, as a way of minimizing the carbon output and negative impacts of produce. There is even an Alternative Farming Systems Information Center within the USDA. One example of these types of farming is hydroponic growing, which is done without soil and can be done underground. The University of Arizona Controlled Environment Agriculture Center is also working on efficient, environmentally friendly, and cost effective methods of farming, which is an exciting direction for the agriculture business to go in. There is already a lot of work being done, but there is still a long way to go in terms of making the agribusiness the best it can be. The journey of a modern vegetable can continue to be shorter, more efficient, more cost-effective, and better for humans and ecosystems.

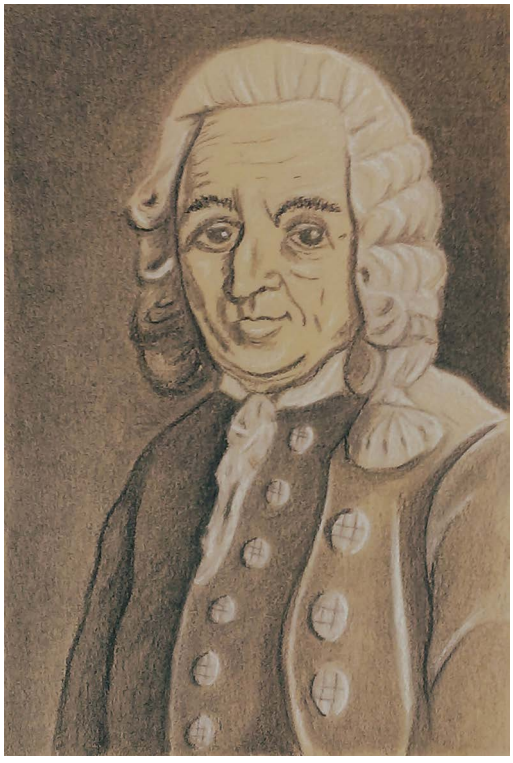
Carl Linnaeus

Conceited Genius or Just Conceited?

By Anah Soble
Artwork by Linnea Fraser

"No one has been a greater botanist or zoologist. No one has written more books, more correctly, more methodically, from personal experience. No one has more completely changed a whole science and started a new epoch."
- Carl Linnaeus (1707-1778)

The modern system of classifying and naming organisms is based on the ideas of a man named Carl Linnaeus. Linnaeus was an egotistical man who thought he was put on Earth by God to classify all of creation. Of course, he did not even come close to identifying all of the estimated 8.7 million species on Earth—a feat that would take much more than one lifetime. He did, however, identify many organisms, including over 4,000 animal species and 7,000 species of plants. His ego, however, was more far-reaching than any of his accomplishments.



As a young naturalist, Linnaeus went into the field only once, when he visited Lapland (a part of Finland) in 1732 to collect botanical samples. On this trip, he studied both the plant life and the ethnography of the area. He never went into the field again. He did not need to, with tons of young students excited to get out into the field under a brilliant and accomplished professor. Most of the species he named were actually sent to him by these students—otherwise known as his "apostles" (yes, like Jesus). Linnaeus received bones and dried plant matter from all over the world. Working for Linnaeus was dangerous --only 10 out of his 17 students would survive working for him in the dangerous terrain where he sent them. When the first of Linnaeus' apostles died on the coast of Vietnam, the student's widow was very angry with Linnaeus; he would only send unmarried students on expeditions from that point on. As the lead scientist on these projects, Linnaeus left notes for his apostles on what to be looking for and undertook all major identification processes, but it was the apostles themselves who had to do most of the physical labor.

What system could such a dangerous and egotistical scientist inspire? There are three major systems of nomenclature: The International System of Nomenclature for algae, fungi and plants; the International Code of Zoological Nomenclature; and The International Code of Nomenclature of Bacteria. All are based on the books and methods of Carl Linnaeus.

These codes of nomenclature all require some similar specific information, including that the names be binary, in Genus species format, in Latin, and conjugated correctly. Having a common language for nomenclature allows for better communication about organisms across various languages. Although Linnaeus believed his work was perfectly methodical and correct, the systems of nomenclature he inspired are flawed. There is little communication between plant and animal nomenclature, and there are no rules against the same name applying to both a plant and an animal species. For example, see the cabbage butterfly (Pieris rapae) and the Japanese Andromeda (Pieris japonica)—these species are not related at all. As you can imagine, this name sharing leads to some confusion.

Classification systems also require a type specimen—that is, they require a part of the organism preserved for scientific use. For plants, this could be a dried out plant collected from the site it was discovered on. For animals it could be bones, skins, casts or, in the case of insects, whole dried bodies. In keeping with Linnaeus's extreme ego, the concept of a type specimen originates from the idea that God himself placed perfect versions of these organisms on earth. Linnaeus indicated himself as the ideal type specimen for Homo sapien. At this point, can we really be surprised?

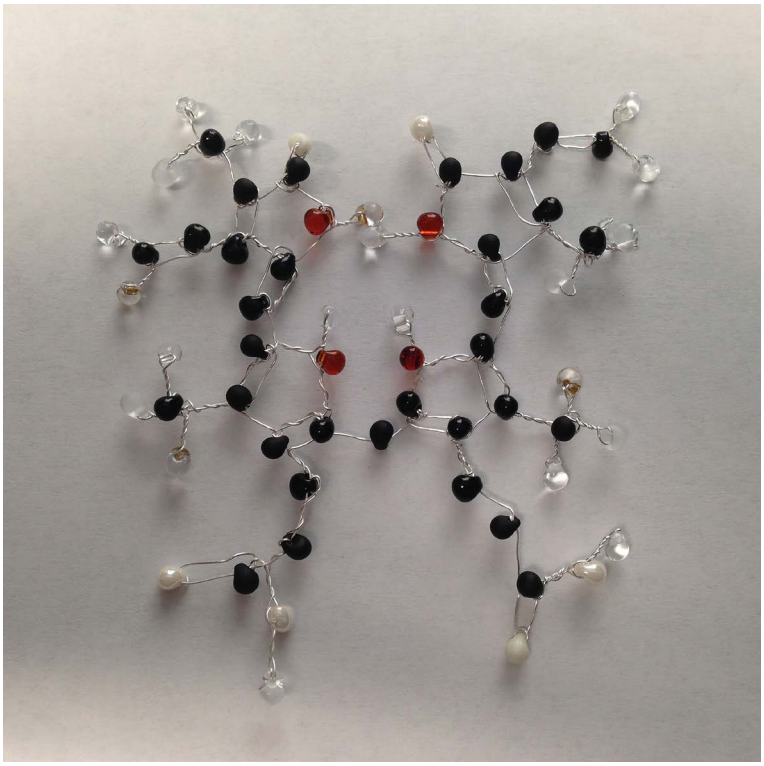
Despite his egotism, Linnaeus made huge contributions to evolutionary biology. Because he took extensive notes on the morphological characteristics of plants and animals, Linnaeus is often used as an example of how to write books containing plant and animal names. A man who deluded himself into thinking that he was put on Earth by God to name all plants and animals, called his students apostles, and carried out a series of egotistical antics, Linnaeus still accomplished a method of organizing the diversity of life that is still in use today.

The Complement System and Schizophrenia

What if a psychological disorder could be treated by targeting part of the innate immune response?

By Sarah Hughes
Artwork by Megan Lee

A recent publication in Nature reports schizophrenia to be linked to alleles of the complement system's component 4 genes, which produce and transcribe for the C4 protein (a member of the complement system). Sekar et al. found that the complement system's component 4 alleles generate diverse levels of C4A and C4B, which are two functionally and structurally distinct types of C4. In humans, this protein attaches to neuronal synapses, dendrites, axons, and cell bodies and limits their activity. Although the pathogenesis of schizophrenia is unknown, it is understood that characteristics of the disease include both reduced numbers of synapses on neurons and excessive loss of grey matter — all of which are affected by the C4 protein. Interestingly, in schizophrenic patients, greater expression of C4A has been found. This is a crucial discovery because it may provide a possible explanation of the pathogenic mechanisms which contribute to the disease — and may aid in the production of new therapies which will target components of the complement system, drastically changing current treatment practices.



Schizophrenia is a mental disorder that is categorized by abnormal social behavior, hallucinations, delusions, and jumbled speech and thinking. Scientists have not yet uncovered the origins of the disease, however, they have noted several morphological differences in the brain such as enlarged ventricles, reduced amounts of gray matter, and synaptic pruning.

The complement system is a phylogenetically conserved arm of innate immunity which functions together with the adaptive immune response. The latter works in a specific manner through antigen-antibody interactions while the former has been long credited as the main contributor to the innate immune response — essentially unchanging in its reaction cascade. It consists of a complex group of about 30 serum proteins which play important roles in the defense against infections. Working non-specifically, they bind to microbes, foreign objects, and pathogens among other foreign bodies, to eliminate anything they recognize as "non-self". Essentially, the complement system works with the adaptive immune system by serving as an important infl ammatory mediator. Moreover, the complement system is more active in the brain than the adaptive immune system due to the blood-brain barrier, which restricts the passage of certain substances, i.e., antigens and antibodies. Under normal circumstances, the complement system provides protection from the aforementioned pathogens and accumulating debris. However, excessive activity in the system coupled with the presence of excessive amounts of specific proteins can tip the balance between health and disease.

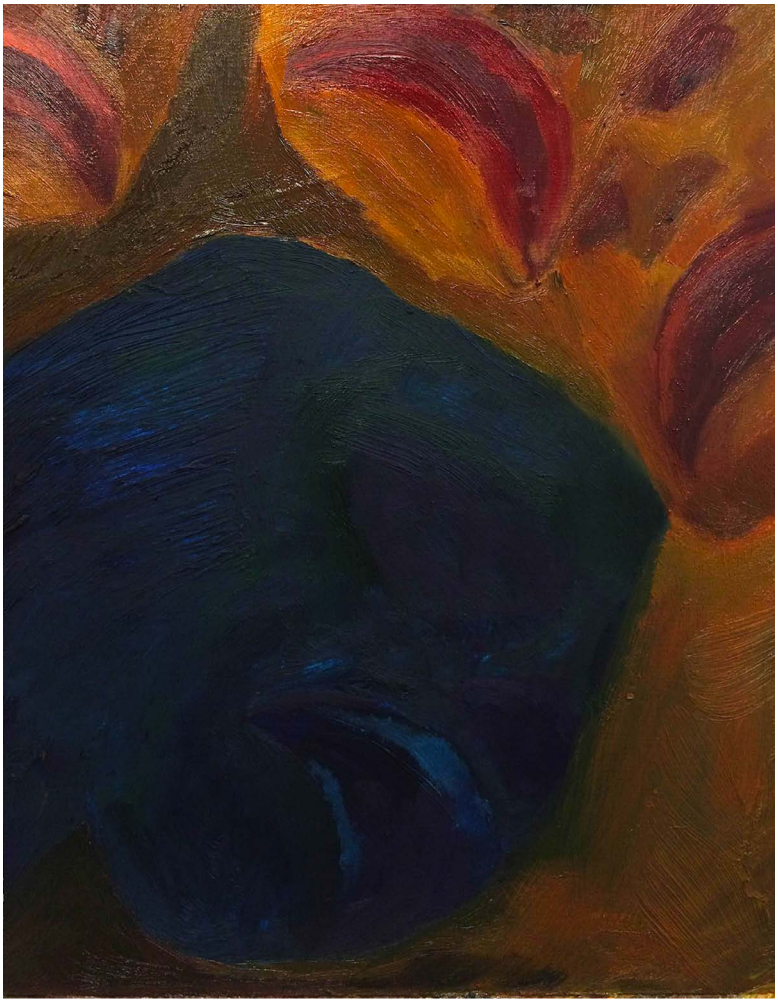
Now, why is the increased amount of C4A in schizophrenia important? In essence, there is a growing desire to understand the role of the complement system in pathological processes and to exploit its targets in developing therapies. Since C4 is a critical component to the system's classical cascade (being a precursor to one of the three pathways that result in the system's activation) it has been the focus of many studies. Thus, its imperative to understand that the increased expression of the protein C4A in schizophrenia patients may stimulate continual amplification of the complement system's cascade — possibly accounting for the increased elimination or 'pruning' of synapses in the brain of schizophrenic patients. This synapse elimination or 'pruning' in humans normally occurs between early childhood and the onset of puberty — the same period when schizophrenia, in most cases, becomes clinically apparent. In summary, new findings have confirmed that the human C4 gene suggests a critical relationship between an overabundance of C4A and risk for schizophrenia.

Meanwhile, since the direct causes of schizophrenia are relatively unknown, therapy focuses on eliminating symptoms through a combination of anti-psychotics, which target dopamine and serotonin, and psychosocial talk-therapy. However, because C4 has been found in excess in schizophrenia patients and is known to contribute greatly to excessive complement system activation, and thus to synaptic pruning, loss of cortical grey matter, etc., complement system inhibitors or other targeted therapies may enhance treatment of the disease. Currently, these types of inhibitors are used to treat known complement system disorders, such as paroxysmal nocturnal hemoglobinuria, and are in clinical trials as promising alternatives to transplant rejection drugs (which intensely compromise the immune system by placing a time limit on the transplanted organ). Furthermore, understanding the complement system and its roles in not only schizophrenia, but also in complement-related diseases may provide information about the management and understanding of disease infiltration as a whole.

Schizophrenia

Genes, Brains, and a New Era of Research

By Emma Hahn
Artwork by Matt Simon



Imagine a friend or close relative gradually but strikingly losing their ability to cope with everyday experiences. Their mind becomes riddled over time with paranoid assumptions about their environment and their loved ones. Eventually, the hallucinations they experience slowly envelop their whole view of the world and their connection to reality is severed. This terrible fate is reflected in the nearly 1% of the population who develop schizophrenia during their lifetime; amounting to 2.4 million people in the United States alone. Schizophrenia is a disease characterized behaviorally by flat affect – a lack of response to emotional stimuli – and a mixture of cognitive impairment and emotional unawareness. As the disease progresses, Schizophrenia's plethora of ailments often rip people from their jobs, families, and homes, leaving them with little way of overcoming their various delusions in order to get back on their feet.

The history of pharmacological treatment for schizophrenia is long and chaotic. Since the initial development of first-generation antipsychotic medication in the 1950s, the theories and approaches toward treatment have shifted with each decade. The first antipsychotic was synthesized in 1951 when a strong antihistamine, Promethazine, was manipulated to enhance its sedative effects. This new drug, Chlorpromazine, was a powerful discovery at the time because it was effective in reducing many of the positive symptoms of schizophrenia. In the context of symptoms, the term positive encompasses abnormal behaviors or subjective experiences that do not occur in the general population. These include hallucinations, delusions, and generally bizarre behavior. Symptoms that are negative, on the other hand, reflect the loss of normal behaviors, such as emotional expression and social engagement. Negative symptoms are tougher to treat, as they tend to be more persistent than positive symptoms and often cannot be directly altered by medication alone. However, the positive symptoms of schizophrenia have indeed been shown to yield at least somewhat to first generation "typical" antipsychotics like Chlorpromazine, commonly called neuroleptics.

Discovery of neuroleptics lead to what is known as the Dopamine Hypothesis of schizophrenia. This hypothesis is grounded in the idea that excess dopaminergic activity in certain synaptic pathways in the brain is the root cause of psychotic tendencies of schizophrenic patients. The preface to this theory included the discovery that the side effects of neuroleptics, called extrapyramidal symptoms - slow movement, muscle spasms, and eventually jerking movements of the body - are the symptoms of Parkinson's disease. Parkinson's disease is characterized by a reduction of dopamine in several areas of the brain. The treatment for Parkinson's in the 1960s, around the time of the surge in use of neuroleptics, was the administration of L-DOPA, a chemical precursor to dopamine. This treatment reduced extrapyramidal symptoms, but sometimes increased psychotic symptoms in Parkinson's patients. Therefore, L-DOPA and Chlorpromazine were seen as mirror treatment methods - each one treated the side effects of the other, so as a result Chlorpromazine was correctly inferred to block dopamine from activating its corresponding D2 receptor in the brain. The logic follows that, if neuroleptics block dopamine and also reduce psychotic symptoms, then psychotic symptoms must be related to excessive dopaminergic activity in the brain. This major discovery was patented by Jaques von Rossum in 1966.

However, Rossum's theory was not maintained for long, because by 1972 the first second-generation "atypical" antipsychotic was introduced in the European market. Pharmacologists named this medicine Clozapine. Clozapine was different from the neuroleptics of the past because it did not produce dramatic extrapyramidal symptoms. Furthermore, it revealed the possibility of pharmacologically treating negative symptoms as well as positive ones. In 1948, as a result of the Wisconsin Card Sorting Task, executive function, or voluntary control of behavior, was localized generally to the frontal cortex. Because executive control includes the negative symptoms present in schizophrenia, this provided insight into a new theory of psychosis that took into account the reduction of negative symptoms. This theory was a renovated version of the Dopamine Hypothesis, because it connected the ideas of excess dopaminergic activity in the ventral striatum (where Parkinson's dopamine abnormalities lie) producing positive symptoms with the new idea that an underutilization of dopamine in the frontal cortex produces negative symptoms. The connection was groundbreaking because it provided answers to questions that rattled the brains of neuroscientists who studied schizophrenia under a dopamine model for years.

However, Clozapine and its atypical cousins produce numerous severe side effects in patients, including weight gain and an increased risk of cardiovascular problems later on in life. Regardless, drug companies drove these medications into the public eye due to their novelty and low cost. Implementation of atypicals into regular treatment methods for schizophren ics was therefore imperfect, but nevertheless important. Still used today, neuroleptics like Chlorpromazine and atypicals like Clozapine

help to relieve some symptoms for schizophrenic patients. Additional efforts to expand our understanding of why atypicals tend to be more successful for patients than neuroleptics lead a team of researchers to discover that atypical antipsychotics are more selective than neuroleptics at blocking the 5-HT_2 receptor in the brain. Yet, because both are established through analysis of the activity of a single neurotransmitter (based on the monoamine model), their effects are restricted to the manipulation of the effects of dopamine itself. Monoamine models cannot account for many of the cascade effects seen in many mental illnesses, and subsequently overtime researchers deemed the Dopamine Hypothesis as insufficient for comprehensive treatment of schizophrenia.

Modern pharmaceutical research focuses on, in addition to the monoamine model, the analysis of excitatory glutamate neurons and inhibitory GABA neurons. This line of research began after comparisons were made between psychotic patients and individuals who had taken the street drug Phencyclidine (PCP) or the related dissociative drug Ketamine. These individuals expressed psychotic symptoms that were nearly indistinguishable from the symptoms of individuals with schizophrenia. This lead doctors to generate the NMDA Hypofunction Hypothesis of schizophrenia, which now forms the basis of much modern research. Rather than looking at dopamine directly, this hypothesis focuses on how abnormalities in NMDA receptors on GABA interneurons and the resulting faulty cascade may lead to the excessive and weakened dopaminergic effects we see in the various parts of the brain for schizophrenic patients. This research is compelling but comparatively new, and while the turnout of new pharmacological treatments has been limited, d-serine, an NMDA receptor activity enhancer, is one example of a potential mitigator of the side effects of antipsychotics, with the exception of Clozapine.

Regardless, psychiatrists continue to use antipsychotics today despite the fact that they are akin to tranquilizers and indeed have a variety of unpleasant and often unlivable side effects. Primarily for this reason, but also due to the irregular nature of the disorder itself, schizophrenic patients often drop out of treatment before it has taken hold and the patient finds relief. However, there have been numerous impressive discoveries in our understanding of schizophrenia and its accompanying negative and positive symptoms in the past year. Largely driven by technological advances in genetic research in the past 40 years, our ability to establish novel insights into schizophrenia and its effects on the brain and body have vastly increased.

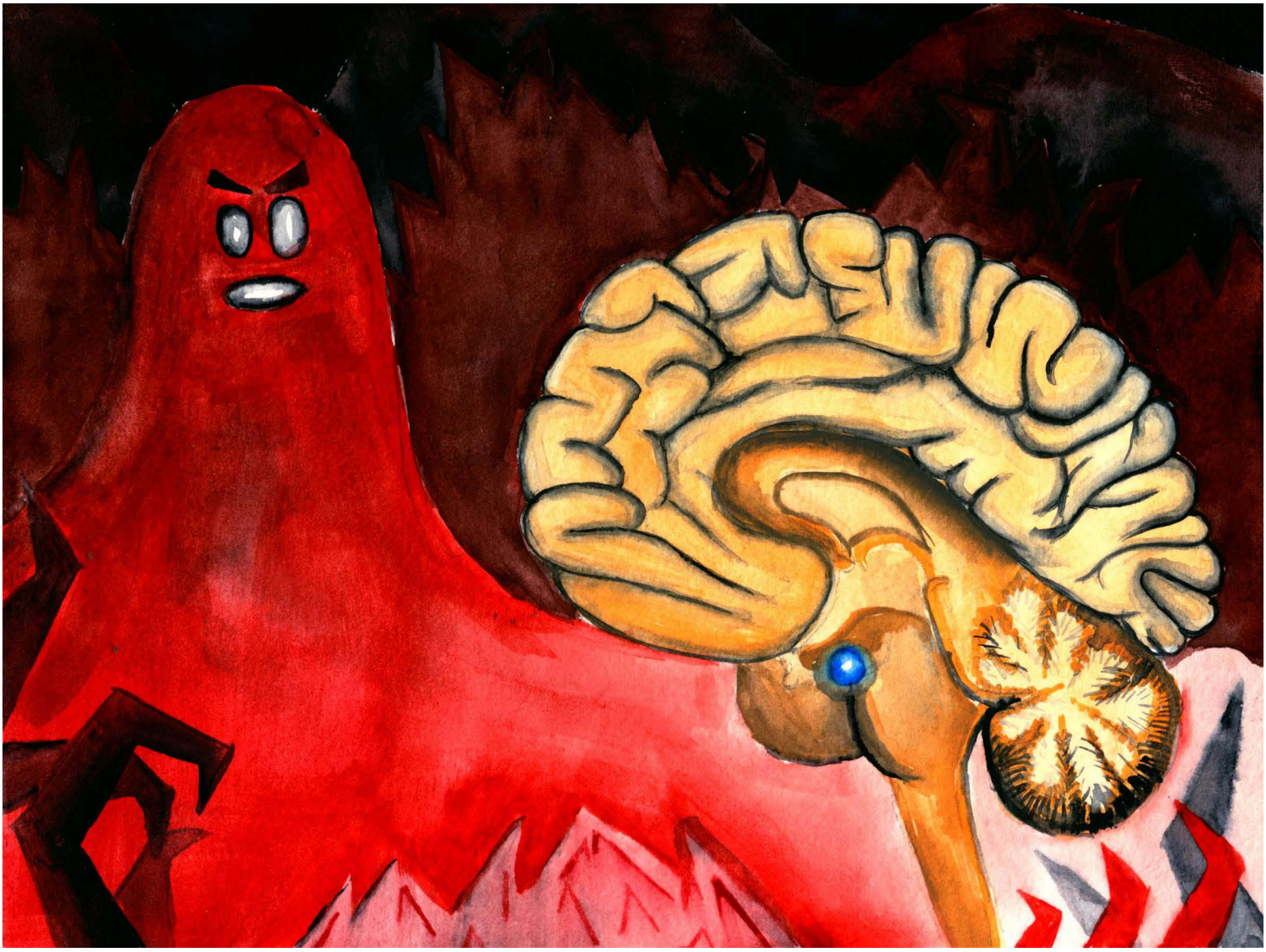
Specifically, advances in gene detection and manipulation have lead us to the discoveries of individual genes that may be at least partially responsible for the symptoms of schizophrenia. A prominent example of gene manipulation is a technique called gene splicing. This methodology is used in research to "cut and paste" gene sequences into different research animals in order to test the functions of the sequences under various circumstances. Gene splicing has been used in a wide variety of fields since its inception in 1977 by Louise Chow and colleagues at Cold Spring Harbor Laboratory in New York. The technique has widely broadened scientists' scope of tools to investigate the world and has only become more precise as time has passed. Furthermore, technological advances such as the ability to manipulate CRISPR or CRISPR-associated proteins (Cas proteins), natural RNA splicers which target specific associated genes, have streamlined the process and essentially triggered a new era of biological research.

One example of a discovery produced by gene splicing is the linking of the C4 gene to the cascade of effects normally produced in the brains of schizophrenic individuals. Therefore, it is an elevation of the C4 gene that increases likelihood of individuals developing schizophrenia, which provides one possible means of preventing the disease before it is expressed. Steven McCarroll and his team at Harvard Medical School observed these phenomena in 2015. This is particularly important because it gives us information on how to treat the genetic origin of schizophrenia. Furthermore, Makoto Tamura and his colleagues at Columbia University also used gene splicing in 2015 to link the gsk3 gene to the reduction or reversal of memory loss in mice. Because memory loss is one primary symptom of schizophrenia, this provides us with better insight into how to treat symptoms of the disease; perhaps by encouraging expression of the gsk3 gene in humans. These two discoveries provide greater insight into the etiological nature of schizophrenia, which is useful in developing more precise and comprehensive treatment methods moving forward.

Psychiatrists continue to use antipsychotics today despite the fact that they are akin to tranquilizers and indeed have a variety of unpleasant and often unlivable side effects.

Additionally, these techniques are partially responsible for a paradigm shift in psychiatric treatment, where the classification of disorders based on symptoms recorded in the Diagnostic Statistical Manual (DSM) is being replaced by classification of disorders by genetic origin. In the past, comparing schizophrenia symptoms to the symptom sets of other illnesses and mental states - such as Parkinson's disease and people who have taken PCP - and then making deductions based on their relative similarity concerning which medicines might relieve symptoms was, as one would expect, successful on a very basic level. This model did not allow for a treatment method outside of the limitations of symptomatic diagnosis. Many of the lists of symptoms in the DSM are not exhaustive and while it is reexamined every few years, it often displays information that is not up to date; this leads to psychiatrists with varying degrees of awareness on what behaviors they should be looking for to make a diagnosis. Accordingly, with the rise of new technological methods, studies on the genetic etiology of mental illness have been the main focus of most research institutions. This has led to the development of a more precise and accurate classification system which can reduce the subjective biases involved in psychiatric diagnosis as it exists today.

Therefore, by providing insight into the genetic underpinnings of mental illness, these technologies have allowed us to tie physics, neuroscience, and psychology together to work towards new treatments to alleviate the crushing effects of diseases such as schizophrenia. Additionally, while schizophrenia is just one mental illness, discoveries therein may be able to overlap with other mental illnesses that share similar characteristics. Through constant assessment of both the outcomes and origins of any mental disease, those in the neurological and psychological fields can work to find new solutions for patients who today still face extremely difficult obstacles to leading a healthy life. As technology advances, these fields will continue to advance, producing diverse and effective solutions for those problems plaguing the human mind today.



No Amygdala, No Worries

By Ilana Ascher

Artwork By Mikaila Hoffman

Jamie is walking down the street late at night, when he notices a figure moving toward him from a side road. His heart immediately starts pounding and he picks up the pace, making it home in half the time it would normally take. This response to a possibly dangerous situation can be attributed to an almond-shaped region of the brain called the amygdala. The amygdala is responsible for processing external cues of fear, including the ability to recognize fear when it is present on others' faces.

Now picture another person walking in the park late at night. It isn't long before she gets accosted by a man, who jumps out at her from the shadows. The man demands money and is baffled when the woman looks him straight in the eyes, says no, and keeps on walking. The assailant, shocked and confused, walks away. This may sound like extreme bravery or stupidity, but for the fewer than 300 people who have been diagnosed with Urbach-Wiethe disease, this reaction is a reality. This rare disorder causes the amygdala to harden, rendering it useless.

The most well-known case of such brain damage is that of a patient called SM, referred to by her initials for her privacy. In order to further investigate the claim that amygdala damage causes altered fear responses, a team of researchers, supported with NIH grants, ran a series of experiments in which they exposed SM to exotic animals, haunted houses, and horror films. No matter what was tried, the experimenters could not induce a fear response in SM. Though she originally claimed to hate both snakes and spiders--the subjects of the two most common phobias-- upon being brought to an exotic pet store, she displayed immense curiosity about the animals. She had to be told a total of 15 times not to touch the larger and potentially dangerous snake. This display of overt curiosity is similar to behavior found in monkeys with Kluever-Bucy syndrome, bilateral lesions on the amygdala. Even after being attacked by a snake, these monkeys would curiously and casually approach it again. Many

people and primates alike would avoid such stimuli, due to the amygdala and its role in processing external cues and producing fear responses based on the cues that manifest from dangerous situations. Furthermore, if SM witnessed someone looking clearly frightened, she would not be able to process this facial expression, since the amygdala is responsible for recognizing fearful faces (Adolphs 2008). The amygdala however is not the only portion of the brain involved in processing fear. This was discovered when SM and other patients were exposed to increased levels of CO2.

When SM was exposed to a 35% increase in CO2, thus causing "air hunger," a feeling of suffocation, she immediately panicked, describing a fearful response. This information supports the idea that the amygdala is not the only portion of the brain engaged in fear responses. In the moments leading up to the experiment, SM experienced no fear, as expected, but as soon as she took a breath of the CO2, she panicked and tried to tear the mask off her face. This response is not typical of patients with intact amygdales, many of whom feel nervous coming into the experiment, but do not panic so intensely upon breathing in the CO2. These findings indicate two interesting, non mutually-exclusive, possibilities in the realm of fear response. The obvious indication is that panic induced by internal threats originates from somewhere outside of the amygdala, possibly in the brain stem. The second possibility is that loss of amygdala function may lead to the development of panic disorder.

The amygdala is a necessary and adaptive aspect of the human brain. Though it may sound relaxing or convenient to experience a lack of fear, panic responses that arise from dangerous stimuli can save a person's life. When Jamie's amygdala picks up a threatening external cue, he books it home, leaving a shadowy figure behind. This figure, a man with a switchblade, is forced to leave Jamie alone and make his way to the park. This is where he begins to stalk his next victim, a woman known as SM, who is walking confidently down the dimly lit path.

"The obvious indication is that panic induced by internal threats originates from somewhere outside of the amygdala, possibly in the brain stem. The second possibility is that loss of amygdala function may lead to the development of panic disorder."

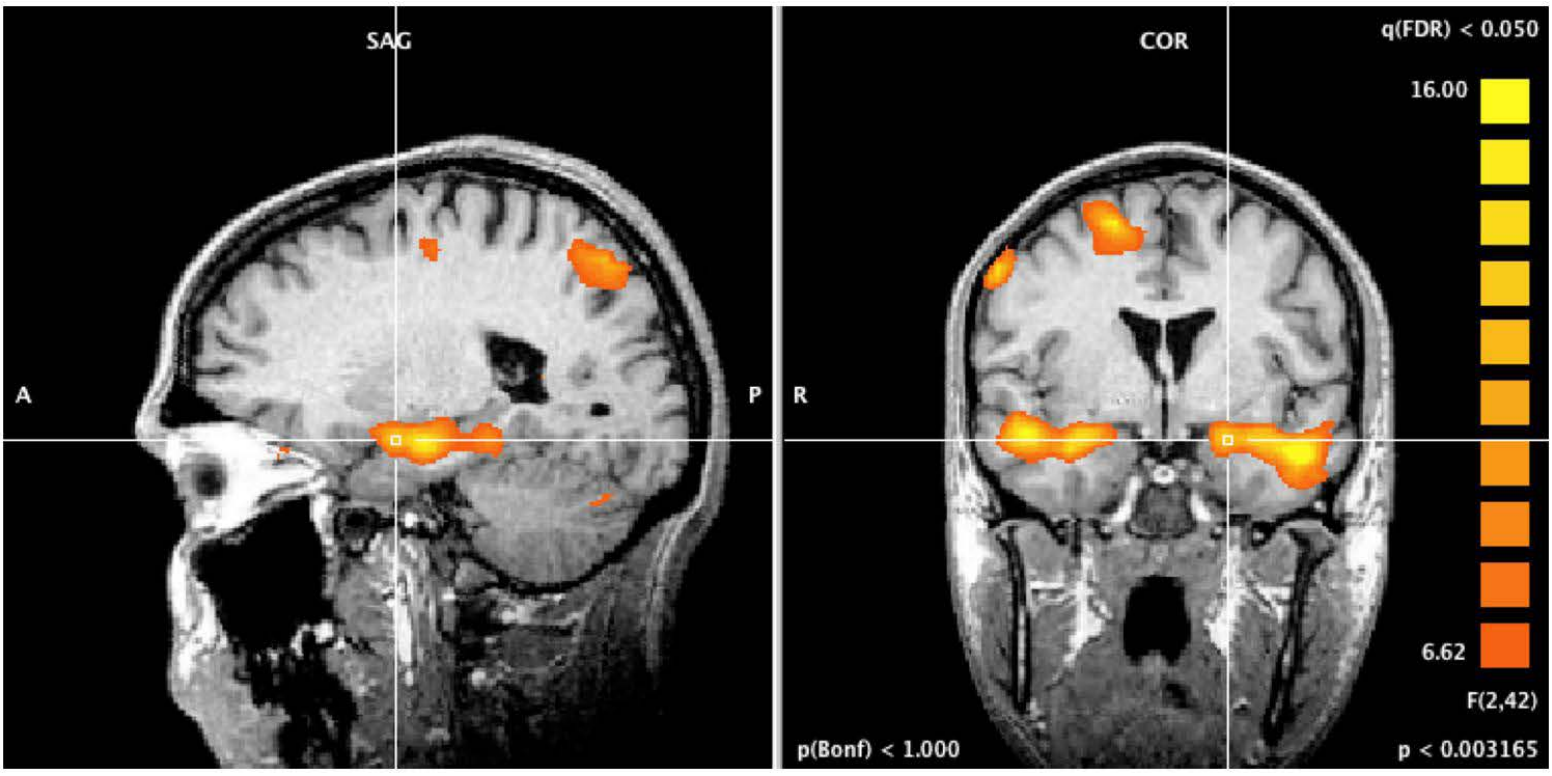


Image courtesy of

Sanchez TA, Mocaiber I, Erthal FS, Joffily M, Volchan E, Pereira MG, de Araujo DB and Oliveira L (2015) *Amygdala responses to unpleasant pictures are influenced by task demands and positive affect trait*. Front. Hum. Neurosci. 9:107.

A Crash Course in Migraines

By Joy Udoh
Artwork by Beatrix Parola

Watching my mom cringe in pain and place her hand to her head always confused me as a child. I would frown in worry and ask her what the problem was, and she would mutter that she had a bad headache. Never experiencing the sensation myself, I wasn't sure how painful it could possibly be and would ask her to describe it despite the fact it was most likely a struggle to respond. She would shake her head and answer, 'You wouldn't know till it happens to you'.

Years later, my eyes tightly shut as I rub my temples and silently beg for the excruciating pain to stop, I can't help but think about how right she was that day. However, where she was simply suffering from a bad headache, I have had to deal with a much bigger beast: migraines. Although my mother couldn't describe how she felt, dealing with migraines for years and experiencing the pain has made it easier to articulate the sensation not only to myself but to my parents and doctor who do not suffer from it. During the early stages before my diagnosis, I thought they were simply terrible headaches. However, the debilitating nature of the pain and how it prevented me from being able to do anything alerted me to the fact that I was dealing with something much more than that.

Migraines differ in every individual from its symptoms, to its intensity, to the duration of time that it lasts. Therefore, I can only write in specifics based on my personal experiences with it. However, due to extensive research that is being done on this condition, there is a plethora of general information that covers the many symptoms that are associated with it as well as the different ways it manifests in individuals. With this article, I would like to share the basic information about this illness, ways it can be managed as well as the current research being carried out in the Neuroscience field.

According to the Migraine Research Foundation, a migraine is an extremely debilitating collection of neurological symptoms that usually includes a severe recurring intense throbbing pain that occurs on one side of the head but can be felt on both sides depending on the intensity of the attack. They can cause significant pain for hours and usually drive patients who suffer from it to find a quiet and dark place to lie down. Sometimes, migraines are preceded by auras, which are sensory warning symptoms that warn an individual that a migraine is coming. Not many individuals have auras that precede their migraines, and some of the individuals that do experience them may not identify them as such. During my diagnosis process, I had described the periods where my vision would blur before the pain would hit to my doctor. Through this, he was able to diagnose my migraines as one that is preceded by an aura. Auras can come in the form of blind spots, shimmering sets or stars, flashes of light, muscle weakness, and much more. In my case, they are blindspots. They usually occur an hour before the pain begins and last for less than that. Despite the fact they aren't completely understood, staff at the Mayo Clinic believe that they are electrical or chemical waves that move across the part of the brain that processes visual signals. As the wave spreads, it may cause these visual hallucinations and, in turn, serve as an informant about the impending arrival of its counterpart.

Dealing with migraines, especially as a college student, is a nightmare. It prevents me from concentrating, getting work done and even communicating well with others. As a result, it is important to learn as much as possible about how it manifests personally. Apart from prescribed medication, certain lifestyle changes have to take place to help keep migraines at bay and to maintain a healthy mind and body. One of the most important aspects of this is identifying and avoiding triggers.

> Migraines differ in every individual from its symptoms, to its intensity, to the duration of time that it lasts.

Triggers occur in most people who experience migraines. However, there are cases where there are no triggers at all. The common triggers that most people have are certain foods, stress, strong scents, loud music, intense sunlight, bright screens, the amount of sleep an individual gets, and many more. It differs in every individual, but the most important thing is identifying them through observation and patience so that they can be avoided. One of the trickiest triggers to manage is stress. As proven by psychologists, stress is a phenomenon that people constantly experience during the day. Classes, deadlines, and impending tests all contribute to it. It is one of the main keys for survival and thinking quickly, but too much of it can be detrimental to a person's health. This point applies to migraines as well; according to The Migraine Trust, if a migraine-prone individual experiences too much stress, it could amplify the severity of the pain as well as the frequency with which the migraines occur. This is something I can attest to. During busier days in my week where I have upcoming deadlines and tasks with which I have to make sure I keep up, the pressure feels considerably higher. The most important things I have learned on days like these are to stay as level headed as possible and not to over-exert myself because if I begin to feel stressed out and to overwork myself, it would only backfire and trigger a migraine, which would prevent me from doing any work at all.

Additionally, good sleeping habits are also very important in preventing migraines. Research has shown that poor sleep can be associated with more frequent and severe migraines, which makes it important to create a stable sleep pattern with the appropriate hours of rest. It should be noted that too much sleep can trigger migraines as well, so a balance has to be created. Finally, eating habits have a strong effect on people who suffer from migraines; notwithstanding the fact that certain foods can be migraine triggers for different sufferers. People who skip meals risk developing a headache, but migraine sufferers are even more sensitive to the effect of lack of food. Small healthy snacks, especially on busy days where getting a proper meal may be a challenge, just might be the thing that keeps the attack at bay.

Currently, there is no cure for this condition. However, researchers are working tirelessly to demystify migraines, and eventually to discover a cure for it. Discoveries leading to this are continuously being made in the field of neuroscience. According to various studies, migraines may have long-lasting effects on the brain's structure. This includes the raised risk of brain lesions, white matter abnormalities which can be seen in Figure 1, as well as altered brain volume compared to people without the disorder. However, the manner of these changes is yet to be explained by scientists.

Based on research at the University of Pennsylvania School of Medicine, a new study reports that 'the network of arteries supplying blood flow to the brain is more likely to be incomplete in people who suffer migraine. The variations in arterial anatomy lead to asymmetries in cerebral blood flow that might contribute to the process triggering migraines.' In other words, the structure of blood vessels in people who suffer from migraines are different from people who don't suffer from it. This anomaly may contribute to the process that triggers migraines. Figure 2B represents the blood vessel structure of an individual who does not suffer from migraines, while Figure 2C represents the blood vessel structure of an individual who suffers from it.

Furthermore, scientists at the University of California- San Francisco have identified a genetic mutation that is strongly associated with a typical form of migraine. Scientific leaps such as these have been made throughout the years and are paving the way to discovering the mechanism of this condition and, hopefully, a cure for it.

Although migraines still remain elusive to the world of science, people like me that suffer from this condition have to manage it as well as we possibly can to be able to achieve the things we wish to on a daily basis. They are unpredictable and uncontrollable most of the time. According to the Migraine Research Foundation, they are much more aggressive during a person's peak years and even more frequent in women, which are two categories I fall within. You may not suffer from this condition, but one in four households in the United States includes someone with a migraine. When they are paralyzed by agony that you can't seem to understand, remaining as silent as possible would be the strongest way of expressing your understanding and support. The pain itself is indescribable, but even if I was able to put it into words, you wouldn't know till it happens to you.

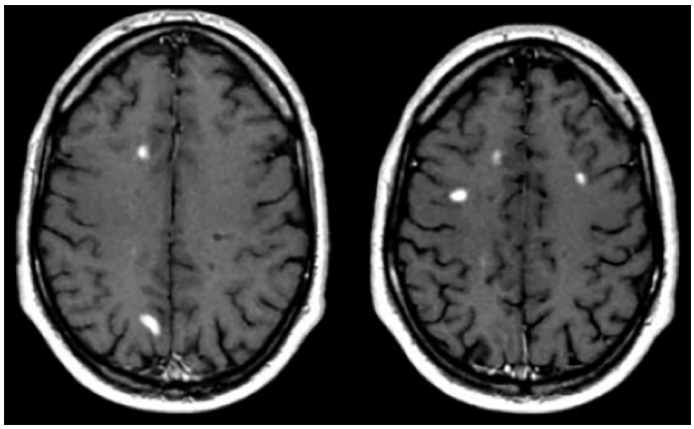


Figure 1

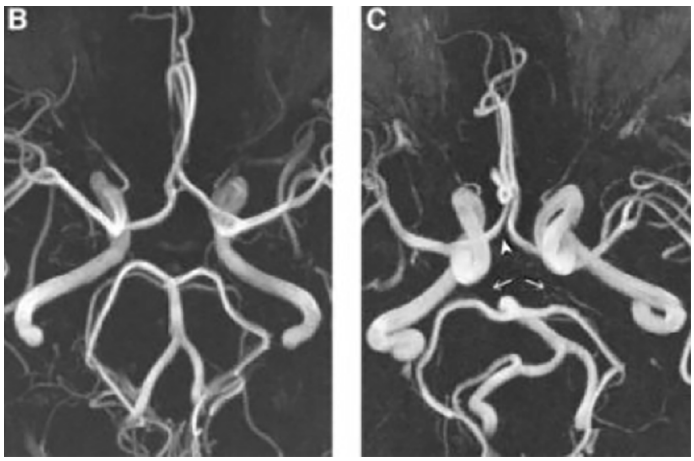


Figure 2

Vitamin MisconCeption

Mythbusting the Link between Vitamin C and the Common Cold

By Alyssa Altheimer
Artwork by Chloe Deshusses

Imagine your throat is ticklish and your nose is starting to run. If you're like most people, you'll reach for a vitamin C supplement. After all, vitamin C is supposed to stop a cold in its tracks, right?

The common belief that vitamin C prevents colds is in large part tied to Linus Pauling. In 1970, Pauling published Vitamin C and the Common Cold, in which he argued that the common cold could be eradicated in the United States "within a few years" if everyone took 3,000 milligrams of vitamin C every day. Partly because Pauling was a two-time Nobel Prize winner, the public listened. His book quickly became a bestseller and vitamin C sales skyrocketed. By 1975, 50 million Americans were following Pauling's regimen. Today, 67% of Americans still believe that vitamin C alleviates cold symptoms, according to a study by Braum et al.

Based on scientific knowledge, it seems plausible that vitamin C supplements improve immune function. Like every vitamin, vitamin C, or ascorbic acid, is involved in the immune response. Specifically, vitamin C stimulates the production of various immune cells, including neutrophils, lymphocytes, and phagocytes. However, according to the University of Florida's Susan Percival, Ph.D., "Whether these immune system changes translate into less illness is the million dollar question."

There are two ways to evaluate this "million dollar question": is it effective when taken year-round, and is it effective when taken at the onset of a cold?

First, let's evaluate vitamin C's effect on colds when taken year-round. A meta-analysis published by the Journal of the American Academy of Nurse Practitioners found that, when taken year-round, vitamin C is not effective at reducing the frequency or severity of the common cold, but may reduce its duration. Another study by a Cochrane review compiled 24 experiments consisting of 11,000 adults and found that taking 1,000 mg of vitamin C reduced the duration of colds by 8%. In other words, taking daily megadoses of vitamin C year-round will reduce a week-long cold by about 12 hours. As Percival summarized, "Large amounts of vitamin C do not prevent colds, but they can shorten the duration if they're taken every day before getting one."

However, some groups under extreme conditions may develop fewer colds when taking megadoses of vitamin C year-round: people living in sub-arctic winter conditions and frequent marathon runners, for example. But, as the Australian National University in Canberra's Bob Douglas wrote, "Vitamin C does absolutely nothing to prevent colds in most people."

Next, let's evaluate vitamin C's effect when taken at the first sign of cold symptoms. In a review of seven experiments that evaluated vitamin C's effectiveness when taken at the onset of cold, only one found a decrease in cold duration. The patients in that study took a massive eight grams of vitamin C — generally, even two grams of vitamin C is enough to cause a range of undesirable symptoms, including diarrhea. In the other six experiments, no statistically significant decrease in cold duration was found. The severity of cold symptoms was unaffected in all seven studies.

Generally, even two grams of vitamin C is enough to cause a range of undesirable symptoms, including diarrhea.

Vitamin C's potential to reduce the duration, frequency, or severity of a cold is bleak. But many vitamin C supplements advertise themselves as cold medicines. How is this questionably false advertising allowed? A decision made by the FDA is to blame. In 2000, the FDA stated that vitamin companies can claim that vitamin C "supports," "maintains," and "enhances immunity," even without meaningful evidence because those statements don't allege to "prevent or lessen disease." Until the FDA changes its guidelines, vitamin companies can continue to claim that vitamin C enhances the immune system and therefore is beneficial to take when ill, despite research supporting this statement.

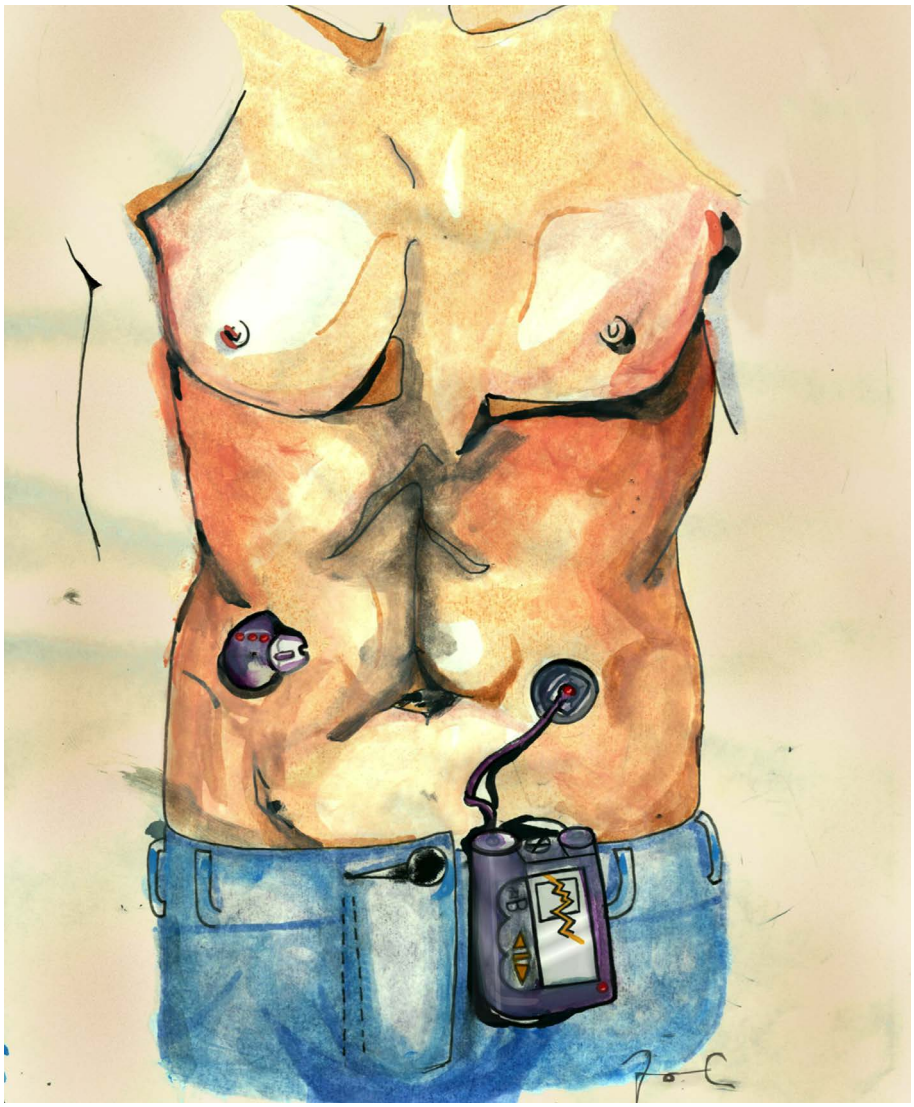
Are there scientifically-proven ways of reducing the frequency of colds? Yes, and you've heard it all before. First of all, hand washing is "one of the most important steps we can take to avoid getting sick," according to the CDC. Second, in a study by Cohen et al, people who slept less than seven hours a night were 300% more likely to catch a cold than people who slept more than eight hours a night. Lastly, in another study by Cohen et al, people who faced long term stressors — marital, friend, or work problems for at least three months — were 300% more likely to develop a cold after exposure to a cold virus. Washing hands, getting as much sleep as possible, and reducing stressors have tangible effects on illness. Unfortunately, there is no known magical cold fix.

So when you feel a tickle in your throat or have a runny nose, don't reach for vitamin C. And unless you run hundreds of miles a year or live in Antarctica, taking vitamin C year-round won't do much other than slightly reducing the length of your cold. If you want to prevent colds, wash your hands, get enough sleep, and try to minimize long-term stressors. Your immune system will thank you.

A Brief History of Diabetes

From Antiquity to the Renaissance

By Gabriel Hitchcock
Artwork by Zoe Cohen



A disease that produces excessive thirst, continuous urination, and dramatic weight loss has fascinated and baffled the medical community for three millennia. Unfortunately, as has been the case for many conditions before the turn of the twentieth century, the prognosis for a patient with these symptoms had been mercilessly consistent: terminal. This is because the cases described by these pioneers of medicine were of what we now know as type 1 diabetes mellitus, which is a product of the inability of the pancreas to produce enough insulin. Only through modern medicine have we been able to combat this long-standing scourge of mankind.

Antiquity

In the beginning there was the word, and the word was conveyed through a lexicon formed of logographic and alphabetic elements known as *Hieratic*, inscribed on papyrus, stuffed in a urn, and sealed in a tomb for over three thousand years. Then, in 1874, this manuscript of Egyptian medicine was discovered and subsequently bought and edited by a German egyptologist. It is after this egyptologist, George Ebers, and the material upon which the word was inscribed that this 1550 BC manuscript became known: the Ebers Papyrus. But what is the word to which I refer? It detials the first recorded case of diabetes, and the word was "bladder." Well, "too much emptying of the bladder," to be precise. For this ailment the ancient Egyptian physicians prescribed a regimen of wheat grains, fruit, and beer.

The next mention of a case of diabetes comes to us from around the same period from physicians in India, where they had developed what can be described as the first empirical test for diabetes. These physicians observed that the urine of people with diabetes attracted flies and ants. As such, they christened the disorder *madhumeha* or "honey urine." Yet it was beyond the capabilities of these early people to differentiate between diabetes and other disorders that produced polyuria, or the production of large volumes of dilute urine.

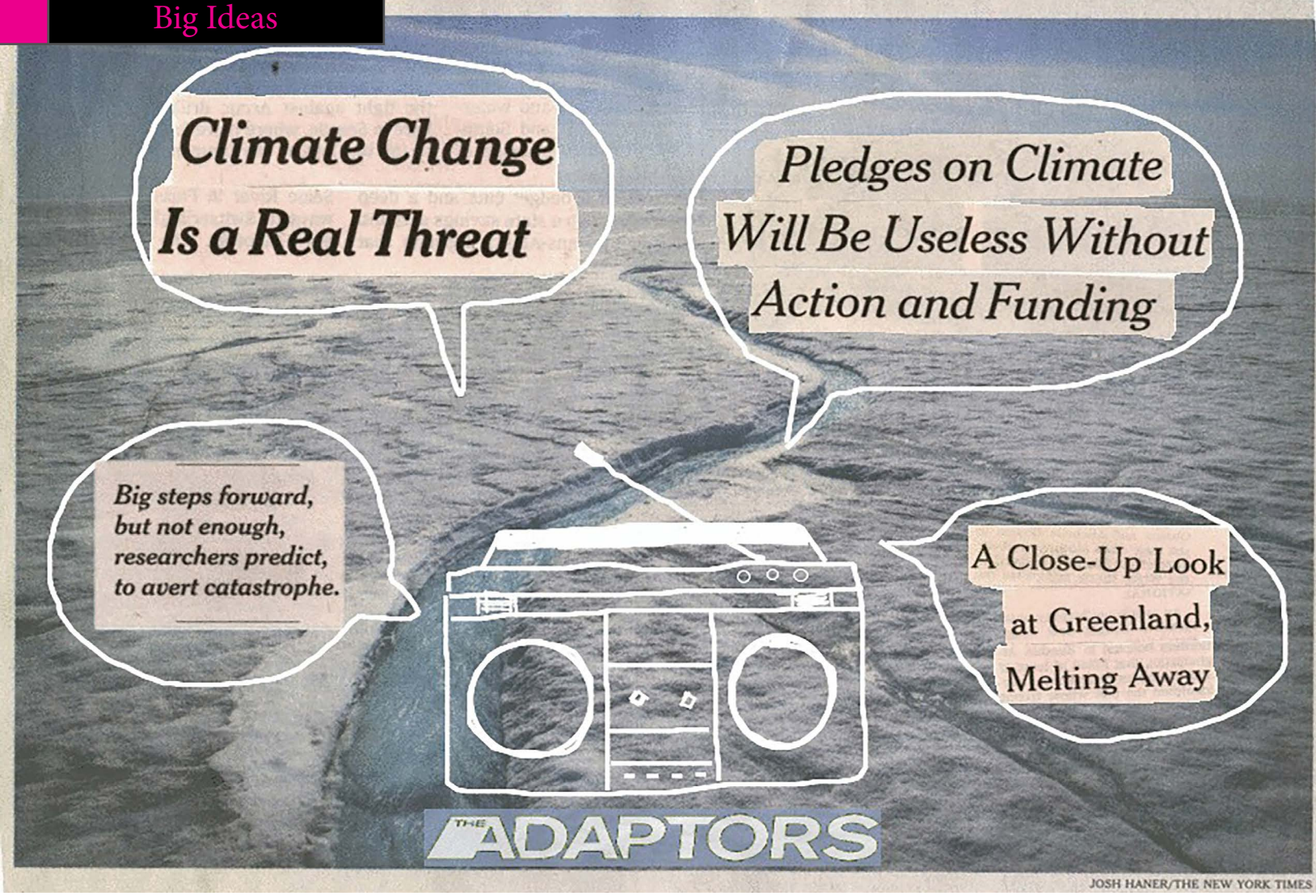
It was not until 230 BC when the Greek physician, Apollonius of Memphis described the the condition and coined the term "diabetes," which in Greek means "to pass through." Later, in the second century AD another Greek physician, Aretaeus of Cappadocia, was the first to distinguish between what we now call diabetes mellitus and diabetes insipidus. He described it as a "dreadful affliction . . . being a melting down of the flesh and limbs into urine. The never stop making water and the flow is incessant, like the flow of the aqueducts."

Renaissance and After

The beginning of modern understanding of diabetes began in Europe between the sixteenth and eighteenth century. The Swiss physician, Aureolus Theophrastus Bombastus von Hohenheim, better known as Paracelsus (1494-1541), unintentionally left a beaker of a diabetic patient's urine in his lab over night. In the morning, Paracelsus noted that a white, crystalline residue had been left behind by the evaporate urine. He incorrectly deduced that it was salt and thereby attributed the symptoms of excessive thirst to and urination to salt deposition in the kidneys.

The basis of the modern understanding of diabetes was formed in Europe between the sixteenth and eighteenth century. It began when a Swiss physician, Aureolus Theophrastus Bombastus von Hohenheim, better known as Paracelsus (1494-1541), unintentionally left a beaker of a diabetic patient's urine in his laboratory over night. In the morning, Paracelsus noted that a white, crystalline residue had been left behind by the evaporated urine. He incorrectly deduced that it was salt, thereby attributing the symptoms of excessive thirst to and urination to salt deposition in the kidneys.

Despite Paracelsus' discovery, it was not until 1670 when an especially inquisitive scientist, one Thomas Willis, discovered that the urine of diabetics had a distinctly sweet taste. Yet, it was another one hundred years before the white residue was linked with the sweet taste. In 1776, British physiologist Mattew Dobson (1713-1784) demonstrated in his Experiments and Observations on the Urine in Diabetics that the substance was in fact sugar. In so doing, Dobson discovered the condition hyperglycemia -- an excess of glucose in the blood stream.



Climate Change in the Media

Adapting to a Skeptical Audience

By Brooke Ortel
Artwork by Caroline Edwards

Despite what some politicians might tell you, the reality of climate change is not up for debate, at least not in the scientific community. In the Arctic and other vulnerable regions, the impacts of climate change are already a reality, transforming ecosystems and ways of life. In light of experienced changes, empirical evidence, and projections based on sophisticated modeling, how can policymakers and U.S. citizens continue to argue about whether climate change exists?

Many environmentalists optimistically approach this formidable opposition from an education-oriented perspective. If people are presented with the facts, they will understand that climate change is, indeed, a reality and is directly related to anthropogenic carbon emissions. Once they have the necessary information at their fingertips, then presumably people will comprehend the call to action. But this seems most probable for people who have not already formed hardened stances on the challenge of climate change. An educational approach may be a useful strategy in capturing the attention of school-age children, but what about the rest of the population—the adults who have already made up their minds? Creative entrepreneurs and environmentalists have used various technological forums to launch innovative campaigns to encourage the public to be informed and engaged. But who are they reaching?

In a recent article in Science titled "If a tree falls…," Gregory Goldsmith reviews a podcast series titled The Adaptors, which highlights inventive responses to climate change. In his review, Goldsmith raises crucial questions about audience, pointing out that while the podcast is engaging and informative, it is "hard not to wonder who exactly is tuning in to hear about climate change on a regular basis." He notes people with strong political ties to a particular side of an issue are more likely to seek out information that augments their position. They are unlikely to look for information that challenges their perspectives, or even to search for unbiased sources. Given this documented psychological phenomenon, how can platforms like The Adaptors reach a larger audience, extending their influence beyond those who already believe climate change is a serious problem? Goldsmith concludes that "resources for science

engagement are limited" and keeping that in mind, educators must think critically about how to engage a broader demographic.

> People with strong political ties to a particular side of an issue are more likely to seek out information that augments their position.

The basic premise of The Adaptors approach is that "climate change is calling" and "the adaptors are responding." Their mission is to make the narratives of these innovative adaptors visible, sharing the stories of people who are actively engaging with the challenges posed by climate change. The stories featured on this podcast series range from farfetched, sci-fi-sounding proposals such as engineering human beings to have cat eyes to more practical solutions such as drinking treated water from flushed toilets. In Goldsmith's opinion, although the show often "weighs in on complex and difficult issues, including the ecological and evolutionary implications of climate change…it is at its best when the topics border on the implausible," as in the case of the engineered cat eyes proposal. The podcast series hooks its audience not only with its commitment to addressing key issues, but also with its potential for entertainment. Goldsmith observes that, at its core, the podcast features human interest stories, conversations with real people who are committed to tackling the challenges presented by climate change.

> A key component of working toward large scale solutions is engaging a greater portion of the population, extending the dialogue on climate change to a more diverse audience.

Although the producers' penchant for the dramatic appeals to listeners, some of their most compelling episodes are more than merely entertaining. One particularly poignant example is titled "Born in the Anthropocene," which features two young reviewers of The Adaptors. These remarkable 11-year-old students wrote about The Adaptors on their climate change-focused blog, Two Green Leaves. The tagline of their blog? "Climate change from the affected generation." Hard hitting, to say the least. Explaining that, "we are aware of what climate change can do to the human race and it certainly isn't good," they state their mission as educating people about climate change and offering suggestions on how individuals can reduce their carbon footprints. In his review of The Adaptors, Charlie writes that it is "nice that other young people are trying to at least spread the word about climate change," referencing host Flora Lichtman. Jeremy and Charlie are a prime audience for The Adaptors, already attuned to the reality of climate change and motivated to act on behalf of the "affected generation" to which they belong.

From an optimist's perspective, if Jeremy and Charlie are faces of the generation burdened with the changes in climate induced by human action, then there is a reason for hope. Perhaps there is a chance that people in affluent consumerist countries like the U.S. that produce the most carbon emissions per capita will rethink their current way of living. Perhaps they will embrace major lifestyle changes in the not so distant future. Perhaps the Paris commitments will inspire the changes on an international scale that are ultimately needed to bring the world's greenhouse emissions into check. Perhaps, perhaps, perhaps …

But meanwhile, it's hard not to wonder, are Jeremy and Charlie outliers among their peers? Their earnest commitment to learning all they can about climate change and sharing their findings is commendable, but is it enough to reach an audience resistant to the very idea of anthropogenic climate change? It's hard to believe that anyone who has come across their blog or their interview on The Adaptors would not be compelled to at least think more seriously about climate change and its implications, but, as with The Adaptors, the people who visit their blog are probably already concerned about climate change. With that in mind, how can Jeremy and Charlie's approach be modified to reach a wider audience, in particular one that includes people who dispute the very existence of climate change?

> If people are presented with the facrs, they will understand that climate change is, indeed, a reality and is directly related to anthropogenic carbon emissions.

Clearly this is a difficult question. On some level, the approaches taken by the Two Green Leaves and The Adaptors are fundamentally ill-suited to reaching an audience unwilling to entertain the notion of anthropogenic climate change. Perhaps it is not so much a question of how their approach can be adapted to reach a wider audience, but more a discussion of how can this audience be reached, period? While Jeremy and Charlie's efforts to educate others are laudable, it's also worth noting that, in order to reach a skeptical audience, other modes and forums for presenting information must be explored. A key component of working toward large scale solutions is engaging a greater portion of the population, extending the dialogue on climate change to a more diverse audience.

Recognizing the limits of their approaches does not invalidate the efforts of Jeremy and Charlie or the producers of The Adaptors, but it does raise serious questions about how to make discussions about climate change engaging and relatable to a wider audience. How can the affected generation reach out to people who remain skeptical and disinterested in a way that encourages them to listen, rather than alienating them?

The Economy of Autonomy

How Will Self-driving Shape Society?

By Nandita Krishna
Artwork by Sydney Bernal

You have had a bit too much to drink at a friend's house, so when you get in the car you decide to plug your address into the GPS and close your eyes. The car knows how to get you home. You are fast asleep on the highway when a deer jumps onto the road. Another driver swerves to avoid it and your car slams into theirs at 60 miles per hour. Who is at fault for the accident?

In a recent incident in Mountain View, California, a Google car in autonomous mode changed lanes to avoid an obstruction in the road and ended up striking the side of a bus. No one was hurt, but it was the first known case of an autonomous vehicle-involved collision where the vehicle itself may have been at fault, rather than its test driver or another driver on the road. Google released a statement admitting that the company bears responsibility and would make changes to the car's programming to prevent similar incidents in the future: "From now on, our cars will more deeply understand that buses (and other large vehicles) are less likely to yield to us than other types of vehicles." The idea that a car can "deeply understand" anything may seem like a sinister anthropomorphism, but it is simply an example of how language, much like the law, struggles to keep up with, understand, and define such technology.

The collision may become a significant obstacle for companies manufacturing self-driving cars, which are already struggling to convince the public and the government that the technology is safe. Before this collision, the only accidents involving autonomous vehicles had occurred when a test driver took control of the wheel or when another driver on the road was at fault. But even those accidents were suspect: autonomous cars actually have a higher collision rate than normal cars, perhaps because human drivers don't expect other vehicles to adhere so precisely to driving laws.

Mistrust of autonomous vehicles is widespread. Many states have already passed legislature to preemptively regulate their usage and to define whether the operator or manufacturer is liable in the case of an accident. Florida, Nevada, and Washington D.C. each require a capable human driver behind the wheel at all times, ready to take control of the vehicle when necessary. Nevada even passed a law - which Google lobbied heavily against - prohibiting the driver of an autonomous vehicle from texting while driving.

But what of the social revolution that was promised? Proponents of autonomous vehicles have highlighted their potential as a transportation system for the elderly, the disabled, and the drunk.

Around 70% of seniors currently live in rural areas or suburbs where it can be impossible to get to a doctor without access to a car. Currently, there are many volunteer programs for driving senior citizens to medical appointments, and ride-sharing programs like Uber have lowered the cost of taxi services. However, in low-density areas where volunteers and Uber drivers are scarce, driverless cars could be a radical solution in terms of safety and medical care for those who cannot drive themselves. But the new laws being passed suggest that "autonomous" and "driverless" are not equivalent. These public health issues will not be addressed by cars that require a "capable driver" behind the wheel.

> A key component of working toward large scale solutions is engaging a greater portion of the population, extending the dialogue on climate change to a more diverse audience.

Proponents of autonomous cars also claim that more benefits will arise when autonomous cars become the majority on the roads. Cars programmed to travel in tightly knit flocks will theoretically be able to reduce congestion and, therefore, energy emissions. Additionally, collision rates could decline as people grow accustomed to driving alongside robots. However, critics argue that once people are free to multitask while driving, they will be more inclined to live far away from their workplaces and commute times may rise, increasing overall traffic and emissions. This problem could be offset if autonomous vehicles were a public resource similar to a taxi service rather than privately owned commodities, but given their market appeal that situation is unlikely.

Will autonomous vehicles empower those who are currently disadvantaged by our transportation infrastructure, or will they become another Silicon Valley product that addresses only the needs of the privileged few? They have been promoted with promises of greater widespread health and safety, but many of these promises seem to have been derived as justification—rather than used as motivation—for their development. While the legal battles rage over our right to text behind the wheel, it remains to be seen whether or not this technology has anything more to offer society.

> "Autonomous cars actually have a higher collision rate than normal cars, perhaps because human drivers don't expect other vehicles to adhere so precisely to driving laws."

THE SCIE

SUPER

PUTTING SCIENTIFIC LOGIC INT

Superheroes are cool again! I, like many comic book nerds, can finally come out of hiding. This newfound freedom is all thanks to Marvel and DC Comics and their onslaught of superhero movies and TV shows, as well as the complex connections that have been woven between them. With the recent record-breaking release of *Deadpool* (my new favorite movie), comic book characters have firmly found their place in pop culture once again. With all the superpowers introduced on the big (and small) screen come plenty of pseudo-scientific explanations for how these powers are possible. As both a comic book and science nerd, I thoroughly enjoy poking holes into the explanations that Marvel and DC give to rationalize their delightfully overactive imaginations. The anti-heroes and heroes we'll be looking at are Deadpool, the Flash, and Batman, so sit back, relax, and read as I put the logic back into a few of your (and my) favorite comic book characters.

DEADPOOL

First on our hit list is the Merc with a Mouth: Deadpool. Deadpool's main power is his healing factor, which allows him to heal things like wounds, cancer, and even regrow entire limbs. This power, along with agility on par with Spiderman's and some degree of super strength, is given to him through a mysterious program that he joins as a last resort for treating his cancer. His story remains fairly constant between the movies and comics except for the identity of the program and the genetic origins of the healing factor. Now here's why that won't work in the real world: cancer.

Supposedly, Deadpool's healing factor is the result of accelerated cell growth, which sped up the growth of his pre-existing tumors. This accelerated tumor growth is what causes his grotesque appearance. Cancer itself is caused by an accumulation of mutations to the genes that control and limit cell growth; these mutations lead to accelerated, uncontrollable cell growth. What the writers of Deadpool neglect is the "uncontrollable" aspect. It can be argued that Deadpool has all the right mutations to cause accelerated, yet controllable, cell growth, which is then employed by the immune system to keep him in tip-top shape. However, if Deadpool's tumors are able to not only persist, but also thrive despite this "right" combination of mutations, then that means that his accelerated cell growth is not all that controllable. If this accelerated cell growth is also uncontrollable, then Wade Wilson shouldn't get superpowers and become Deadpool, he should get even more malignant cancer than before and become dead. Even if the rest of his cells do have controlled growth, the already cancerous cells seem to still maintain their uncontrolled status, meaning his cancer would persist and eventually his tumors would disturb his normal, heightened body operations to the point that it would kill him, like any other cancer patient.

THE FLASH

The Flash is known as the fastest man alive. He is capable of incredible feats, such as vibrating through objects, running faster than the speed of light, traveling through time, and an accelerated metabolism. This all comes from a lightening strike that accelerates his molecules, granting him access to the Speed Force, the source of the powers of all DC speedsters and a subset of the Source which is the source of all DC powers. So what could go wrong with super speed? A lot, according to physicist Randall Munroe in his book *What if?: Serious Scientific Answers to Absurd Hypothetical Questions*. As I've said, the Flash, Barry Allen in particular, is capable of running faster than the speed of light when he needs to. In his book, Munroe considers what happens to an object moving at just 90% the speed of light. Apparently, since Barry would be moving faster than air molecules vibrate, the air molecules wouldn't be able to move out of the way fast enough. The air molecules would hit Barry, according to physicist Hans Rinderknecht, and most of the molecules would go through our favorite speedster. DC accounts for this by claiming that when the Flash runs, an inertia force field forms around him, protecting him from these hostile air molecules. Munroe says that a force field would form, but it would be one of gamma rays and debris, formed from the fusing of the air molecules around the speedster. This field would be traveling slightly faster than the Flash. The constant fusion occurring right in front of him would slow him down, but not by much due to his high speed. The fusions would eat away at Barry, spreading Flash fragments all about. The fragments would cause more fusions. Eventually, Barry would be a speeding mass of fusion-causing plasma. In short, the plasma would expand, swallowing everything around until it caused a nuclear explosion, killing not only the Flash but also an entire city. At this point, it seems like possessing superpowers is quite fatal.

NCE OF

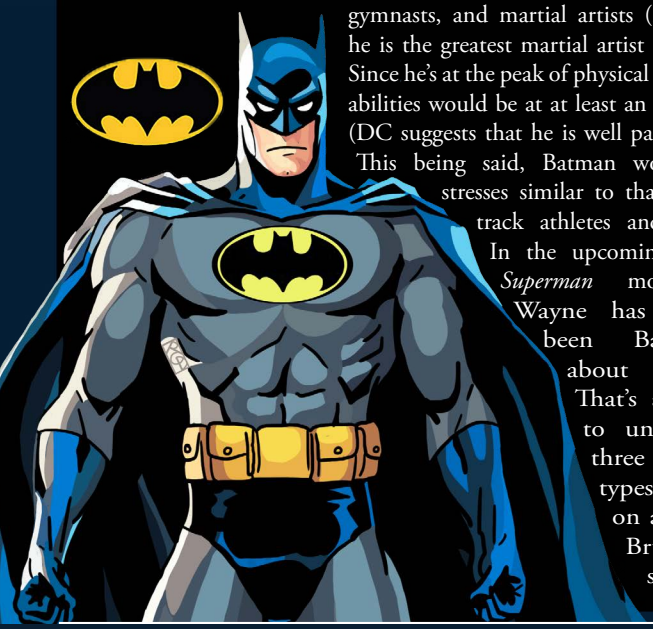
TO THE SUPERHERO NARRATIVE

By Oluwadamilare Ogunjimi

BATMAN

Batman doesn't have powers, but that doesn't make him any more realistic. The Dark Knight is at the peak of human physical performance. In the comics, Batman can bench press over 1000 pounds (see *Batman* #655) and leg press 2,500 pounds (see *Batman Odyssey* #2). For reference, the world bench press record is 1,102 pound and Ronnie Coleman (a rather famous bodybuilder) can leg press 2,300 pounds. Although these stats are humanly possible, they come with massive muscles. Despite this, Batman still requires the agility and flexibility of a gymnast, with the speed and endurance of a track athlete (sprinter and distance runner respectively). Already, we run into problems. The size of many Olympic gymnasts suggests that it is possible to be both muscularly large and flexible up to a certain point; however, I know first-hand that training for the speed of a sprinter and the endurance of a distance runner does not work out very well. Sprinting and distance running use two different types of muscle fibers, white and red twitch, respectively. White twitch is good for quick, short term bursts, whereas red twitch are good for sustainable, long-term stress. Training for long distance is great for red twitch muscle fibers, but white twitch muscles tend to suffer as a result.

As aforementioned, Batman requires the abilities of track athletes, gymnasts, and martial artists (it is said that he is the greatest martial artist in the world). Since he's at the peak of physical perfection, his abilities would be at at least an Olympic level (DC suggests that he is well past that point). This being said, Batman would undergo stresses similar to that of Olympic track athletes and gymnasts. In the upcoming *Batman v. Superman* movie, Bruce Wayne has supposedly been Batman for about 20 years. That's a long time to undergo these three different types of stresses on a daily basis. Bruce Wayne shouldn't even be able to last ten years as Batman. An Olympic track athlete can last for about 8-10 years. A male Olympic gymnast usually retires by the age of 26. With all these stresses together, on a nightly basis, he should be good for about 5-7 years, assuming he is able to avoid injury, get enough sleep, and eat right, just like an Olympian.



Except Bruce Wayne doesn't get enough sleep or eat right like an Olympian. His job, or rather hobby, requires him to deprive himself of sleep. As college students, we all know what that's like. Although scientists are not completely sure what sleep does, we do know that sleep deprivation can lead to adverse health effects and a lack of focus, which could be fatal to the Caped Crusader. Sleep deprivation itself shortens one's life expectancy; add that to the dangers of being Batman and there may be a Bat-memorial before a Bat-cave. If you're interested in more information, I recommend reading E. Paul Zehr's *Becoming Batman: the Possibility of a Superhero.*

Of course, these are only a few examples of the plethora of super characters that have resulted from the pseudoscientific rationale of their creators. Fans have created many conversations revolving around this pseudoscience, showing us how strong the suspension of disbelief is when it comes to superheroes. I invite you too to occasionally drag these characters down to reality — it may be fun to find out just why Superman can't turn back time by flying fast enough to spin the planet backwards!

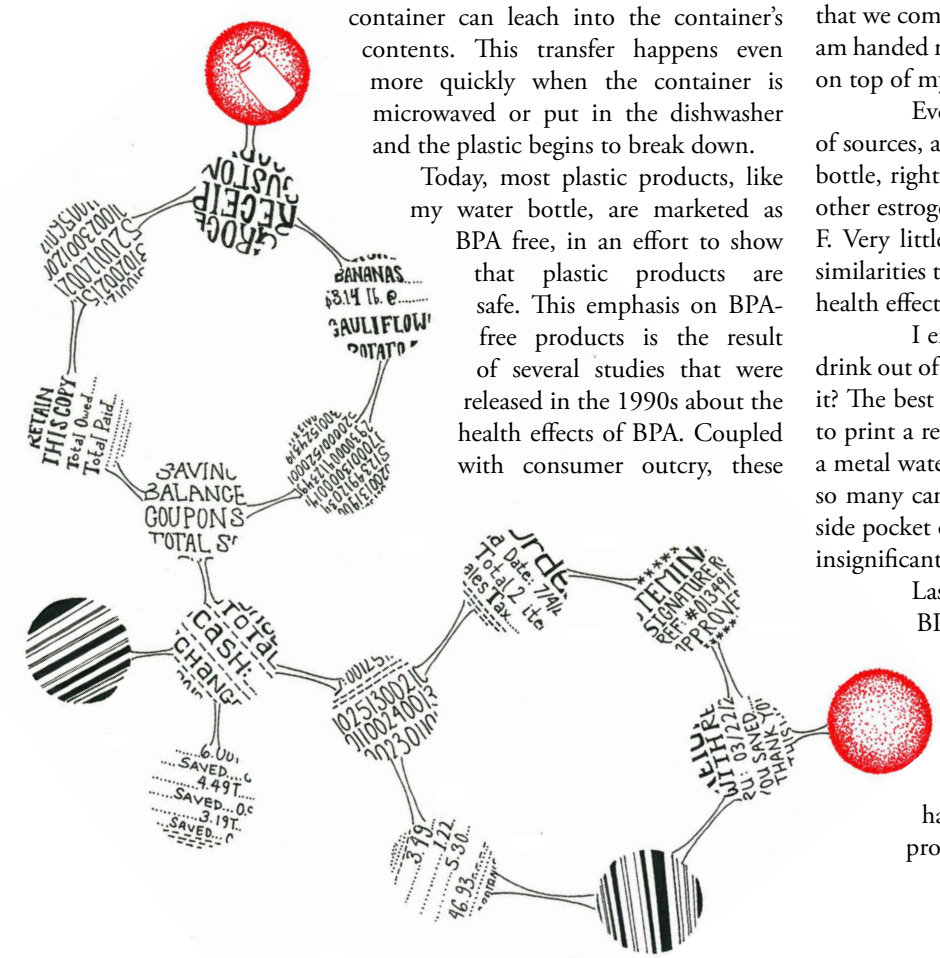
BPA Here, There, Everywhere

By Jane Sedlak
Artwork by Jane Sedlak

When my mom bought me a Nalgene water bottle a few years ago, I left the BPA-free sticker it came with on the side. It stayed there for the next few years even after the sticker turned brown from exposure to farm summer camps and the daily grime of high school. I was too lazy to take it off and the sticker seemed to make my bottle a novelty – older water bottles didn't have a sticker like mine. But even though I was proud of my sticker, I didn't know what BPA was.

BPA stands for Bisphenol A, which was used to make plastics starting in the 1960s. BPA was and is in almost every plastic product because it is used to make polycarbonate plastic, a plastic that is both clear and tough. But BPA is also an endocrine disruptor, a xenoestrogen, known to have negative impacts on human health. As a xenoestrogen, BPA mimics a naturally occurring hormone in your body, estrogen. A xenoestrogen, like BPA, can disrupt the synthesis, metabolism, and binding of estrogens naturally present in your body. Estrogen plays a key role in the body, in everything from puberty to bone development, which means that a xenoestrogen can wreak havoc. Because of its role as a xenoestrogen, BPA has been declared a developmental and reproductive toxicant for adults and children.

Why should BPA in a plastic container impact the safety of its contents? It shouldn't, but BPA from the container can leach into the container's contents. This transfer happens even more quickly when the container is microwaved or put in the dishwasher and the plastic begins to break down.



Today, most plastic products, like my water bottle, are marketed as BPA free, in an effort to show that plastic products are safe. This emphasis on BPA-free products is the result of several studies that were released in the 1990s about the health effects of BPA. Coupled with consumer outcry, these studies ultimately led to the banning of BPA in baby products starting in 2008 and led many producers to phase out BPA from their products.

So I don't have to worry about BPA exposure; my water bottle is BPA free, right? Wrong. BPA is still used to coat the inside of cans and other food packaging materials. BPA is also in a product that we all come into daily contact with – receipts. Thermal receipt paper, the kind found in almost every cash register, uses BPA as a developer to make the print visible. A study published in *Plos One* in 2014 showed that handling receipts results in a spike in BPA blood and urine levels. In the study, researchers replicated a scenario that frequently plays out at a fast food restaurants: subjects were instructed to use hand sanitizer, handle receipts and eat French fries. When subjects used hand sanitizer before handling receipts they had higher levels of BPA present on their hands and in their blood compared to subjects who handled the receipts with dry hands. Hand sanitizer led to higher BPA exposure because some types of hand sanitizer and lotions contain dermal penetration enhancing chemicals, chemicals that increase the absorption of lipophilic or lipid dissolving compounds, such as BPA. Another study in *Environmental Science and Technology* showed that individuals with high occupational exposure to BPA (e.g. waiters or sales clerks) had higher levels of BPA in urine than workers not in those industries. Clearly, avoiding BPA isn't as simple as buying a new water bottle. It is present in a variety of different products that we come into contact with every day. The receipt I am given before I am handed my lunch or the receipt the teller puts in the grocery bag, right on top of my family's food, has BPA on it. BPA seems to be unavoidable.

Even though I come into contact with BPA through a variety of sources, at least I'm not ingesting a xenoestrogen when I use my water bottle, right? Wrong again. Many "BPA-Free" products actually contain other estrogen-mimicking compounds such as Bisphenol S or Bisphenol F. Very little is known about BPS and BPF, but given their structural similarities to BPA many scientists believe they may have similar negative health effects.

I encounter BPA everywhere, everyday. It's in the water bottle I drink out of and the receipts I am given at every store. So how can I avoid it? The best way to avoid BPA is to be an informed consumer. I opt not to print a receipt or to have the receipt sent by email. And I switched to a metal water bottle. My old Nalgene water bottle that came with me to so many camps and followed me through high school doesn't sit in the side pocket of my backpack anymore. Although these changes may seem insignificant, I've at least lowered my exposure.

Lastly when producers learn that customers prefer a product BPA, BPS or BPF-free product, some of them respond. Recently, a local grocery store in my hometown switched from using thermal receipt paper with BPA to one without it. That means when my family gets groceries the receipt the teller puts in the bag, right on top of our food, doesn't get BPA all over the food. Although the chain stores in the area haven't switched yet, I'm hopeful. One grocery store's switch proves that consumers and producers have a voice.

Elizabeth Kolbert

Mythbusting the Link between Vitamin C and the Common Cold

By Willa Kerkhoff

Elizabeth Kolbert is a staff writer for the New Yorker. Her series on global warming, titled "The Climate Man," wan an award from the American Assocition for the Advancement of Science. Her articles on the enviroment grew into Field Notes from a Catastrophe: Man Nature, and Climate Change, which was later chosen as one of the 100 Notable Books of the Year by the New York Times Book Review. Her recent novel, The Sixth Extinction: An Unnatural History, won the 2015 Pulitzer Price for General Nonfiction

There was a convocation talk on March 2 here in Oberlin and never in my life have two amazing people with such good intentions depressed me so thoroughly. The two people in question were David Orr, Oberlin environmental activist and Elizabeth Kolbert, a journalist for the *New Yorker*. Dr. Orr has an incredible background in both environmental studies and international politics, and is the executive director of the Oberlin Project, our campus effort to improve the sustainability of our campus. Ms. Kolbert is a Pulitzer Prize winner and advocate for communication about scientific issues of global importance. When Elizabeth and David walked onstage, I was both excited and sad. I knew that I was about to receive opinions and facts from two of the most reliable sources available, but I knew that nothing would be good.

I could spend time listing for you the facts that they shared that night. I could tell you that, for us to meet our (incredibly depressing) goal of keeping the warming of our planet to just two degrees celcius, we would have had to stop carbon emissions a long time ago. I could mention that, as described in Ms. Kolbert's book *The Sixth Extinction,* we are facing a massive crisis of biodiversity on our planet. Coastal cities are destined to drown, land locked cities are destined to burn. There is a reason that climate change is one of the most significant bummers of our lifetime, a reason that it ranks alongside war and poverty on the list of "fun party conversation topics." We know the facts, or we have at least heard the doomsday prophecies. What, then, is the next step? What can we do, other than completely freak out?

The answer is, according to both Elizabeth and David, "I don't have the answers." Now, for an anxious college student seeking reassurance, this was not the most fun to hear. I immediately started worrying about whether I had left the lights on in my dorm room, and so I nearly missed the greater message that this conversation sent. Truthfully, climate change is too big a topic for one night in Finney Chapel. It can't be fully described or solved by just two people, even by two such determined and brilliant people. Climate change is, as Ms. Kolbert put it, "a symptom of the fact that people change the world." So at risk of sounding like an admissions pamphlet, I have to conclude that we have no choice but to continue to change the world and to change it for the better. We cannot wait for Elizabeth and David to solve this problem for us. We cannot count on some future crop of reasonable and educated politicians to implement the perfect policy initiative. We cannot wait for technology to deliver us the perfect energy messiah. When faced with such a massive problem, we cannot expect to solve it alone. We can only try to do many small things, and hope that we as a species still have the unprecedented ability to enact enormous change upon the world.

Also, as individuals, we can start buying up real estate in the Great Lakes area. With the coming catastrophe, Cleveland and Detroit will soon be the place to be.

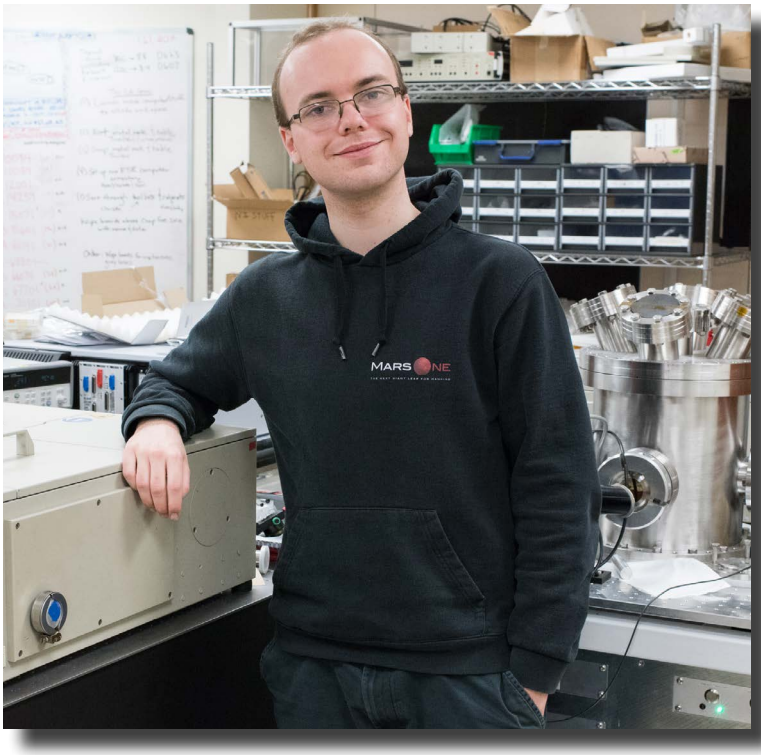
> "Though it might be nice to imagine there once was a time when man lived in harmony with nature, it's not clear that he ever really did."
>
> - Elizabeth Kolbert,
> *The Sixth Extinction: An Unnatural History*

Interview with a Martian

Mars One Candidate Ryan MacDonald

By Tara Santora

Ryan MacDonald is one of the top astronaut candidates for Mars One, a non-profit organization aiming to send four humans to colonize Mars on a one-way mission by 2027. He is currently 1 of 100 final candidates, selected from an application pool of over 200,000. Ryan, 22, has a Masters in Physics from Oxford University and is currently studying for his PhD in Astrophysics at the University of



How did you learn about Mars One?

I saw a talk that the CEO of Mars One, Bas Lansdorp, was doing -- a recording of a TEDx Talk that he delivered over in the Netherlands, which I believe I originally encountered in 2012. I was then following the progress of the project because I found it absolutely fascinating that they were proposing to effectively do something much bigger than NASA was prepared to do, ten years quicker, and relax the whole return mission part. I wanted to find out more about the technical aspects of the mission because the FAQ on the website is good, but I wanted more of the numbers, of course. So I noticed that Bas Lansdorp was going to be talking at the Edinburgh International Science Festival back in 2013, and fortunately my grandparents live up near there, so I arranged to go so I could meet him in person, and ask him my own technical questions about how the project would work. I was quite impressed by my conversation with him because he was immediately able to answer all of my questions, even stuff that deliberately wasn't included in the FAQ; that's what really convinced me they did a lot more technical design work behind the scenes before they actually went public. It was only a few weeks after that they opened up their applications, and I suppose the rest is history.

What was included in Round One of the application process?

The first step was very similar to what you would use to apply for any job: CV, resumé, qualifications, etc. Where it got different was that we had to do a psychological profiling questionnaire, and it wasn't just multiple choice questions. We're talking full-written paragraphs and essays, and in my case I remember it taking a week just to complete, although some of the other candidates who were perhaps a little more meticulous spent about a month writing that part of the application. The application also had basic medical data we had to include; there's only a certain size you can be to fit into traditional spacesuit, for instance. We had to record a short video as well, outlining why we wanted to go, our sense of humor, etc.

And what did you have to do for the Round Two of the selection process?

The second round was split into two parts. The first part was a medical examination; we were given a list of medical tests that needed to be conducted by a local physician. It was a very similar test actually to what you have to do if you want to apply to, say, the European Space Agency or NASA. So the medical examination cut about 300 candidates out of the process, leaving 1200. We then had online interviews with the chief medical officer of Mars One, Dr. Norbert Kraft, who runs the selection process. That was two-faceted. First, the interview was accessing our psychology, and the second part was accessing our technical understanding. We were sent a large amount of information about a month before the interview, maybe 50-100 pages total, and we weren't told what information was relevant, what we might get asked. For example, we were given tables with information about all of the previous missions to Mars, what their goals were, the dates they launched, etc. Now all of that is pretty much useless, so they were testing our ability to recognize that and prioritize what we were learning. We might have been told beforehand what the oxygen reserve supply would be, say in days, for instance. Then they would say on the spot, "how long would the oxygen last in a dust storm in hours?" And I would say, "are you talking hours on the Earth or hours on Mars?" So it's not necessarily testing your ability to answer; you're not just regurgitating information. You're processing and recognizing that you're being asked a different question than what you were originally prepared for.

What was the significance of these interviews?

At the end of my interview, I actually asked Dr. Kraft if I could set up another interview with him so that I could ask him some questions about his methodology, why the interview was only 20 minutes and what thought he put into the process. I ended up having three 40 minute conversations with him. He said he wasn't selecting people who were suitable to go to Mars, but he was out-selecting people who were not suitable to go, and he only needed 20 minutes to be able to make that judgment on someone. He was searching for psychological contradictions in the questions he was asking. So, for instance, he might ask us how we get on in a team environment. So you might say "I get on well in a team, blah blah blah, I like being a leader," etc. Then towards the end he might ask say, "three years down the line, if it becomes possible to return from

Mars to the Earth, would you take that trip?" In asking that question, one might think a rational answer would be "yes, I would return, tour the Earth to talk at schools," etc. Sure, that's a great answer, but what you're neglecting is all the crews that are going to come after you who need the expertise that you have. So it shows you're not actually thinking as a team player; you're thinking more about what you would prefer to do. It's amazing just from two questions how much you can deduce about someone's personality.

How has being a Mars One top-100 candidate affected your life so far?

I've always been passionate about communicating science. I was doing that before Mars One came about, occasionally going into schools, giving talks for instance on the planets and the solar system. But now, after Mars One, I have seen a very large increase in the platform that I have to reach out to people. Next month I'll be traveling to the Netherlands to talk about my motivations, and about human space flight and why it's important that we push back the frontier. So even though Mars One is at such an early stage of its operations at the moment, it's already serving as a positive catalyst to excite the world, particularly young people, about space exploration. As far as I see, even if I don't get selected, if anything that I could do through my involvement in the project can get young people excited by space exploration, then that's exactly what I'll do. Whether I'm ultimately on Mars or on the Earth, this is what excites me.

Why do you think it's important that humans colonize Mars?

We already have an important case study from history of the impact of the first Apollo landing. In fact, just in the decade after that, the number of people studying science in the U.S. doubled, which is a massive increase. There's no better way that I can think to secure our future against the greatest challenge we're going to face right here on Earth in the 21st century than by inspiring young people to become scientists. It was the large investment into the moon landings, in particular into integrated circuitry and intel, that led to the militarization of computers, which then enabled things such as communication technology and the Internet. The 21st century is not going to be easy; we have climate change, we have the energy crisis, food and water shortages -- and all of those, I like to believe, can be solved. By increasing the average science literacy of the population of the world as a whole, by something as inspirational as having people not just visiting Mars, but living on Mars, I like to believe that we would see a gradual increase of science literacy in people, decision-makers and politicians as well. It's a very long-term, gradual, demographic shift. But in order to make that trend sustainable, not just a sudden peak that plateaus off, I think we need to have a permanently staffed base on Mars.

So for you the mission is not about establishing a way to escape the Earth, ensuring the survival of the human race, in case of some apocalyptic catastrophe?

Not at all. I don't think we should go to Mars out of fear for the future of the Earth. I think we should go to Mars out of hope for what we can become as a species.

In choosing candidates, one of the important attributes Mars Ones looks for is emotional and psychological stability. Obviously, living 225 million km away from Earth can be extremely mentally taxing. How do you think living on Mars would affect you psychologically?

I don't think anyone has an answer to that; no one has experienced being further away from the Earth than the moon. Even when you're on the moon, you can see the Earth, for instance. I'm more worried about the psychological impact of being halfway between the Earth and Mars when you can't see where you've come from or where you're going to go. That would persist for about 4-5 months of the journey. I don't see any obvious indicators at the moment that I couldn't cope psychologically with the isolation, but as a scientist I always have to be aware that I have limited evidence of the situation. So I would say, lock me up in a box — that's what we'll be doing in about two weeks in September — and see how I cope. If I can't cope, then great, don't send me. I have no problems with not going if I'm not suitable. Indeed, amongst the candidates, we want the mission to succeed. It's not a competition, it's a collaboration. The mission has to come first. But if I am selected to train for Mars One, those two weeks would increase gradually to three months in isolation, and that's probably the best indicator you can get of whether you can cope or not. Dr. Kraft has said that he wants to make life in the simulation habitats on the Earth actually tougher than they would be on Mars itself to try and break us. So I'd like to believe that if I can survive that — well, not survive, he's not going to try and kill us! — but if I can cope with it psychologically and still want to go to Mars, then Mars doesn't frighten me. If I can't cope with it, don't send me.

You mentioned that in September you will be participating in a two-week simulation?

Yes, that's the start of the Round 3/Round 4 of Mars One's selection process. All one-hundred candidates will be gathering in a single location. We will go through an initial five days of group challenges, which will be the third round, in groups of 10-15 candidates. These will be challenges such as blindfolding all the candidates and, say, form a perfect equilateral triangle . . . kind of bizarre challenges. The group challenges will immediately be followed with forty candidates who will be selected to continue and then go into the isolation chamber itself. That will be the fourth round of the selection process. The location hasn't been officially announced yet, but some of the possible ones that have been mentioned publicly are Iceland, Dubai, Reunion Island, and Cyprus.

One more question to wrap everything up: I saw on your Mars One profile page that you are currently writing a science-fiction novel. Can you tell me about that?

Oh, yes! I have a rough draft, but it's difficult to find time when doing a PhD to produce a second draft. Hopefully I'll find the time when I'm on Mars or locked up in a simulation habitat. Maybe I can be the first author on Mars, that would be wonderful. Funny enough, in the future I envision [in the novel], which is in the 2080's, some people went to Mars but everyone got bored, so only people that you want to get rid of or bizarre scientists would ever go and spend a tour of duty on Mars. I have fun playing around with that.

I will look forward to reading it. Do you have any final comments?

Well, if any of your readers are looking for updates on Mars One, then on my YouTube channel I produce a video at the beginning of the month. You can look for those if you want to keep updated within the quiet periods of Mars One's official announcements.

I definitely will. Thank you so much for meeting with me.

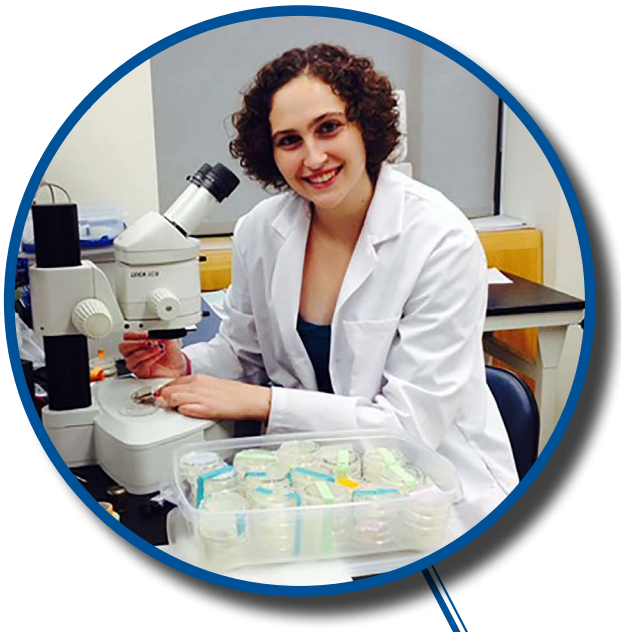
Yes, thank you for taking the time to speak with me.

Honors Research

Featured research by Oberlin College students

Investigating the Function of Intestinal Cell-Cell Communication in C. Elegans Peptide Secretion

Lisa Learman



Groups of organisms exhibit social behavior that is thought to improve survival and reproduction. Different forms of social interaction are present in all sorts of organisms, from bacteria forming microfilms to flocks of birds navigating a migration. However, the molecular mechanisms responsible for these behaviors remain poorly understood. We are investigating the role of an intestinal gap junction in a C. ***elegans*** behavior known as social feeding, in which worms cluster together while foraging. In wild isolates this behavior is due to a single nucleotide polymorphism in neuropeptide receptor NPR-1. NPR-1 is a G protein-coupled receptor that suppresses social feeding when active. NPR-1 can be activated by FLP-21, a peptide expressed in many neurons and the posterior intestine. The intestine can act as a neurosecretory organ in C. ***elegans*** and many peptides are found there. We identified a social feeding defect in strains with mutated intestinal gap junction IN¬X-16 and have conducted research showing that INX-16 and NPR-1 act in a common pathway to mediate social feeding. We hypothesize that in ***inx***-16 mutants defective FLP-21 secretion from the intestine leads to insufficient activation of the NPR-1 receptor to promote social feeding. Current and future research will attempt 1) to show that FLP-21 and INX-16 act in the same pathway to mediate social foraging 2) to determine where FLP-21 functions to suppress aggregation and 3) whether FLP-21 is properly synthesized, packaged, released, and received in ***inx***-16 mutants.

Implicit and Explicit Attitudes Towards Transgender People: The Role of Social Desirability and Tolerance for Ambiguity

Stephanie Atwood

Although transgender visibility is on the rise, ample research suggests that people still harbor negative attitudes towards transgender individuals. My honors research in social cognition explores the issue of transgender stigma by examining the magnitude of association between people's implicit and explicit attitudes towards images of transgender people with a particular focus on the demographic and psychosocial variables that predict unfavorable reactions at the implicit and explicit levels. This study utilized a picture version of the Implicit Association Test (P-IAT) to measure implicit attitudes and a battery of self-report scales to measure explicit attitudes towards transgender individuals as well as other demographic and psychosocial variables. Analysis revealed that some psychosocial variables such as participants' level of psychological authoritarianism, endorsement of binary gender, and prior contact with gender and sexual minorities universally predicted attitudes towards transgender individuals. Other measures such as the nature of the relationship between implicit and explicit attitudes were found to significantly differ by gender. This research has the potential to enhance our limited understanding of potential motivations behind prejudice and discrimination targeted against transgender individuals and sheds light on the broader stigma against gender-nonconformity.

Carbon Stable Isotope Analysis of Mudstones at Slope Mountain, Alaska

Ashely Ratigan

This project uses carbon stable isotopes (δ13C) of mudstones and coal fragments to determine past environmental conditions of North Slope, Alaska during the Albian-Cenomanian (Cretaceous). Samples were taken at Slope Mountain, Alaska located north of the Brooks Range, along Mile 305 of the Dalton Highway. Slope Mountain, also known as Marmot Syncline, includes the Upper Nanushuk and Lower Nanushuk Formations that consists of alluvial, deltaic, and shallow marine facies that were deposited during the Albian to Cenomanian. δ13C analysis can help determine different information about the past environment and the different types of organic matter contributing to the system. If possible, identifiable microfossils, such as pollen, diatoms, and foraminifera will be separated from the organic material for analysis that would provide additional information about the climate and vegetation.

Need More *Synapse* In Your Life?

Then help us create it! For every publication, *The Synapse* relies on returning and new undergraduate writers, editors, artists, and photographers. Do you have a way with words? Talent with a sketchpad? Eye for photophgrahy or graphic design? Deep love for grammatical correctness? Then you have exactly what we here at *The Synapse* want!

Applications are available online for every position.

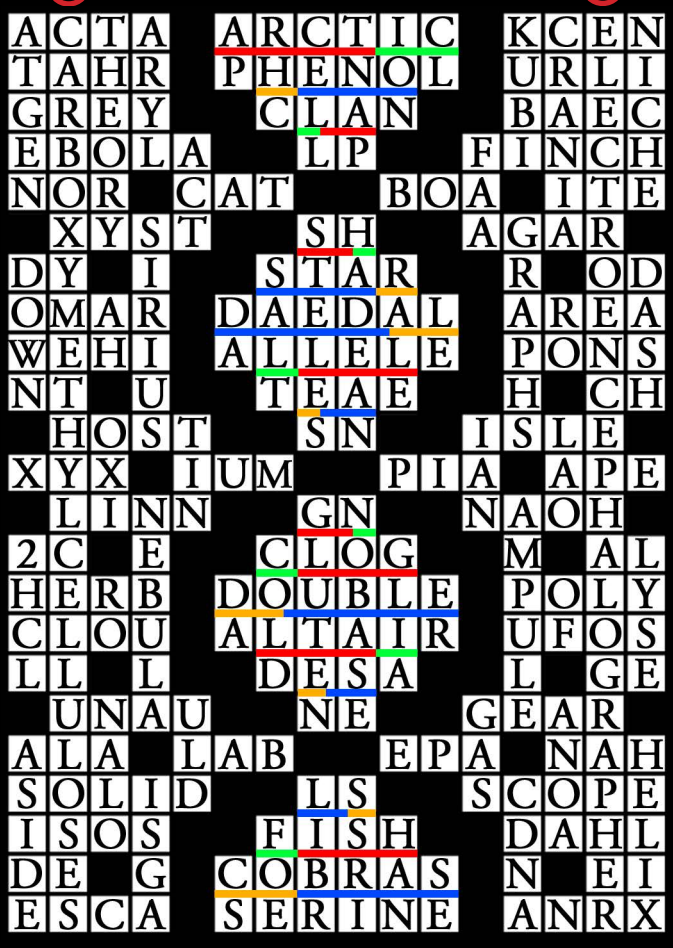
Not an Oberlin Student?

No problem! Shoot us an email at *Synapse@oberlin.edu* and we'll work with you to start your own branch of the magazine at your school.

Ready to Apply?

Then visit our website now!
TheSynapseMagazine.org

Answers To Previous Crossword



Acknowledgements

A Crash Course on Migraines
Figure 1
Barkhof, F. "Multiple Sclerosis" The Radiology Assistant. www.owndoc.com/dutch-radiology-lyme-coverup.htm. (accessed March 29, 2016).

Figure 2 B & C
University of Pennsylvania School of Medicine. "Migraines associated with variations in structure of brain arteries." ScienceDaily. www.sciencedaily.com/releases/2013/07/130726191731.htm (accessed March 29, 2016).

The Science of Superheroes
Deadpool, Illustrator: Briana

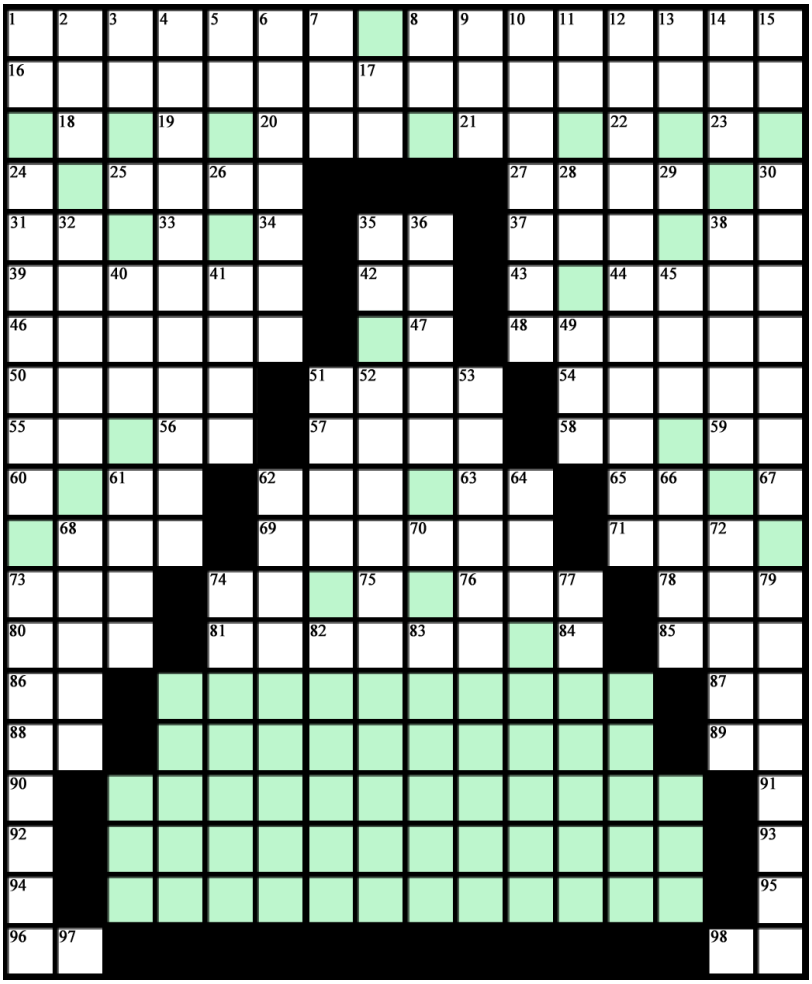
Flash, Illustrator: Claudio Montes

Batman, Illustrator: Rachel Dan

Deadpool and Spiderman, Illustrator: Oluwadamilare Ogunjimi

Crossword Corner

By Rachel Dan



ACROSS

1 Increase magnetic flux*
8 Between the earth and moon
16 With 51-ACROSS, a biomolecule
18 Symbol: number of oscillators
19 Most common blood type
20 Prefix denoting sharpness
21 Home state of Vanderbuilt Medical School
22 DNA form of Uracil, abbrev
23 When lowercase, half a circle's diameter
24 Element with six protons
25 Joule, centimeter, gram, etc...
27 Antidepressant type increasing serotonin levels
30 Solution's concentration, abbrev
31 76, Periodically
33 Most abundant element
34 Neurotransmitter form of adrenaline
35 $\Delta U\sigma + \Delta U\theta + \Delta U$ _ _ $= \Delta U tot$
37 Mater after dura and arachnoid
38 Action potential cation, abbrev
39 Renaissance patrons of Galileo
42 Two elements in glucose
43 Central Nervous System myelinating glia, first letter
44 Completely empty
46 Mouse-straggering glycoprotein
47 Sex chromosome
48 Type of bond
50 Fully grown or developed*
51 Acetic, for example
54 Haploid egg cell
55 110, Periodically
56 With the first half of 51-DOWN, a plant genus: ____ vera
57 Positions of genes on chromosomes
58 Blood glucose measurement: mg/_ _
59 Prefix meaning 'without'
60 = mc^2
61 DNA nucleotide combo
62 Oberlin's natural amphitheater
63 With 'hominem', relating to a person
65 Latin meaning 'for example'
67 Symbol for 1-ACROSS
68 Acorn yielder, or a famous professor
69 Most abundant rock in earth's crust, after feldspar
71 Involuntary muscle movement
73 Humerus location
74 Distance between earth and sun, abbrev
75 First initial of neuroscience professor Kwayke
76 Carboxyllic Acid: C _ _ _
78 Ruby or sapphire
80 With 18-ACROSS, a glutamate receptor
81 Organic compound containing NHCO as part of a ring
84 Symbol for free energy
85 Tending to or capable of
86 Archaic, plural of 'thou'
87 With 67-ACROSS, Lou Gehrig's disease
88 Type of steroid receptor, abbrev
89 The single-letter Chalcogens
90 Letter grade one notch above failure
91 Oberlin geology department chair, first initial
92 Second most common blood type
93 2.71, approx
94 Molarity denominator
95 Funtional group that differentiates amino acids
96 The other DNA nucleotide pair
98 Alliteratively initialed Oberlin chemistry professor

DOWN

1 Prefix meaning 'toward', hint to the two single-starred clues
2 Animal hideaway
3 Amount of gaseous oxygen in water, abbrev
4 Connects neuron soma to axon
5 Prefix meaning 'muscle'
6 Amino acid chain
7 Number of carbons in benzene
8 Elemental symbol for 52-DOWN, hint to the two double-starred clues
9 Whole number, abbrev
10 Solar acne
11 Nucleus in the pons involved with stress and synthesis of 13-DOWN, abbrev
12 Infrared's counterpart
13 Common neurotransmitter, abbrev
14 Atmosphere
15 Silent Spring author, inititals
17 Denoting authorship
24 Watson to Crick**
25 Radioactive actinide
26 Halogen disinfectant, abbrev
28 Element present in 69-ACROSS, abbrev
29 Square root of -1
30 What DNA polymerase did
32 Vegetable precursors
35 Father of the Uncertainty Principle, initials
36 Poisonous
38 Cochlear hairs
40 Einstein's homeland, first three letters
41 What you do with sources in a paper
45 Prefix meaning 'eye'
49 Photoreceptor
51 13 and 44, Periodically
52 Deep blue element from the greek for 'goblin'**
53 Single-celled algae with a cell wall of silica
61 Bruce Banner's radiation
62 Water
64 Cow-Yak hybrids
66 Oberlin neuroscience lab technician
68 Entropy antonym
70 Universal gas constant
72 Ribosome residences
73 Fear factory
74 Element pronounced differently in US and UK, abbrev
77 1 atm = 760 mm _ _
79 Between endoderm and ectoderm
82 Specific heat
83 Star-shaped glia, first letter
97 PV/NR = __
98 Thermodynamic symbol for mass

/syn . apse/ noun : the point at which a nervous impulse passes from one neuron to another

The Synapse is an undergraduate science magazine that serves as a relay point for science-related information with a threefold objective. First, we aim to stimulate interest in the sciences by exposing students to its global relevance and contributions. Second, we work to bridge the gap between the scientific and artistic disciplines by offering students a medium through which to share their passions, creativity, and ideas. Third, we strive to facilitate collaboration between undergraduate institutions across the country, especially within the natural science departments.