Mission Statements 2
Letter from the Editor 3
History of Neuroscience 4
Neuroscience Basics I 10
Disease 14
  Disease Introduction
  Alien Hand
  Diabetic Neuropathy: An Overview
  Migraines and Music
  Rabies
New Technology 31
  New Technology Introduction
  Limb Regeneration
Research 36
  Research Introduction
  Famous Case Studies
Interview 41
  Neuroscience Research Spotlight
  PhD Interview
Satire 47
Contributors 49
Sources for Pictures 50
Mission, Vision, and Purpose Statements
Youth Neuroscience Clubs of America

MISSION STATEMENT: What do we want to do? (Action-guiding statement, or why do we exist)

To bring together a network of young American neuroscientists for collaboration, study, and ultimately progress in the field of neuroscience.

VISION STATEMENT: Who do we want to become? (Desired End-State, or what we want to look like when we are successful in fulfilling our mission)

A group of young neuroscientists who intentionally work together to achieve excellence in the study and collaborative progress of neuroscience.

PURPOSE STATEMENT: What do we want to do because of who we are? (Combination of Mission and Vision statements)

To facilitate and advance the intentional collaboration of young American neuroscientists to achieve excellence in the study and progress of the field of neuroscience.
Letter From the Editors:

Readers,

We are extremely excited to be publishing our inaugural issue of the YNCA Journal! We greatly appreciate your interest in this exciting field of study.

The YNCA will establish a national network of neuroscience clubs, along with publishing this monthly journal. Our overarching purpose is to facilitate and advance the intentional collaboration of young American neuroscientists to achieve excellence in the study and progress of the field of neuroscience.

You will notice that our journal is divided into several sections. Each issue, we will include articles describing interesting and relevant new studies, diseases, and interviews. In all subsequent issues, we will center all articles around one core theme—some of the themes we plan to discuss in future issues include neurodegenerative disorders, mental health, and neuroimaging. We hope that these themes will provide you with a breadth and depth of neuroscience knowledge to succeed in whatever you hope to accomplish.

Finally, it is critical that we recognize all of our dedicated staff for helping us make this first issue the success that it is. You can find all of their names and positions on our Contributors page.

If you have any questions, comments, or suggestions for us, please feel free to contact us at YNCA.info@gmail.com. We hope you enjoy our first issue as much as we enjoyed writing it!

Best Regards,

William Ellsworth
Editor-in-Chief, YNCA Journal

Alexander Skvortsov, Jacob Umans, Jordan Bartfield
Senior Editors, YNCA Journal
A Brief History of Neuroscience

By Alexander Skvortsov, Jacob Umans, and William Ellsworth

Pre-Modern

For thousands of years, humans have been fascinated with their unique intelligence and computational abilities. The source of this wonderful power has been a mystery since ancient times. Some early humans, recognizing the importance of the brain, drilled holes in the skulls of the diseased (in a process known as “trepanation”). Many, however, denied the significance of the brain and instead attributed *homo sapiens’* cognitive dominance to the heart. This was the prevailing paradigm in ancient civilizations such as Egypt: while Egyptians preserved the rest of the body after death, the brain was casually discarded (Bear, Connors, & Paradiso, 2016, p. 4 - 5). The brain’s importance was only truly considered with the dawn of intellectualism and philosophy in Ancient Greece.

Some of the first to attempt to consider the brain’s function were Hippocrates and Aristotle. Hippocrates, known by many as the father of medicine, was the first to posit that the brain is the seat of intelligence and reason. Furthermore, he found that damage to the brain causes paralysis on the opposite side of the injury (Schatz, 2009). This idea is now accepted by neuroscientists, as many (though not all) motor and sensory systems are *contralateral*, meaning that their axons cross over to the opposite side of the body. Aristotle, a famous philosopher in ancient Greece, had different ideas. He thought that the brain was merely a radiator, cooling blood that goes to the heart. Unfortunately for neuroscience, many people accepted Aristotle’s view, which remained prevalent for over a thousand years in Western thought (Schatz, 2009).

However, not all intellectuals accepted Aristotle’s position. One of the next major researchers to make breakthroughs in neuroscience was Galen. He was the first neuroscientist to study the **ventricles**, or large fluid-filled spaces inside the brain. He suggested that the ventricles hold *pneuma*, or animal spirits, that regulate bodily functions such as movement. In addition to this, Galen was a physician to the gladiators. Therefore, he was able to gain specific experience with treating wounded patients (Schatz, 2009). Through this, he learned that some functions were localized to different regions of the brain. For example, Galen correctly surmised that the cerebrum was involved in sensation and memory, while the cerebellum was involved in control of the muscles (Bear et. al, 2016, p. 5 - 6).
Much later, in the 15th century, Descartes discussed his views on the brain. One of his key beliefs was dualism, or a separation between the physical brain and metaphysical mind; however, like Galen, he accepted the existence of animal spirits, but thought they were physical liquids that flowed through the brain. Therefore, he suggested that the brain followed the same physical rules as other objects. His theories were related to new developments in fluid mechanics (Schatz, 2009). This represents a common phenomenon in neuroscience: the use of modern analogies. Today, we think of the brain as a computer; in the past, people understood it in terms of the technology they had.

**Cellular Neuroscience**

With the knowledge that the brain is the primary source of our unique abilities as humans, scientists were now faced with a much more difficult question: How does it work? How does this 3 pound mass of cells control everything that we are? The answer is as complex as the brain itself. The brain is a supercomputer of unimaginable strength, composed of about 80-100 billion neurons. We know this due to the work of Santiago Ramon Y Cajal, widely acknowledged as the father of modern neuroscience. Working together with the Italian scientist Camillo Golgi, they were able to identify the basic structure of the brain as composed of many thin, threadlike structures. However, their opinions differed on the composition of the brain. Golgi believed in the reticular hypothesis, which proposed that the brain was one continuous network composed of many conjoined cells. In contrast, Ramon y Cajal thought that the brain was made of distinct cells, separated by gaps which we now know as synaptic clefts. In time, this theory of independent cells, called neuron doctrine, was proven to be true.

After discovering the structural basis of the brain, scientists concluded that those independent cells had to have some method of communication with each other. One of the first to investigate this was Luigi Galvani, who had already conducted studies on the electrophysiology of movement, or the
study of how electricity contributes to normal bodily functions. As we know today, movement is a complex phenomenon in which neurons in the brain send down signals through motor neurons to muscle fibers. Those fibers then contract, in turn moving the desired limb. Galvani discovered that sending an electrical pulse down a frog’s nerve would cause the limb to move, thus disproving Descartes’ fluid-mechanical theory of movement. This was the first in a series of stepping stones leading to the discovery of electricity and it’s use by the nervous system.

Once neuroscientists figured out that neurons communicated through electricity, they began to wonder how they did so. In the 1950s, Alan Hodgkin and Andrew Huxley used voltage clamping, the precursor to modern day Patch-Clamping, to record from individual neurons. This technique uses microscopic recorders to measure the difference in electric potential between the inside and outside of neurons. The pair discovered the output mechanism of neuronal transmission, called the action potential. In action potentials, ion channels in neurons open to allow positive charges to flood into the cell, and another set of channels release these positive charge to restore the neuron’s resting potential, or normal electrical charge. Now, the interesting thing about action potentials is that they work in a binary system—they either fire at full strength, or not at all (Bear et al., 2016, p. 92).

In the early 20th century, there was increasing research devoted to the mechanisms by which messages are transmitted between neurons. Ramon y Cajal’s neuron doctrine suggested that neurons were distinct entities; therefore, posited neuroscientists, there must be some way for the electric charge to be transmitted from the axon, or output end, of one neuron to the dendrite, or the input end, of the receiving neuron. Owing to the presence of the synaptic cleft between neurons, an electric charge is unable to simply pass between two neurons. Thanks to Otto Loewi and Sir Henry Dale, we now know that neurons transmit electrical signals using chemicals called neurotransmitters. Thanks to Dale and his colleagues, acetylcholine was discovered by Dale and his colleagues (in 1914). Later in 1921, Loewi showed its importance in the neurons system. He did so by cutting out two frog hearts, one with the regulatory nerve still attached, and one without the nerve attached. By stimulating the nerve, he found that the heart beat slower. However, when he removed some of the fluid that the first heart was floating in and poured it on the second heart, he found that the second heart beat slower as well. From that, he concluded that there must be some chemical secreted by the neurons that controlled heart rate. Later on, Dale conducted
experiments to discover that neurotransmission occurs throughout the nervous system. For their work, Loewi and Dale won the Nobel Prize for Medicine in 1936 (“Neurotransmission Demonstrated”, 2016).

Functional Neuroscience

Understanding how neurons communicate was one thing, but to understanding how these microscopic electrochemical changes gave rise to cognitive, motor, and sensory functions represented a major frontier in neuroscience.

In 1809, Franz Joseph Gall suggested that bumps on the skull corresponded to bumps on the brain, and that these bumps corresponded to tendencies towards specific behaviors. Gall called this idea phrenology, and although we now dismiss his claims as pure frivolity, phrenology was a step in the right direction—we now know that the brain does, in many ways, localize function.

Functional specialization gained tremendous credence in 1823, when French physiologist Marie Jean Pierre Flourens used a technique called experimental ablation to prove what Galen had suggested millennia before: that the cerebellum is involved in movement and the cerebrum in sensation. Flourens, however, did not believe that the cerebrum could be functionally subdivided—less because of any sound scientific reason, and more because he was a harsh critic of Gall and could not bring himself to even somewhat accept his views (Bear et. al, 2016, p. 10 - 11).

Functional specialization of the brain would not be solidly accepted until the 1861 discovery by Pierre Paul Broca. Prior to 1861, Broca had seen a patient with an inability to produce speech (even though ability to comprehend speech was largely unaffected). After the patient died, Broca examined the brain and found a localized lesion in the left Frontal lobe of the brain. The implication was that a certain area of the left brain functionally specialized for speech production. Today, we call this area “Broca’s area” (Bear et al., 2016, p. 10).

Elsewhere in the nervous system, neuroscientists were making significant advances in their understanding of functional specialization. In 1810 Charles Bell and Francois Magendie conducted research on the spinal cord. Knowing that nerves attached to the spinal cord form two separate bundles,
known as roots, the two aimed to see if there was a functional difference between the two roots. Through experimental ablation (in this case, cutting each root), Bell and Magendie found just that (Bear et al., 2016, p. 9). The dorsal roots (the root that attaches to the back of the spinal cord) carry sensory information from the body, while the ventral roots (the root that attaches to the front of the spinal cord) carry motor information to the body.

Another functional neuroscientist, Korbinian Brodmann, attained his fame because he “constructed a cytoarchitectural map of the neocortex” (Bear et al., 2016, p. 210). Brodmann used the physical characteristics of neurons in order to construct a map with the belief that cells that appeared different had different functions. Over the years, his divisions have been proven to be remarkably accurate, with many of the areas he identified corresponding to functional divisions within the brain. Brodmann also studied the evolutionary history of the brain, and proposed that “[the] neocortex expanded by the insertion of new areas” (Bear et al., 2016, p. 211).

In the early 20th century, Wilder Penfield made an interesting finding regarding the primary somatosensory cortex, or S1 (involved in processing touch sensation). Penfield, when conducting research on surgical patients, noticed that S1 contains different regions that correspond to different parts of the body; the tongue, for example, was found at the base of S1, the toes were found at the top of S1, and the face and hands were found in between. Penfield also noticed that the amount of cortex allotted for each body feature correlates directly with the amount of sensory input from this area (Bear et al., 2016, p. 431 - 432).

Questions to think about:
Which neuroscientist or discovery had the largest impact on modern understandings of neuroscience?
What makes this the most significant?
How did rivalries between neuroscientists (e.g. Ramon y Cajal and Golgi, Bell and Magendie, Gall and Flourens) shape neuroscience? How did partnerships (e.g. Hodgkin and Huxley, ) shape neuroscience?
Which were more significant? Which are more significant today?
Why has the pace of neuroscientific progress increased so rapidly in the 20th century?
How do analogies and simplifications contribute to our understanding of the brain? What are the benefits and drawbacks to using them?

Key Terms (In order of their mention)
Contralateral—Crossing to the opposite side of the body from the brain
Ventricles—four large spaces inside the brain holding cerebrospinal fluid
Dualism—The idea that man has a physical brain, and separate, metaphysical mind
Reticular hypothesis—an outdated theory that the brain is a large “neural net” composed of conjoining neurons
Synaptic clefts—the tiny space between the sending part of one neuron (axon) and the receiving part of another neuron (dendrite).
Neuron doctrine—the theory that the brain is made of many distinct cells called neurons
Electrophysiology—The study of electricity in normal biological function
Motor neurons—One of the three main functional classifications of neurons, along with sensory neurons and interneurons. Motor neurons transmit messages to muscles
Patch-Clamping—a technique in which researchers can record action potentials in individual neurons.
Action Potential—a rapid change in the electrical state of a neuron that is used to convey information in the nervous system.
Resting potential—the normal electrical charge of a neuron relative to the extracellular medium, generally accepted to be about -70mV
Experimental ablation—a technique in which areas are experimentally removed or damaged in order to ascertain their function.
Cytoarchitectural Map—a map of the brain made based on cell types

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Basics of Neuroscience I: A Cellular View of the Brain

By Alexander Skvortsov, Jacob Umans, and William Ellsworth

Some general definitions to know before starting

Neuroscience-The science of the brain and nervous system
Neuron-The basic functional cell of the nervous system
Central Nervous System (CNS)-The brain and the spinal cord
Peripheral Nervous System (PNS)-All neurons not part of the Central Nervous System

Introduction

Hello, reader, and welcome to the YNCA’s Basics of Neuroscience Course. This course will help provide a basic understanding of how the brain and nervous system works. Throughout our issues, we will explain every facet of neuroscience, from the level of massive connected systems to the level of discrete cells and molecules. We’ll look at how neuroscience affects what it fundamentally means to be human. We’ll tackle how we feel, move, love, and think.

Neuroscience is one of the fastest growing scientific fields, and neurological disorders affect countless individuals worldwide; despite this, most people don’t learn about neuroscience until they reach college. Our Basics of Neuroscience section provides an introduction to the wonders of the human nervous system. We hope to educate, entertain, and ultimately inspire young minds to enter one of the most important fields of study in the modern world.

To fully understand how the brain works, we must consider it on many different scales. From subatomic polarities to complex computational systems of neurons to the many parts of the brain itself, the study of the human mind is an immense field including not only neurobiology, but also mathematics, psychology, engineering, computer science, medicine, chemistry, electrophysics, biology, philosophy, and many other fascinating subjects.

This first lesson will cover the basic structure of neurons, and how the structure of each individual neuron contributes to its function.
The human brain is composed of approximately 80 to 100 billion neurons, which work together to form complex computational systems.

Neuron Structure

As explained in greater detail in the History of Neuroscience article, Santiago Ramón y Cajal developed a theory, called the Neuron Doctrine, that stated that the brain is composed of many distinct cells. A neuron consists of same basic components as any other cell. Like a muscle cell, or a skin cell, neurons have cell membranes, nuclei, cytoplasm, mitochondria, and the numerous other structures found in any eukaryotic cell. The cell body (also known as the soma) contains the nucleus, and most of the support systems and organelles found in all cells. What differentiates neurons from all these other cells, however, are two large, branching structures protruding from a neuron called the axon and the dendrite. During the process of signal transmission, the dendrite serves as the input end, while the axon is the output end. Dendrites extend in many directions from the soma; the pattern of dendrites protruding from a neuron is known as arborization. The number of dendrites varies throughout neurons, depending on their specific function. The signals sent to neurons are typically received on dendritic spines, specific sites on the dendrite specialized for signal reception.

From the cell body, electrical signals known as action potentials travel through the axon (more on this in the next issue). The cell body transfers signals to the axon at the axon hillock. Many neurons have axons covered by a myelin sheath, a layer of lipids meant to allow faster transmission of these electrical signals (represented in blue on the diagram above). In neurons, myelin allows for propagation of the
action potential faster through the axon: they act as a sort of insulation for the electrical signal. Between myelin are Nodes of Ranvier, sites that contain high concentrations of ion channels to propagate the action potential (more on this in the next issue). Axons then branch out (thinning along the way) and end at small bumps called axon terminals.

The Synapse

It is also important to understand how signals are sent between neurons to form the unique communications systems that neurons use. In general, an axon terminal connects with a dendritic spine, forming a synapse. The axon and dendrite are separated by a miniscule gap called the synaptic cleft. This gap allows chemicals called neurotransmitters to cross over from the axon to the dendrite and react with receptors, but more on that in the next issue. The synapse is the main way neurons communicate with each other.

One final thing to keep in mind is that neurons are extremely specialized cells. There are no two identical neurons, as each and every neuron grows and changes to serve a specific purpose. One specialized type of neuron is the Purkinje neuron, which is involved with motor function, and plays a critical role in integrating and transmitting massive amounts of information. These neurons have massive branching dendrites in order to handle such a large amount of information; however, Purkinje cells have only one axon to relay the information to the next cells in the circuit. The structure of every neuron likewise directly correlates to the function they enact.

Support Cells

Aside from neurons, many types of support cells, known as glia, exist throughout the nervous system. Astrocytes, one common type of glial cell named for their star-like shape, provide a wide range of support for neurons, including the uptake of used neurotransmitters. Astrocytes also have end-feet that attach to blood vessels to help create the Blood-Brain Barrier (BBB). The BBB helps filter out dangerous substances from the brain, yet also in some cases makes developing medications difficult as only certain molecules can enter the brain. Also involved in protecting the brain, microglia act as the immune cells of the nervous system. Microglia function to attack and destroy invading pathogens.

Two types of glial cells are involved specifically with creating the myelin sheaths. Oligodendrocytes myelinate CNS neurons, and each cell has many protrusions from its cell body that
allow them to myelinate more than one neuron. Schwann cells have an analogous function within the PNS, yet each cell creates only one segment of the myelin sheath.

Much like neurons, glial cells in the nervous system are also structured to match their function. For one, the astrocytic end-feet allow them to filter blood and protect the brain. Furthermore, the differences between oligodendrocytes and Schwann cells exist in order to account for different spatial issues within each main part of the nervous system. Oligodendrocytes have long extensions that allow them to myelinate many neurons, while Schwann cells are only capable of myelinating one neuron. The crowded nature of the CNS has contributed to the development of many mechanisms (such as the use of oligodendrocytes) to save space.
An Introduction to the Disease Section:

The Disease Column will be a section of the monthly journal that features one or more articles on specific neurological diseases and chronic conditions that relate directly to the theme of the month. Rather than focus on a feature of a disease that has been studied in research publications or write about the discovery of a treatment for a disease like other journal sections may do, contributors to the Disease Column will focus on informing readers about both common and uncommon diseases of the central and peripheral nervous systems in a more general sense. Since neurology and neuropathology are very broad fields, the aim of the column will not only be to teach readers about the mechanisms behind a condition and the resulting symptoms, but also to raise awareness of the disease by providing the audience with additional resources to further understand the condition and opportunities for students and adults to get involved with national and international organizations that help patients suffering from the illness discussed in the monthly Disease Column. Typically, each issue will have one main article or disease that is focused on, but writers can contribute as much as they want and are strongly encouraged to do so.

Christian Gonzalez,
Chief Editor of Disease Section
The Uncontrollable Plight of Alien Hand Syndrome

Christian Gonzalez

A Moving Discovery

In 1908, eminent German neuropsychiatrist Kurt Goldstein saw a patient who complained of involuntary movements of her left hand shortly after suffering from a stroke (Sarva, H., Deik, A., & Severt, W. L., 2014). Goldstein observed the unusual nature of the uncontrollable and repetitive grasping movements made by the patient. The movements which the patient experienced took place entirely without her control, and thus left the patient with an overwhelming sense of having her left arm belonging to another person. Suffering from not knowing the cause of her misery, the patient exclaimed “There must be an evil spirit in the hand!” While this of course was not true, there was still reason for genuine confusion given the disorder was then unknown (Mark, V. W., n.d.). Eventually, though, this curious phenomenon was named “alien hand” syndrome (AHS) in a study that was conducted on the disorder in 1972 (Brion, & Jedynak., 1972). Today, scientists know that AHS is the result of injury to the brain in a number of different regions and that the disorder occurs most often in patients who previously suffered from other conditions such as stroke or brain tumors.

Physical Manifestations
The most prominent feature of AHS is the loss of sense of agency, or being consciously aware of moving a specific body part. The loss of volition results in the experienced autonomy of the affected “alien” body part. While AHS covers a broad spectrum of involuntary hand movements that can sometimes be accompanied with a loss of sensory processing known as agnosia, there are three primary variants that stem from neural damage that the majority of patients have. The first of these forms of AHS is known as the anterior variant and is caused by lesions of a number of brain regions, most notably the corpus callosum, or the part of the brain which connects the left and right cerebral hemispheres through its 200 million axonal nerve fibers. (Hubel, D., n.d.). In this type, the patient will experience the alien hand unilaterally in their non-dominant hand. Another variation, known as the posterior variant, is the product of damage to the thalamus, the parietal lobe, and occipital lobes. In this form, patients withdraw their affected hand from physical contact with others when an object or a person gets near to them and nearly touches their hand. Additionally, some patients may experience involuntary hand levitation. The other main type of AHS is the callosal variant. This form is very similar to the anterior variant, but differs in that it can only be caused by damage to the corpus callosum. Patients with the callosal variant often experience intermanual conflict, or the involuntary opposition to voluntary movements of the unaffected hand by the affected alien hand. The callosal variant is the type of AHS in which it is common to see the hands of a patient fighting each other. In short, the frontal (anterior) variant causes unconscious purposeful actions such as grasping, the callosal variant produces intermanual conflict and the posterior variant primarily results in involuntary hand levitation. (Sarva, H., Deik, A., & Severt, W. L., 2014)

**Etiological Facets**

Although the different variants of AHS each have their own unique causes and pathologies, the cause of the syndrome as a whole can be defined as the damage to a specific brain area that results in abnormal sense of agency with a hand. Within this inclusive definition are a broad array of separate diseases that can onset the condition by evoking the initial insult to the brain. A number of ordinary
causes which have been documented to cause AHS include anterior cerebral artery strokes, 
neurodegenerative diseases and midline tumors. Brain damage causes disruption of networks which may 
result in the loss of inhibition of neural activity responsible for the symptoms that AHS patients 
experience (Sarva, H., Deik, A., & Severt, W. L., 2014).

**Treatments**
Currently, there is no cure or approved treatment for any of the three variants of AHS. Many 
threats can aid in the reduction of how AHS disrupts the life of a patient, but no methods are able 
to completely stop the alien movements. Some of the therapies are aimed toward providing coping 
mechanisms to lessen the severity of the condition, while others focus more on distractions to dampen down the syndrome (Sarva, H., Deik, A., & Severt, W. L., 2014). Benzodiazepines such as clonazepam have been used to treat patients, but they have been less effective than behavioral modification therapies and are thus not widely used.

**Key Terms**
Volition- the ability of choosing to do something
Agnosia- loss of sensory processing and interpretation
Anterior variant- type of AHS associated with involuntary purposeful actions
Corpus callosum- bundle of nerve fibers bridging the two cerebral hemispheres
Posterior variant- type of AHS associated with involuntary hand levitation
Thalamus- the part of the brain involved in processing received sensory information
Parietal lobe- brain lobe whose main functions are sensory processes, attention and language
Occipital lobe- brain lobe responsible for visual perception
Callosal variant- type of AHS associated with intermanual conflict
Intermanual conflict- movement of the alien hand that interferes with non-affected hand
Sense of agency- the awareness of initiating and controlling movements
Benzodiazepines- class of drugs that increase the activity of the neurotransmitter GABA

**References**


Diabetic Neuropathy: An Overview

By: Priya Vijayakumar

Introduction

As of 2012, approximately 29.1 million Americans suffer from diabetes (Statistics About Diabetes. n.d.). From that population of diabetics, diabetic neuropathy affects, or will affect, at least 50%. Characterized by a tingling sensation, numbness, pain, and a loss of sensation or motor control, diabetic neuropathy is the leading cause of peripheral neuropathy, or peripheral nerve damage (Smith, A. G., & Singleton, J. R. 2012). Diabetic neuropathy, or nerve damage, is prominent in diabetics with type 2 diabetes and progresses with the severity and duration of the diabetes (Fink, E., & Oaklander, A. L., 2005). A troubling feature of diabetic neuropathy is that it is often undetected while the disease process progresses. Due to this problem, patients with diabetic neuropathy do not consider treatment options until the problem has advanced to a severe extent; this issue causes patients to suffer frequent falling, foot ulcers, and limb amputations which in turn lead to morbidity, mortality and increased medical spending (Ramsey, S. D., Newton, K., Blough, D., et al., 1999).

Classification

Diabetic neuropathy can be broadly described based on the body region impacted by the neuropathy: sensory, autonomic and motor (Diabetic Neuropathy (Nerve Damage) - An Update. n.d.). Based on the onset of symptoms and the nerves and muscles involved, diabetic neuropathy can be categorized in two ways: chronic and acute. Chronic neuropathies refer to distal symmetric polyneuropathy (DSP) and diabetic autonomic neuropathy (DAN). Acute neuropathies refer to diabetic amyotrophy and treatment-related neuropathy (Smith, A. G., & Singleton, J. R. 2012).

Prominent Forms

Identified by its gradual onset, DSP primarily affects the lower extremities, developing from the toes and feet.
before progressing upwards. As its name suggests, DSP develops in a symmetric manner. Nearly 50% of patients with DSP experience further neuropathic symptoms aside from pain such as allodynia or dysesthesia (Zelman, D., Gore, M., & Brandenburg, N., 2005). DSP is also linked to the development of Charcot neuroarthropathy, which further increases in mortality (Smith, A. G., & Singleton, J. R. 2012). As the disease progresses, patients experience a loss of sensation, which may lead to the onset of undetected foot ulcers that go untreated—DSP is the most prevalent cause of foot ulcers and limb amputations (Tesfaye, S., Boulton, A. J., & Dickinson, A. H., (n.d.), Smith, A. G., & Singleton, J. R. 2012).

DAN affects the autonomic nervous system, impacting internal organ systems such as the gastrointestinal tract, cardiovascular system or sex organs (Fink, E., & Oaklander, A. L., 2005). For example, in the case of DAN causing cardiovascular autonomic dysfunction (CAD), patients can suffer from silent myocardial infarctions without prior indications of pain. The majority of patients experience general symptoms such as dizziness, abdominal pain, nausea, vomiting, and erectile dysfunction (Smith, A. G., & Singleton, J. R. 2012, Nagsayi, S., Somasekhar, C., & James, C. M., 2010).

Diabetic amyotrophy is the most common of the two acute diabetic neuropathies (Smith, A. G., & Singleton, J. R. 2012). Diabetic amyotrophy is characterized by severe pain and weakness in proximal muscles located in the hips or thighs such as the hip adductors and/or the quadriceps (Nagsayi, S., Somasekhar, C., & James, C. M., 2010). Atrophy of muscles and dysfunction in ambulation can lead to wheelchair dependency (Smith, A. G., & Singleton, J. R. 2012).

Treatment-induced neuropathy develops after sudden corrections in glycemic index of diabetics (Gibbons, C. H., & Freeman, R. 2014). Patients with treatment-induced neuropathy often experience unintentional weight loss. Patients typically experience widespread pain and sometimes, autonomic dysfunction. Treatment-induced neuropathy often improves over time but can reoccur if triggered as previously mentioned (Smith, A. G., & Singleton, J. R. 2012).

Methods of Detection

There are several ways to detect the presence of diabetic neuropathy. Common detection methods include the knee or ankle jerk reflex test, electromyography, nerve conduction tests, clinical observations and at times, X-rays if needed (Diabetic Neuropathy (Nerve Damage) - An Update. n.d.).

Treatment Options and Preventative Measures

Although there are no treatment options that reverse damage caused by diabetic neuropathy, treatments are available to prevent, cope with, and decelerate its progression. Currently, there are three types of treatments available: disease-modifying treatments that mitigate the disease process, anticonvulsant drugs, and opioids for symptomatic relief. Since diabetic neuropathy accompanies diabetes, the best preventative measure is to reduce risk factors for diabetes such as increased
consumption of triglycerides, smoking, hypertension, and obesity (Fink, E., & Oaklander, A. L., 2005; Smith, A. G., & Singleton, J. R. 2012). Controlling body weight, pursuing a heart-healthy diet, and exercising regularly significantly reduce the chance of developing diabetes thereby preventing the onset of diabetic neuropathies.

Key Terms
Neuropathy- A disorder caused by peripheral nerve damage.
Type 2 diabetes- A chronic condition in which the body’s ability to process glucose is impaired.
Autonomic nervous system- The portion of the nervous system that regulates viscera (internal organs)
Glycemic index- Value that represents how carbohydrates in food raise blood glucose levels.
Electromyography- Device that records electrical activity produced by skeletal muscles.
Anticonvulsant drugs- Type of drugs that are used to treat seizures.
Opioids- Drug that produces morphine-like effects such as relieving pain.
Triglycerides-A specific type of fat with three fatty-acid tails extending from a glycerol core.

References


Migraines and Music: How Are They Connected?

By Janvie Naik

It’s 7:00am, and the alarm clock emits loud, obnoxious music. With her head pounding, Mrs. N shuts off the insufferable shrieking. Another migraine, she thinks. To her daughter across the hall, the music from the alarm clock sounded peaceful and serene; however, Mrs. N was suffering from what is known as phonophobia, a common migraine symptom characterized by an aversion to sound and heightened auditory sensitivity. Although some migraineurs have symptoms causing music to be unpleasant, music may actually be used to help other migraine patients. June is National Migraine Awareness Month, so we will be delving into an interesting exploration of the links between migraines and music. First, some background information: what are migraines?

Migraine Basics
Migraines typically present as recurrent throbbing pain affecting one side of the head, and each episode can last anywhere from a couple hours to several days. Accompanying symptoms include sensitivity to head movement, nausea and vomiting, photophobia, and phonophobia. In about 30% of patients, migraine pain is preceded by an aura, usually manifesting as visual disturbance (Goadsby, 2012). Migraines have a complex etiology, and triggers vary significantly from one patient to another. Potential triggers include hormonal changes, certain foods, stress, and weather changes (Silberstein, 2014). The pathological progression of a migraine is complex and not completely understood, but scientists believe that it involves a dilation of blood vessels (Gobel, 2013). Serotonin is also believed to be involved in migraines. For migraine treatment, a class of drugs known as triptans have been effective and interact with serotonin receptors (“Neuroscience: Science of the Brain,” 2003).

Music in Migraine Symptoms
As demonstrated by the example of Mrs. N above, many migraineurs suffer from an aversion to sound, known as phonophobia, which may occur hours before a migraine attack or during the attack itself. A study conducted by a group of researchers in Norway demonstrates that migraine patients who suffer from phonophobia are “significantly more sensitive to sound than
headache-free controls both during and outside of an attack (p < 0.0001)” (Vingen, 1998). Since phonophobia can be an ever-persistent condition, it can have debilitating consequences in everyday life and cause listening music to be uncomfortable experience.

**Music in Migraine Treatment**
Utilizing music for migraine treatment has become a new and exciting field of research. Neuroscientists are still investigating the effectiveness of music therapy and how it should be implemented, but existing research has shown promising results. Through the use of EEG technology, a group of researchers created a customized musical pattern for each patient in the study to use for migraine therapy. Their results show that after 12 months of treatment, 56% of participants receiving EEG-based music therapy were relieved of at least half of their symptoms (Meister et al., 1999). The innovative integration of music and brain imaging technology has potential to greatly improve the lives of migraine sufferers. EEG-based music therapy is not the only form of music therapy being investigated; music-aided psychotherapy is also a rich area of research. A group of German scientists compared the effects of butterbur root extract and music therapy on migraines, and the music therapy consisted of “music-aided relaxation training, body awareness techniques, and conflict training in musical role play” (Oelkers-Ax, 2007).

In the post-treatment phase, which refers to the 8-week period immediately following treatment, music therapy was shown to be more effective than both butterbur root extract and the placebo drug. Subsequent analysis showed that in the follow-up phase, which is the 8-week period immediately following the post-treatment phase, music therapy and butterbur root extract were both more effective than the placebo drug (Oelkers-Ax, 2007). The promising evidence supporting the effectiveness of migraine therapy merits further investigation and more widespread implementation.

**Migraines Expressed Through Music**
Music serves as a vehicle for expressing human emotions and experiences. A sufferer of migraines himself, Richard Wagner composed “Siegfried,” an opera that vividly depicts a migraine attack. At a superficial level, the story of “Siegfried” has no relation to migraines, but further analysis of the music brings out striking similarities. Describing the persistent and severe nature of Wagner’s migraines, the opera begins with the phrase, “Compulsive plague! Pain without end!” (Wagner, 1876). Much like a migraine, the music begins gradually, and soon
escalates to a loud, pulsating sound. To symbolize the aura phase, the opera includes flashing lights, and the music conveys a random pattern characteristic of visual auras. In modern music, migraines have been portrayed in a dismal light. The American Headache Society conducted an analysis of popular music and found that as of 2012, 54% of pop music with the word “migraine” in the title had lyrics referring to feelings of hopelessness and despair, and only 11% referred to hopefulness or successful treatment (Roberts, 2012). Although migraine symptoms can be debilitating and extremely painful, music serves as an outlet for many migraineurs to express their pain.
Works Referenced


Rabies: Hope and Controversy

By Jack Ross-Pilkington

Introduction

Rabies is one of the most infamous diseases in history. While there is still a great deal of mystery surrounding it, what scientists do know about it is both fascinating and controversial. It is caused by a virus that targets the central nervous system, including the brain (World Health Organization, 1). The initial symptoms are mild - usually nothing more than a fever or a headache (World Health Organization, 1). However, this does not mean that rabies is passive or harmless. After the patient is infected, the virus spends two weeks to a month incubating (CDC, 1). Finally, it reaches the brain, where it begins to wreak havoc. The brain begins to swell, which is ultimately fatal (Giesen, 2). The period before death is incredibly painful. The patient usually expresses symptoms that are traditionally connected with rabies - hallucinations, violent behavior and extreme agitation (Giesen, 2). However, the arguably most famous symptom is hydrophobia - the fear of water (CDC, 1). Those suffering from rabies have difficulty swallowing - this is beneficial to the virus because it is spread through saliva (Giesen,1). As a result, because swallowing is incredibly painful, a strong aversion to water is present in most rabies victims (World Health Organization, 1). This compounds the suffering of those who are infected, as they are extremely thirsty but simultaneously unable to drink (World Health Organization, 1).

The Vaccine

For most of human history, rabies was almost 100% fatal (Giesen, 2). By the time the symptoms expressed themselves, it was too late - the brain had already begun to swell (Giesen, 3). However, in 1885 Louis Pasteur created a vaccine from the spinal cord of rabid rabbits (Vander Hook, 8). This type of vaccine is called a nerve tissue vaccine (NTV) (Giesen, 3). He used this to successfully cure a boy who had been bitten by a rabid dog (Vander Hook, 8) However, NTV vaccines are not frequently used anymore because they contain myelin, which the patient can become hypersensitive to (Giesen, 3). This can lead to paralysis and even death (Giesen, 3). As a result, researchers pursued a vaccine that did not use neural tissue. This led to the discovery of cell culture and embryonic egg based vaccines (CCEEVs) (Giesen, 3). These are far more effective - with early detection, rabies can almost always be cured (Giesen, 3).
The Milwaukee Protocol

But what would happen to rabies patients who did not get the vaccine? For a long time, the answer was simple - they would die. But in 2004, a teenager named Jeanna Giese was bitten by a bat in her hometown of Fond Du Lac in Wisconsin (Lite, 1). Because she ignored it and did not seek medical attention, the virus incubated and spread. Normally, this would be a death sentence. But Ms. Giese went down in history as the first person to get the virus, not get vaccinated - and survive (Lite, 10).

How exactly Ms. Giese survived is still controversial to this day. According to the scientist who led the team treating her, Dr. Rodney Willoughby, Ms. Giese survived because they administered what would soon become known as the “Milwaukee protocol” (Lite, 1). The idea behind the Milwaukee protocol is simple: the immune system can battle rabies naturally, but the inflammation in the brain and the hyperactivity triggered by the virus kills the patient before it can work (Lite, 1). Therefore, the hyperactivity can be controlled by essentially reducing the patient to their brainstem through an induced coma (Lite, 1). For months, Giese was completely unconscious and fed through a tube (Lite, 1). Finally, she made a full recovery and remains famous in rabies research circles (Lite, 1).

However, some scientists have called into question the usefulness of the Milwaukee protocol. Since Ms. Giese has recovered, a child from the Philippines has received the protocol but has died (Aramburo, 1). In addition, some scientists say that Ms. Giese had a very weak version of the disease and was able to fight it off naturally (Healy, 1). In fact, many have hypothesized that the Milwaukee protocol had a neutral or even negative effect on her well being (Healy, 1). However, Dr. Willoughby remains an advocate of the protocol and an alternative solution has yet to be found (Aramburo, 1).

Conclusion

In many ways, the fight against rabies is a microcosm of neuroscience itself. Both the study of Rabies and the general study of the brain have a long and challenging road ahead of them. Controversy and unclear findings are commonplace in both fields. However, both disciplines are full of miracles and hope. Above all, rabies is both one of many terrible brain diseases and is in a league of its own - full of darkness, but also full of possibilities.
References


An Introduction to the New Technology Section

As wonderfully crafted the human body is, it still cannot see microscopic organisms, locate galaxies beyond the Milky Way, or even detect a dangerous cancer existing between its own organs without the use of technology. Technology is so empowering and so advantageous that by using it, we have expanded the scope of human power tremendously in the last few centuries. The use of technology allows us to conquer many unknowns about the brain. After all, if we can uncover brain tumors through functional imaging and detect epileptic fits using electroencephalography, we can most definitely conquer the rest of the mysteries of consciousness through future developments in technology.

We include this column in this journal with the hopes of inspiring rising neuroscientists to take the initiative to build machines and computer programs to answer the unanswered. We hope that by including the accomplishments of other prominent computational neuroscientists and engineers your minds will be stimulated enough to lend your own unique perspectives to tackle the most devastating of disorders, cease unimaginable pain seemingly arising from nothing, or even the process of aging.

All of us are lucky enough to be living in the age of unbridled technological development. If you are passionate about bettering the quality of others’ lives, learning about technology is a must. After all, when you have a powerful machine at your fingertips, why not use it to make the world a better place?

Dhanya Mahesh
YNCA Head of New Tech
Salamanders and newts have the extraordinary ability to regenerate lost limbs. If a newt’s tail is cut off, epidermal cells will cover the opening, and pattern formation genes (or Hox genes) will allow the proliferating cells at the edge of the wound to reform into the necessary muscle cells, nerve cells, skin cells, etc. (Endo et al., 2004). Unfortunately, humans cannot perform quite a feat through biology alone, but with technology they may be able to develop the next best thing.

Human limb regeneration has been sought after by patients who suffer from paralysis, strokes, or have experienced some variation of limb amputation. By bridging neuroscience and technology, researchers may finally be able to construct a near replica of the human arm, working nerves and all.

In October 2014, the first person to receive a mind controlled prosthetic was a male amputee from Sweden. This prosthetic, while a revolutionary development, was neither one hundred percent accurate nor highly sensitive to his thoughts (Criado, 2014).

In May 2015, Mr. Les Baugh, a double amputee, received a high-tech prosthetic arms. Baugh was provided with a pair of prosthetic limbs that were controlled by his thoughts and would even allow him to experience physical sensations (Cot, 2015).

In September 2015, a mechanical arm built by DARPA managed to allow an amputee to feel physical sensations with metal prosthetics. The prosthetics were able to stimulate sensory nerves in the brain (Wood, 2015).

More recently, in February 2016, researchers at the Johns Hopkins University Applied Physics Laboratory further developed this technology and manufactured a prosthetic limb that would move individual fingers in response to the user’s thoughts (Hotson et al., 2015).

The researchers at Johns Hopkins developed a Brain Machine Interface or BMI to connect the electrical signals concerning movement in the brain with the actions of a prosthetic limb. The scientists used “high density electrocorticography” to build a model of the electrical signals passed in order to initiate and control individual finger movements (Hotson et. al, 2015).
To do so, teams of scientists at Johns Hopkins first began mapping the patient’s brain by placing intracranial electrodes on sensorimotor regions. The subject then underwent several finger associated tasks to collect data for the researchers’ BMI (Brain Machine Interface). These tasks included finger tapping and “vibrotactile stimulation” or stimulation by inducing pressure upon the fingertips. While the subject underwent such experiments, the researchers collected electrical data from the brain concerning the initiation and movement of each finger. This data was then used to train the prosthetic to identify whether a movement was occurring and if so, which finger was moving, and to then move a corresponding finger at a fixed speed in response. Thus, the researchers were able to program the prosthetic limbs to respond to the movement controlling neurons in the brain accordingly (Hotson et al., 2015).

Rigorous testing was administered to calculate the prosthetic limb’s overall accuracy. The accuracy of its ability to classify movement signals was calculated to be approximately 76% while the finger detection balanced accuracy, or the accuracy of the program in detecting the correct moving finger, was approximately 92%. As this technology develops, it is quite possible that the accuracy level will increase (Cot, 2015).

This new technology combined with the work of other prosthetics researchers may be able to yield a high-functioning prosthetic limb that responds to user’s thoughts with a high level of accuracy. For example, studies have shown that similar electrocorticography research has allowed prosthetics to reach and grasp items with approximately 81 - 84% accuracy and to move and gather items at an accuracy level of approximately 70% (Fifer et al., 2014; McMullen et al., 2013). In the future, researchers may be able to combine such research to create a functioning BMI prosthetic.

Unfortunately, at this stage in development, these prosthetics currently valued at approximately $500,000, making them unaffordable to many people (Cot, 2015). Hopefully, in the near future, scientists will be able to develop better prosthetics and increase their affordability, so that amputees and stroke victims can enjoy the sensations of their lost limbs once again.
References


An Introduction to the Research Section:

In the modern era, neuroscientists are making countless discoveries about the brain. From molecules to cells and networks, researchers are revolutionizing the way we understand the brain. For this reason, the YNCA Journal will have a recurrent feature on new studies that are changing the world’s understanding of neuroscience. In our inaugural issue, we will discuss several of the most famous studies in neuroscience history to introduce readers in more depth to the ways neuroscientists studied the brain before today. In future issues, the research section will be subdivided into two parts: research methods, and new studies. In the research methods section, articles similar to the one below will describe key research methods in neuroscience. Future issues will describe topics such as animal research and statistical methods. In the new study portion of this section, we will present the key findings of a study related to our core theme in an accessible manner. As our inaugural issue lacks a clear theme, no new study is described in this issue. I can understand the feeling of confusion felt by readers when first exposed to peer-reviewed journals--I still find it difficult to understand everything in studies myself at times. For this reason, I hope that the new study section of the YNCA Journal will allow all readers to make an easier transition into the complex world of peer-reviewed studies.

Jacob Umans,  
Chief Editor of Research Section
Famous Case Studies of History
By Jacob Umans and Meenu Johnkutty

Though in the modern era, neuroscience is becoming increasingly reliant on digital means to obtain data (as described in the new technology section of the journal), case studies have a lasting legacy in neuroscience. From ancient times to the present, case studies have given neuroscientists new means to understand the brain. Up to the advent of neuroimaging devices, studying patients with brain damage has been the primary means for neuroscientists to gain knowledge of the brain’s inner workings.

One such famous case study was conducted by Pierre Paul Broca in the mid-1800s. Broca wrote in the *Bulletin de la Société Anthropologique*, as translated by Dr. Christopher Green, “whenever a question was asked of [the patient Broca studied], he would always reply *tan, tan*” (2003). Although Broca noted that the man’s intelligence seemed normal, he found that the patient (referred to simply as Tan by Broca) had significant speech deficits. While Tan was still alive, Broca had no means to discover the exact deficit causing Tan’s issue. However, upon Tan’s death, Broca examined his brain. He noted “The frontal lobe of the *left* hemisphere was soft over a great part of its extent; the convolutions of the orbital region, although atrophied, preserved their shape; most of the other frontal convolutions were entirely destroyed” (Green, 2003).

From this data, Broca suggested that the frontal lobe lesion he discovered caused the patient’s speech deficit. Eventually, other scientists began to confirm Broca’s hypothesis. This area of the brain, presently referred to as **Broca’s area**, is known to be implicated in speech production. Furthermore, Broca’s discovery that the lesion only appeared on the left hemisphere proved to be significant—this discovery provided evidence that the brain’s two hemispheres perform different functions. In specific, the left hemisphere is implicated in speech production. Later studies have provided support to the idea that the left hemisphere is dominant for speech in most individuals, which has become common knowledge in neuroscience.

Another case study which has provided invaluable to the study of the relationship between the mind and the brain is the story of Phineas Gage, a foreman who fell victim to an explosion which drove a
tamping iron through his left cheek and into his skull. Remarkably, Gage survived the blow and was alive and conscious minutes later. The only thing which changed about Gage was his personality - as his friends and family would later note: Gage was “no longer Gage” (O’Driscoll & Leach, 1998). Though Gage became blind in the left eye and exhibited left facial weakness, Gage suffered no further neurological defects, despite the fact that the tamping iron lay embedded within his brain for the remaining twelve years of his life. During the time of Phineas Gage, the functions of the frontal lobe were shrouded in mystery. Scientists today would categorize Gage’s injury and resulting personality change as damage to the orbitofrontal cortex, an area within the frontal lobe critical for attention and emotion. In an age where the mind was regarded as separate from the body, Gage’s story launched an ensuing 150 years of further research concerning the intricate connections between the mind and the brain. (Driscoll, 1998).

However, one of the most iconic case studies in the field of neuroscience is that of patient H.M. Patient H.M developed chronic memory impairment resulting from a series of experimental procedures designed to cure his epilepsy. The medial regions of his left temporal lobe were removed, and his epilepsy was largely ameliorated. However, he developed a condition known as anterograde amnesia. This condition is characterized by an inability to form new memories. Prior to studying H.M., scientists and doctors believed that memory was stored in several cortical areas and was associated with intellectual and perceptual functions. H.M. altered this way of thinking with the impairments he suffered from after the medial temporal lobe resections. His severe short-term memory loss indicated that a specific subset of memory could be attributed to a unique cortical area, and not just the cortex as a whole (Squire, 2009).

Though he passed away at the age of 82, the case study of HM launched the modern era of memory research. Despite his difficulties in declarative memories, several tests determined that not all types of memory were altered by H.M. ’s injury. After repeating the same test of motor ability several times, H.M. showed robust improvement despite not having conscious recollection of completing the task. According to Dr. Larry Squire, “This demonstration provided the first hint that there was more than one kind of memory in the brain and suggested that some kinds of memory (motor skills) must lie outside
the province of the medial temporal lobe.” (2009). Thus, studies on patient H.M. revolutionized how neuroscientists thought about memory--researchers began to recognize that memory was multifaceted and different types of memory were located in different brain regions.

Case studies continue to be pivotal components of neuroscientific research. They have opened up many channels for expanding knowledge on the human brain, as human ablation studies are often impossible to conduct due to ethical concerns. Though relics of the past, Tan, Gage, and H.M. have contributed tremendously to the fields of speech, personality, and memory, respectively, and they will continue to do so as research continues to progress in these fields.

Questions to Consider:
Will there ever be a time when case studies are no longer needed? What would have to happen for such a time to occur?
What do case studies provide to researchers that in vitro research cannot provide at the present?
Which of the three case studies described was most significant? Why?

Key terms (in order of their mention)
Broca’s Area-A part of the frontal lobe implicated in speech production
Orbitofrontal Cortex-A frontal lobe region linked to personality and higher cognitive functions
Anterograde Amnesia-A condition characterized by the inability to form new memories

Works Cited

Neuroscience Research Spotlight: Dr. Geoffrey Ganter

By Kyle Ryan

Last week I sat down with Dr. Geoffrey Ganter to discuss his research. Dr. Ganter works in the University of New England’s (UNE) Center for Excellence in the Neurosciences; like many of his colleagues at the university, he specializes in pain research. Dr. Ganter uses *Drosophila Melanogaster*, or fruit flies, to conduct his research, and explained that the main purpose of his research is “to understand how pain works at a basic biological level...the neurobiology of pain.” In his lab Dr. Ganter uses fruit flies with the goal of making relevant connections with humans hoping to eventually develop drugs that attack pain without having the dangerous side effects that many opiates cause, especially after long exposure to these drugs. One such effect is addiction, which is becoming an increasing problem in the United States and world today. Dr. Ganter hopes that his research will, “result in finding new drug targets outside the opioid system to be effective without the side effects.” Dr. Ganter also explained to me that like the more usual rodent model, fruit flies enables his team to study the pathways that exist in mammals, but these flies have added benefit of being able to reproduce quickly and effectively offers results, as well as giving his lab the ability to study many generations of flies in a matter of weeks. Dr. Ganter emphasized that the most significant reason he uses fruit flies versus the typical pain research model is because, “the fruit fly is a very tractable model...[he] can more easily manipulate the genetics of the animal and [he] can ask more detailed questions...at the basic biology level.” The ability to manipulate the genome of a fruit fly is essential to Dr. Ganter’s
research and with these transgenic *drosophila* larvae, Dr. Ganter can, “cause genes of interest to be underexpressed [or overexpressed] in the nociceptor neurons...the sensory neurons that perceive the painful stimulus...[and] target genetic manipulations just to [a certain] cell type.” It allows Dr. Ganter’s lab to not have to trigger mutations across the whole animal as many rodent pain research may require, and instead specifically manipulate the genome of the fruit fly to expose new pathways and drug targets. This technique has allowed Dr. Ganter’s lab to identify over 12 genes in the past few years that can be used as drug targets for pain medication. Before Dr. Ganter began conducting research on fruit flies and even before deciding to focus on neuroscience, he was interested in botany, the study of plants. In fact Dr. Ganter had received his PhD studying plants at Boston College, before he was inspired to pursue neuroscience research. His pursuits of neuroscience began when he met a visiting seminar speaker to Boston college, Dr. Edward Kravitz from Harvard Medical School, who was studying aggressive behaviors in lobsters, and later became his postdoc mentor. Dr. Ganter eventually found himself at UNE in part due to UNE’s unusually high proportion of neuroscientists. This allows a neuroscience researcher, like himself, to be in a community “that supports you, gives you ideas, helps you with technical assistance, [or simply] chat and get ideas from other professors.” It also makes it easier to get large grants for their programs—UNE Pain Researchers have been awarded the COBRE grant for the past five years from the National Institute of Health. To end the interview I asked Dr. Ganter what he believed was the most pressing issue in neuroscience today and he answered “pain,” going on to explain how, “pain is a huge issue [today]...we don’t have a national institute of pain...[yet] pain is a huge,
huge problem...more than 100 million americans are affected by chronic pain.” He continues with his passion for the need for more of a focus on pain by telling me that, “we think about pain in the wrong way, that it’s only a symptom...but in many ways we should be thinking as pain as it’s own disease, especially chronic pain.” The problem thus being for him and many other researchers without a national institute of pain is that they have no “national institute to oversee that [research], to apply for grants, you have to decide where it is going to come from,” and this lack of a centralized national group is a “problem because of global problems like opioid abuse leading to things such as social problems, violence, devastation of communities, connecting back to their problem of pain.” Pain leads to many problems in our society and as Dr. Ganter explained there needs to be a greater effort in its research and significance to bring about a significant change. To all those interested in research, Dr. Ganter implores you to “get involved with research and try it” which is why he has always been “passionate about offering research opportunities to students;” with that hope that the field of neuroscience will continue to grow, hopefully with a greater emphasis on pain research in the future.
PhD Student Interview

By: William Ellsworth

I interviewed Desirée De León, a rising 3rd Year PhD Student at Emory University. She described her research, thoughts, and experiences as a PhD student working on behavior in primates. Despite the grueling demands of PhD programs, Desirée manages to find the beauty in her studies.

William: What kind of research are you currently performing?

Desirée: I study social behavior and genetics in rhesus macaques, a very social species of monkey. I'm very interested in how individual differences in genes and early life experience impact brain development and shape an individual's social profile throughout their life. This is particularly relevant for understanding the social impairments that characterize disorders like autism spectrum disorders, social anxiety disorder, and schizophrenia. In my research, I am closely analyzing how small changes in two genes influence levels of the neuropeptide oxytocin in the brain and how individual differences in the genes may predict a variety of social "personalities". Oxytocin is the neuropeptide I focus on because it is the hormone in the brain responsible for facilitating social bonding in many different species. Oxytocin initiates new mothers' care-taking behaviors in rodents and sheep after parturition. Oxytocin is also necessary for rodents to remember previous social interactions, and in the prairie vole, it is largely responsible for establishing a monogamous bond between mates. I spend a lot of time doing genetics work, sequencing the gene for oxytocin and the gene for its receptor, using blood samples acquired from the rhesus macaques. I also spend time observing and recording the monkeys' behaviors as they interact in large social groups, and track their behavior from birth through adolescence. This will allow me to see how social behavior changes for each monkey across development. Understanding the link between variation in the oxytocin genes and social behavior will
allow us to get an idea of what specific genetic combinations most directly influence the brain, and what combinations make an individual more or less susceptible to developing social disorders.

**W: Describe a typical day as a PhD student.**

D: As a new student, the typical experience involves attending a daily class where you get a very intensive overview of every imaginable topic in neuroscience. Each day there is a new topic with a new speaker. After the first year, most classes are out of the way, so the bulk of your time is spent in the lab, defining your thesis and beginning to collect data. For me, this means I am out at the field station, where my monkeys are. Working with monkeys makes my lab experience slightly atypical because taking care of a rhesus takes an entire team of people. The monkeys I am studying are also studied by different people for other projects--as a team effort, we all help train the monkeys and collect samples for the others on our team, even if it is not directly related to our project. Being a primate researcher, you also have to work on the monkeys’ schedule. Many samples needed for the research (like certain blood measurements) are time-sensitive and need to be collected before the animals wake up and become active. This means the workday begins before the sunrise. My days typically have very early starts because of this, but it usually involves being able to hold and cradle a baby monkey while we get the sample we need, so it's completely worth it!

**W: I understand that you did lab rotations during your first year as a PhD student. Can you tell me more about this process?**

D: A rotation is basically an 8-10 week experience where you become a temporary employee of a scientist's lab. The idea is that you will find a lab that has a research topic and work culture that is a good fit for you to stay on long-term for your thesis. It's a really great way to sample many different parts of the field. At the conclusion of each rotation, we wrote up a lab report detailing the projects we completed in the lab. My first rotation was spent in a pharmacology lab. There I did a lot of work at the molecular level, growing neuron-like cells in petri dishes and measuring protein levels with western blots. My second rotation also involved growing cells in petri dishes, but the focus of the second lab was on microscopy. I learned to take 3D images of the parts of the cells I was growing (like axons and dendrites)
with a specialized microscope. For my third rotation I worked with brain tissue of monogamous rodents and learned several anatomy techniques. I learned to stain brain tissue and characterize how neurons that produce oxytocin project from one region of the brain to another. This was the rotation where I learned about oxytocin's role in social behavior. My last rotation was at the field station where I learned to work with primates and study their behavior. When it came time to commit to a lab, I decided to forge a co-mentorship between the principal investigators of the oxytocin lab and the primate lab. I am now a member of both of their labs, and my research blends their respective expertise.

W: What is the most difficult part of being a PhD student?
D: The most difficult part of being a PhD student is being able to stay motivated when different parts of a project inevitably fail. You obviously can't control whether the data will be what you expected. Sometimes you can't get a necessary technique to work, or you get messy results that seem to contradict each other. It's important to stay determined and keep an open mind about new directions your project could take.

W: What is the most rewarding part of being a PhD student?
D: Ultimately, the most rewarding thing will be able to look at my dissertation work and know that I contributed something to the scientific community that others will be able to build on. Until that day comes, though, I think it's really rewarding to fully immerse yourself in a question that no one else has ever answered before. The fun part is being able to get creative about how to answer it.
Madison F. Wilson, tenured researcher at the Smith Institute of Neuropharmacology and Ph.D in Statistics, is making waves in the scientific community. After completing her latest study on *Caenorhabditis elegans* feeding behavior, Wilson used a 0.60 level of significance instead of the 0.05 generally accepted by scientists. By doing so, she proved that nachos are, in fact, delicious to all animal species.

One reputed scholar calls the move to alter the significance level “revolutionary”, representing one of the most “exciting advances in neuroscience research since the Golgi Stain.”

Using Wilson’s novel system, researchers have found that proving hypotheses has become substantially easier, and an outpouring of statistically significant research has followed. For example, a separate research team has discovered that the incidence of Alzheimer’s is directly correlated to per capita yogurt consumption in Wisconsin. By removing all yogurt from the state, researchers expect to see the incidence of Alzheimer’s decrease to zero within five years.

Many scholars have criticized Wilson’s methods, calling them “statistically illogical” or “outright stupid”. However, a new study from Wilson’s lab at the 0.60 significance level found that scholars generally support Wilson’s methods. One reason for this may be recent publications, with the following provocative titles:

- Nice Guys Finish Last: The Link Between Selfishness and Sprint Pace
- Puppy Love: Affection a Result of Stockholm Syndrome
- Whiteboard Marker Usage and Cancer: The Deadly Truth
- Smiling and Cancer: The Deadly Truth
- Vegetables and Cancer: The Deadly Truth
- Smoking and Cancer: No Relationship Found
The Wilson lab is in desperate need of results to maintain its generous funding from major institutions; thus, this discovery came from a rich combination of necessity and innovation. A large-scale scandal emerged after members of the Wilson lab were found placing cyanide in drinks at their gala intended to celebrate Wilson’s discovery. Lab members defended themselves by claiming that “using our novel methods,” cyanide ingestion is proven to “extend the human lifespan by 15 years.” The researchers are currently being held on $500,000 bail; should this money be received, the researchers promise to use it to fund new studies into the relationship between croquet and major concussions.

Disclaimer: This article is intended purely as satire. As such, any resemblance to existing persons living or dead, events, or locations, is purely coincidental. Any references to well-known celebrities, locations, or corporate entities is intended purely as fiction, and all statement made in this article are intended to be interpreted as purely fiction; no statement made should be interpreted as fact. The YNCA Journal holds high standards of quality and respect. Thus, should any entity want us to change the names used in our article, the YNCA editing staff will promptly rectify this problem. Please contact YNCA.info@gmail.com with any queries regarding the aforementioned service. Furthermore, tobacco smoking is a dangerous habit that has been conclusively shown to increase risk of lung cancer. Do not treat any statements made in this article as fact or medical advice.
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Regional Outreach Directors: Meenu Johnkutty (Northeast), Alexander Skvortsov (Mid-Atlantic), William Ellsworth (Southeast), Jessica Reisinger (Central North), Karina Bao (Central South), Jacob Umans (Pacific), Dhanya Mahesh (Southwest)
Founder/Advisor: Dr. Norbert Myslinski

Want to contribute to the YNCA? Contact us at ynca.info@gmail.com for more information!
Sources for Pictures

Alien hand

Diabetic Neuropathy

PhD Interview
https://pixabay.com/en/microscope-slide-research-close-up-275984/

History of Neuroscience

Famous Case Studies

Neuro Basics 1