

TUNA

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SYNAPSE

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Amyloid plaque buildup on an aging neuron

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Executive Board, 2014-2015

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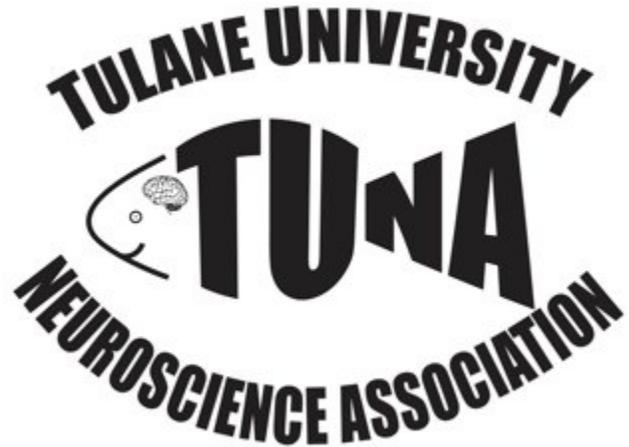
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GiST & Halloween Day

Every semester, TUNA is involved in the hosting of an event called Girls in Stem, which invites fifth through eighth graders to meet with women role models in the fields of science, technology, engineering, and mathematics. The girls have the chance to explore different interests or ask questions at the welcoming tables and then break off into smaller groups to participate in more hands-on activities. This semester, TUNA's welcoming table offered a variety of optical illusions and other tests, as well as the addition of the memory boxes activity. It was great to see the girls being actively engaged and curious about the brain mechanisms which allowed them to perform the activities (or in some cases, how their brains were tricked!). They then had the opportunity to rotate between groups in the neuroscience teaching lab, performing dilutions, executing experiments, and seeing actual brains and spinal cords. The beautiful, rewarding part of this event is not what was written on paper, or even the activities the girls were

participating in; it was witnessing the intellectual spark and curiosity that is ignited when their minds are given the chance to explore new ideas without fear of wrong answers.

TUNA also hosted a table on Halloween Day, a fun-filled event in which students from local elementary schools were brought to campus to experience a variety of different things, from food, music, and decorating pumpkins to bounce houses and even a petting zoo. Last semester, members of TUNA got super *spookyyyyyy* and performed the phantom limb demonstration on several curious children; some of the responses were hysterically priceless. It was great not only to have the chance to teach younger students about how the brain communicates with the body, but also to simply see the kids running around the quad with bags full of candy and smiles on their faces.

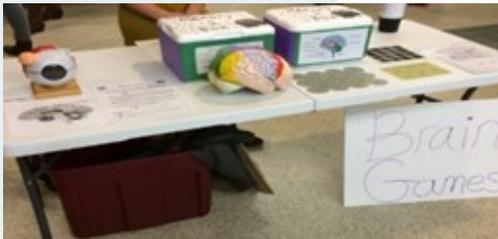
- Megan Haney ('18)

Girls in STEM

What Do You Want To Be When You Grow Up?



Through GiST, Tulane invites girls from local middle schools to come to campus and experience both the fun and educational—but mostly fun—aspects of science, technology, engineering, and mathematics. I volunteered for the neuroscience section this semester, and as I helped these girls discover the wonders of pipetting, I found myself asking them, “What do you want to be when you



grow up?” I was always the kid that changed her answer every time someone asked. But when I asked these girls, they defi-

nitely knew what they wanted to be. Their answers would range from chemist to doctor to engineer, but they all had one thing in common—science.

When kids are younger, an equal amount of boys and girls declare they would like to become scientists. As these kids grow older, however, the balance is disrupted since fewer girls remain interested in science. Reasons may range from the lack of female role models in STEM, girls feeling as if they aren’t capable enough, or even from distaste for science since it’s no longer “fun.”

Girls in STEM provide an atmosphere in which the girls can find successful role models, are encouraged to pursue their love of science, and have fun while doing it. Ask these girls if they like science and they will enthusiastically reply, “I love science!”

- Sharon Luc ('18)

“When kids are younger, an equal amount of boys and girls declare they would like to become scientists.”



The Neurobiology of Decision-Making

Suppose you are buying a new car. You head down to the dealership, take a few test drives, and examine the contours, the varying colors, the makes and models. You have a preference, because not any one car will do. It has to be something that you like, that is aesthetically appealing, that fits your taste. You come across the car that fulfills these requisites, and you buy it. You make an executive decision. Or suppose it's November; the time to vote has finally come back around. You've been listening to Obama's relentless ads on television, but every word he says seems to strike you the wrong way. You're a rational conservative at heart; you've held right wing beliefs ever since you can remember. So you check the box next to the Republican on your ticket and call it a day. Your decision seemed innate; you can't exactly pinpoint why you possess the ideals that you do, but you run with them anyway.

Though these may be simple examples, they both represent a decision seemingly made with a purpose. On the surface, our actions represent something of a choice, an assumption of free will or conscious deliberation. We decide how we act and we ultimately carry out that action through conscious processing. But upon closer examination, this argument becomes problematic. David Eagleman, a neuroscience professor at the Baylor College of Medicine, suggests in his book *Incognito: The Secret Lives of the Brain* that, "Human behavior cannot be separated from human biology." In an effort to substantiate this claim, Eagleman states that our choices and behaviors are restricted to our neural circuitry, the unique pattern of neural connections in the brain. These connections, Eagleman proposes, are formed and altered by our genetic code, our experiences, and our environment. As it turns out, one's apparently conservative agenda may not be so much a matter of free choice but rather a result of inherent biological processes.

Molecular and behavioral genetics is definitively showing that there is a genetic basis for many of our behaviors. Consider the genes you were given at conception. Not only were you unable to choose what your genetic code was going to be, you also cannot be *responsible* for the genetic code you received. Genes are instrumental in defining who you are and how you behave. An individual with autism experiences social deficits and impaired communication skills, behaviors directly linked to their genetic expression. It has also been reported that males are 13 times more likely to sexually offend than females, eight times more likely to commit murder, and three times more likely to commit a robbery. Males, it seems, are genetically predisposed to be more violent than females (Eagleman). Genes shape the brain's physiological functioning, which has a great impact on one's decisions.

But genes aren't the only thing that determine our behavior; our environment, particularly in our most formative years, can modify the brain's plasticity. In studies of brain plasticity and behavior, it is assumed that any change in behavior must be a result of a change in the brain's organization that is involved in that particular behavior. This is evident in a study conducted at the University of California at Berkeley, which examined the behaviors of rats living in an enriched complex environment; these rats demonstrated a dramatic increase in synaptogenesis, dendritic spines, and myelination, three neurological processes that aid memory, spatial reasoning, and a myriad of other cognitive functions. Recent studies in humans who experience similar environmental enrichment have found similar results. However, exposure to in-utero drugs, sexual or physical abuse, or even high levels of stress can compromise these excesses, resulting in a decrease in dendritic density and length, synaptic loss, and neural death.

This regressive reorganization of the brain accounts for negative changes in behavior such as poor social judgment and impulsivity. It is of considerable interest to understand the relationship between brain plasticity and experience because it aids in differentiating between the causes of normal and abnormal behavior. A wide range of experiential factors are responsible for the constant changing of the structure of the brain and consequently, the way in which we make decisions.

It is important to understand that the interaction of genes and environment means that everyone has a different perspective and a varied capacity for decision-making. But it is also just as important to understand the behavioral effects of more extreme variations of the brain. Take Charles Whitman as an example. On the morning of August 1st, 1966, Whitman murdered his wife and his mother while they were sleeping. Later that day, he engaged in a spree shooting at the University of Texas at Austin, killing 16 people and wounding 32 others. His weapon of choice was a sniper rifle, perfect for long-distance shots from the top floor observation deck of a 27 story building located in the heart of campus. Whitman fired upon the students below for a relentless two hours until the Austin PD were able to storm the building and take fire at Whitman with a 12 gauge shotgun. Whitman was shot in the head and neck and was killed instantaneously.

This was not a deliberate act of violence. Whitman maintained a journal in which he detailed his intentions and his thoughts. In this journal, he admitted that he could think of no logical reason as to why he intended on killing his family and the students at the University of Texas. He claimed that he was a victim of many unusual thoughts and impulses, but could not find any legitimate basis for them. Believing there was something biologically wrong with his brain, he requested to have his brain examined after he was killed in order to uncover the reason for his violent behavior. His intuition was right – after his death, the medical examiner opened up Whitman’s skull, inspected his brain, and found a glioblastoma near his amygdala in the right temporal lobe, impinging on the thalamus and hypothalamus. The amygdala serves a primary role in the processing of decision-making and emotional regulation; when it is damaged, one may act out in violence and aggression, or may not have an emotional reaction at all. Psychiatric reviewers of Whitman’s case concluded, “The tumor conceivably could have contributed to his inability to control his emotions and actions” (Eagleman).

Tumors may influence our behaviors, but much less obvious abnormalities such as chemical imbalances may also affect behavior, as is the case with some Parkinson’s patients. Parkinson’s is a degeneration of dopamine-producing cells in the substantia nigra, a structure in the midbrain responsible for projecting dopamine to the basal ganglia, an area associated with control of voluntary motor movement. Along with supplying this area to carry out motor function, dopamine also mediates the reward systems in the brain, driving people towards things necessary or useful for survival such as food and sex. When these patients are prescribed too high a dosage of pramipexole, a drug that impersonates dopamine, their reward system goes haywire, resulting in gambling, binge-eating, and drug addiction. These decisions seem to the patient as voluntary and autonomous, but they are not. They are linked to a chemical imbalance in the brain entirely out of the patient’s control.

All these examples raise an important question – if there is a biological explanation for our actions, ranging from a simple harmless vehicle purchase to a premeditated and violent murder, then to what extent are we *responsible* for these actions? Does free will exist, and if so, to what degree should we be held accountable? As we have already seen, it seems as though our capacity for decision-making depends on factors outside of our control; who we are, what we think, and how we behave all stem from inherent biological roots. It is counterintuitive, then, to assume the existence of free will if we have no choice regarding the biological makeup of our brains. Eagleman provides an example to illustrate:

Consider a decision to move or speak. It feels as though free will leads you to stick out your tongue, or scrunch up your face, or call someone a name. But free will is not required to play any role in these acts. People with Tourette's syndrome, for instance, suffer from involuntary movements and vocalizations. A typical Touretter may stick out his tongue, scrunch up his face, or call someone a name—all without choosing to do so. We immediately learn two things from the Tourette's patient. First, actions can occur in the absence of free will. Second, the Tourette's patient has no free won't. He cannot use free will to override or control what subconscious parts of his brain have decided to do. What the lack of free will and the lack of free won't have in common is the lack of "free." Tourette's syndrome provides a case in which the underlying neural machinery does its thing, and we all agree that the person is not responsible.

The Tourette's patient gives us insight into the inner workings of the brain and its relationship to decision-making and free will, but the argument can go further than just proving that certain behaviors don't require free will as a prerequisite. Research into the correspondence of electrical signals from the brain and the contents of consciousness might provide an answer to this question of free will. Benjamin Libet was a neuroscientist at the University of California at San Francisco. His experiments were simple—he measured the electrical activity in the brain when volunteers were asked to do simple tasks. He compared the times of increased brain activity to the times at which the volunteers were consciously aware of making the decision to perform a task, such as moving a finger. These experiments consistently found that brain activity preceded the conscious awareness of a decision by a couple hundred milliseconds, meaning that our decisions are carried out before we are even consciously aware of them. This could possibly justify the claim that free will is an illusion.

The judicial system presumes the existence of free will, that we are all logical reasoners before the law and are capable of making decisions and understanding the consequences. We condemn those who don't show any obvious signs of neurological duress and release or rehabilitate those who do. But what is the basis of this assumption that some are responsible and others aren't? It may seem presumptuous to suggest we are not responsible for our behaviors and decisions, but we only have to look back to the early 1900s to see there has already been a shift from responsibility to the details of our biology. Patients with psychological disorders such as schizophrenia, mania, and depression were once treated as criminals; they were jailed, subjected to violence and torture, and were accused of being overindulgent, unmotivated, or poorly disciplined (Eagleman). However, as our understanding of the brain has increased, individuals with these disorders have been held less and less responsible for their actions. The effectiveness of prescription drugs has aided in this venture, helping us identify and treat involuntary behaviors that we once considered voluntary. Responsibility changes as we progress in our understanding of neurobiology. Soon, there will be enough evidence to prove that bad decision-making is just as biologically rooted as schizophrenia or depression, and will require the same rehabilitation as these mental illnesses.

Thinking of human behavior from a biological perspective is no longer questionable. Every day, new research is being conducted that suggests our genes and experiences are the foundations of our behavior, from simple things like who we vote for to a propensity to commit a certain crime. Every action and reaction is due to our biology. It is only after our technology for understanding the brain improves that we will be able to succinctly answer this question of responsibility. We cannot yet pinpoint a particular location in the brain or a particular set of neural connections accountable for a particular behavior, but once we can, once we do reach that point of technological competency, we will gain even more insight into quite possibly the most liberating and compelling facet of neuroscience: why we do the things we do.

Thoughts on Alzheimer's

It might be superfluous to say that Alzheimer's is a tragic disease. With a disease so saddening comes a cornucopia of uncertainties. What are the risk factors? How can I cure it, or at least counteract the devastating effects? Is it preventable? What's the prognosis? These questions are starting to haunt more and more people as Alzheimer's maintains its sturdy and unrelenting grip.

For a neurological condition such as this one, these questions cannot be answered with succinct certainty. Alzheimer's, one form of dementia, is a multifactorial disease. There is not one causative agent to be detected and then uprooted. We do know that an amyloid plaque build-up is one of its hallmarks. We also know that it's at least partially heritable. But there are more subtle factors that might also influence the onset of the disease. Such subtle factors include, but are most certainly not limited to, diet and exercise habits. More neurologists are starting to adopt this holistic approach - and with reason indeed. That's because many studies have nudged them in that direction.

My research (if it can be regarded as such) with regards to Alzheimer's and other forms of memory deterioration is only empirical and anecdotal in nature. I've been working in nursing homes since 7th grade. Needless to say, I've absolutely adored my time with my sweet, old friends. In the meantime, I've also learned a lot. After so many years, I've made the observation that those who engage themselves in mentally stimulating tasks tend to be the sharpest ones with the most primed memories. Mentally stimulating tasks, in my usage, does not encapsulate only expected activities like solving puzzles and reading novels.

Rather, even engaging in conversation seems to fit, with an ever so slight stretch, the label in this context. I'm not saying that introversion is a predictor of Alzheimer's or anything of the like. Instead, I only mean to suggest that there seems to be a correlational link between the two variables of intellectual or social stimulation and memory. My claim begs the labyrinthine question, "Which came first: the chicken or the egg?" Is it that those who are more proactive are less susceptible to Alzheimer's wrath, or that those with the earliest symptoms of Alzheimer's are unable to engage in mentally stimulating activities in the same way that those without them are? Unfortunately, I don't have the answer. This is simply an illustration of an aforementioned point: questions about Alzheimer's (and other things, of course) are not nicely bifurcated between an easy yes and no. Instead, they teem with murkiness.

One thing seems clear, though: we should strive to make the lives of those living with Alzheimer's as comfortable as possible. Art is a good avenue, I think, for defusing feelings of anger, sadness, or confusion. By art I mean visual craft as well as music, which holds great therapeutic virtue. Responding to patients' anxieties with comforting words and gestures is also of paramount importance. After all, evolution has primed us to be social creatures. It's wholly possible that neglecting Alzheimer's patients and allowing them to sort through their problems alone could exacerbate the progression of the disease. In my (sometimes) optimistic heart, I believe that progress with regards to Alzheimer's research isn't so remote.

-Hanan Rimawi ('18)

The Brain Health Registry: Investigating Aging

Approximately one third of the total cost of neuroscience research comes from recruiting participants for studies. In response to this obstacle, the University of California, San Francisco, in partnership with Luminosity, Cogstate, and the Veterans Health Research Institute, has launched a novel initiative called the Brain Health Registry, through which volunteers provide neuropsychological data by playing online games.

The project's founder is Michael Weiner, MD, UCSF professor and principal investigator of the Alzheimer's Disease Neuroimaging Initiative, the largest observational study focused on Alzheimer's in the world. Said Dr. Weiner in a press release, "The greatest obstacles to finding a cure for Alzheimer's and other brain disorders are the cost and time involved in clinical trials. This project aims to cut both and greatly accelerate the search for cures...It will open up the research world."

The only requirement for participants is that they be at least 18 years of age. Volunteers can register at www.brainhealthregistry.org, upon which they will be asked to complete a questionnaire about their medical history and lifestyle before beginning to take cognitive tests in the form of online games. Participants are asked to return to the site every 3-6 months to update their information and play more brain games, and to continue to return regularly for years to come. The hope is to collect a large pool of data that can be used to increase understanding of how the brain ages. Any outside researchers can apply to gain access to this data. To date, over 22,000 participants have added themselves to the registry, with the project's goal being 100,000 participants in the database by the end of 2017. The initiative is believed to be the first Internet neuroscience study of this scale.

Many of the 22,000 who have already volunteered to register their brains have done so in honor of a person close to them who is struggling with the effects of a neurodegenerative disorder, as exemplified by the testimony of California resident and study participant Anne de la Rosa: "My college roommate was recently diagnosed with Parkinson's. She's working hard – exercising, meditating, doing yoga – to keep her symptoms at bay, and she's holding on to the positive attitude she's always had. I'm hoping this research can lead to a cure and help her stay positive and vital. That's why I'm here."

- Natalie Pilgeram ('17)

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O'Connor, Lydia. "How Online Gaming Could Help Neuroscientists Research Most Troubling Brain Disorders." *The Huffington Post*

<http://www.brainhealthregistry.org/>

Thief

A dog runs in his sleep, paws milling uselessly, unaware.
The alarm pulses green, an eerie eye peering balefully into the gloom.
The refrigerator hums, the ice shifts, crunches.
Upstairs, husband and wife sleep blissfully, soft snores.
All is still.
But up above, cloaked in gloom, a shadowy figure cracks open the attic window.
Slips inside, stealthy as a whisper.

Morning rises, the coffee maker chugging away.
She pauses by the door, one boot half on,
Wonders, why am I here?
Shakes her head, pads back to the kitchen.
Feeds the dog, carries on.

The moon, a glint of a grin, rises over the house.
A blustery wind disguises the creak of floorboards,
The slam of an upstairs window.
He surveys the wooden trunks stacked in precarious pyramids,
One chest already open.
Examines the boxes that line the walls,
Cheap packing tape securing their flaps.
Draws a fingernail down the side,
Selects a journal at random.
Runs a tar-colored finger down the page,
Rips.

Almost daily he returns,
Steals a parchment page here, a word there,
A key here, a few minutes there.
Never pocketing a whole journal, nor many objects at once.
Insidious.

Downstairs she forgets her mother's pastry recipe,
Wanders looking for a key that was always in her purse,
Loses the words to a favorite poem,
That only return hours later, smudged.
Sometimes they notice,
Often they laugh.
She jokes, blames her wrinkling skin,
Aching back, thinning hair.

Still upstairs, the heist continues.
Sometimes he brings other thieving friends.
Throws a flute out the window,
Snatches a fistful of cheap jewels,
Crumples up a photo.
Never choosey.

The laughter downstairs begins to echo thinly,
Wrinkles foreheads once free of creases.
Sends concerned friends and family to the phone,
To the doctor,
To the hospital,
To gloomy corners they don't want to face.

Years later, the wooden trunks are overturned,
Empty turtle shells, dry bone,
Their contents are spilled upon the floor,
Picked through at random.

Aging cannot explain
The absence, the forgetfulness.
Aging cannot explain
Post-it notes covering the fridge,
Family photos hidden beneath the deluge.
Aging cannot explain
Jokes that have long since died,
Fallen silent on murmuring lips.

Fast forward.
Talk of caskets and gravestones,
Organs and antiques.
A dog limps by, cataracts clouding its eyes,
Forgotten for a moment.

Weeks later come wills and wilted flowers.
Casseroles left untouched.
A new fridge, bare,
Its steely surface reflects condolences and hushed tones.
A draft blows upstairs, whistling through the rafters.
But no one hears.

Eventually the daughter pulls down the ladder,
Climbs upstairs.
Hasps lie shattered on worn planks, keys tossed aside.
The stained glass window gapes open,
A silent scream in awe of crushed beads and splintered wood,
Crocheted scarves stretched out and sullen,
Lacy pillow riddled with holes.
The spines of old journals are scattered across the floor.
She sinks to the ground,
Eyes filling,
Loss all-consuming.
Then falters
At the smell of carnations lingering, an old woman's perfume,
And a scrap of paper untouched,
Her name.