Preface

For as long as I have known, I have been obsessed with the brain. By appearance, the brain looks like a three-pound glob of mushy tissue packed together. But this glob of mush creates and sustains human life. It produces our movement, senses, ideas, and most important, our personality. I have always felt that the brain probably does even more than we are able to understand at this present moment. This mystery—the unknown aspects of the brain—intrigue me. I want to find out more to solve as many mysteries about the brain as possible. I have a personality that hungers for discovery. I want to fall down the rabbit-hole and into the knowledge and processes the brain creates. Every so often I have experiences where I feel like my soul is looking out of a separate body. I wonder how I got to this point. Why am I in this body? How did I become *this* person? From these questions, my curiosity about the brain has thrived. What created me? Who am I today? Throughout this paper, I plan to discover where the sense of self is created and what "self" means to me.

Introduction

It may seem as though we know all about the brain, but in truth there are many unanswered questions about the brain and its processes. The one major question in this paper that I want to address is: "What makes 'you', you?" In Joseph Ledoux's book, *Synaptic Self*, he asked neuroscientists the question, "What do we know about the brain's mechanisms of self and personality?" (LeDoux 1). They mostly would say, "Not much." Every single human being is, generally speaking, made up of the same parts, but somehow we all are different. In our movement, thoughts, even in how we perceive our senses, we are unique. Everyone internally feels like he/she has a sense of self. We know who we are. By looking deep into the brain and its capabilities, I am going to learn more about how the self is created, consciously and unconsciously. To begin, I will discuss the background of what exactly makes the brain achieve its processes: neurons. Next, I will introduce the hypotheses of Joseph Ledoux and Sebastian Seung about how the brain creates our identities. In the next part of the paper, I will thrust myself into the nature vs. nurture debate and, ultimately, introduce my own metaphor into what I believe a "self" is. Finally, I will explore the personal nature of who I am.

Connectome and Synaptic Self-Hypotheses

At first glance, the brain looks like a pulpous mass, but trillions of microscopic chemical and electric connections are found inside. The main component found in the brain that generates these connections are neurons. The brain is made up of 100 billion neurons that talk to each other and make everything we do possible. Who we are and how we interact with the world is made possible by neurons and their connections. The basic architecture of a neuron starts with its center known as the soma. Next comes the axon; the axon contains neurotransmitters, which transmit information to other neurons across a space called a "synapse." Lastly, what receive the signals of other neurons are the "dendrites."

Axon from another cell

Synapse

Dendrite

Axon

Nucleus

Synapses

Cell Body or Soma
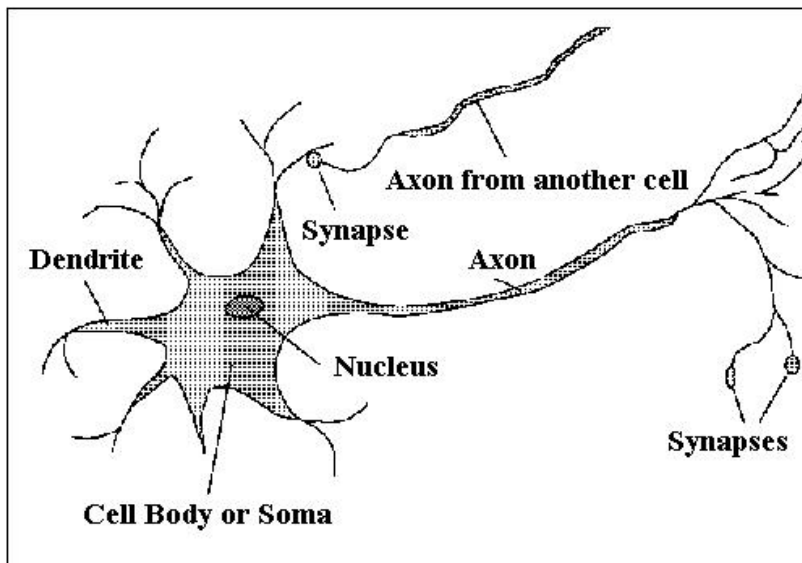
Neurons are the basic components in the brain, but what really makes us who we are, are the synapses. A synapse is the space where two neurons touch, or where the chemical or electrical signals between neurons are passed. These chemical signals create our movement, thought, memory and speech. A sequence of neurons with synapses receiving or transmitting signals is known as a pathway. From all this information, two scientists have developed similar hypotheses into what in the brain's wiring makes us who we are.

Both Joseph E. LeDoux, in his 2002 book, *Synaptic Self: How Our Brains Become Who We Are*, and Sebastian Seung, in his 2012 book, *Connectome: How the Brain's Wiring Makes Us Who We Are*, present hypotheses into how the brain's wiring creates personality. LeDoux argues, "Self is synaptic." Self, or personality, is shown in the patterns of interconnectivity between neurons in the brain: "Connections between the neurons, known as synapses, are the main channels of information flow and storage in the brain" (LeDoux 2). Seung makes the hypothesis that, "We Are Our Connectome." In this statement, he uses the word "connectome" as an analogy to a genome, which is the pathway of the brain's neurons and synaptic connections. He believes every connectome is unique. A person's uniqueness is then encoded into the neurons. Even though these two scientists made their hypotheses ten years apart, they are each basically stating the same thing. The "self" is found in the connections between our neurons. These synapses contain our identity and make us who we are. Both of these hypotheses seem believable. Then why then are they still hypotheses?

Humans make new technological advances everyday. But the one that remains undiscovered is how to map the connections of neurons in the brain. It has taken scientists twelve years to map a worm's pattern of 300 neurons. In this pattern, they found 7,000 connections. A human brain consists of 100 billion neurons; imagine how many connections would be found in it. More sophisticated technology is needed to map a human's neuron pattern. Once this technology is finally achieved, scientists will be able to fully discover and prove or disprove

where a person's self is found. If it is believed that individuality is encoded in these connections, how is a person's uniqueness created and can it change?

Where Nature + Nurture meet

A person's identity is found in the synapses or connections between neurons. Yet how are these connections created to show a person's identity? As most of us know, "People don't come preassembled" (LeDoux 3). Everyone has different genes and different experiences in life. No two person's lives are the same. Humans are not carbon copies of each other. Nature and nurture battle each other for control over shaping a person's identity. The statement that, "We are our synapses" debunks the battle of nature versus nurture (LeDoux 2). The synapses are where nature and nurture combine in order to contribute to the formation and changing of connections. Nature and nurture both make deposits in the synaptic ledgers, which ultimately shape synaptic connections in an individual's brain. "The particular patterns of the synaptic connections in an individual's brain, and the information encoded by these connections are the keys to who that person is" (Ledoux 3). The connections are not what make a person's self; the information that is shaped by nature and nurture concealed in these connections is the true architect of our underlying "self."

Everyone changes from childhood to adulthood. We age, grow, learn, and gain knowledge about ourselves as people. As a result, our neuron connections change as well. In his "Ted Talk," Seung states what he conceives to be "the four R's" of neurons:

1. Rewaiting (the change in strength of an existing synapse)
2. Reconnection (the creation of an entirely new synapse or the elimination of an old one)
3. Rewiring (the growth or retraction of neuron branches)
4. Regeneration (the creation or elimination of neurons)

Rewaiting happens all our lives, due to the fact that we are life-long learners. Both reconnection and rewiring likely happen in adulthood, but it has not been proven. And regeneration does not happen in adulthood since we are usually born with an exact number of neurons. What allows the four R's to formulate the "self"?

Nature (our genes) provides the chemical signals we are innately born with. Half of our genes come from our mothers and the other half come from our fathers. The integration of these two different gene pools gives our brain unique qualities from birth. Our genetic heritage also plays a part in creating personality. Without the genetic evolution of our species, we would not have the capacity to learn and remember, which is made possible by the genetic makeup of *Homo sapiens*. Genetic heritage and genes affect individual behavior by making proteins that shape how neurons are wired together. Genes only give the outline of our mental and behavioral functions. They give us a bias in one direction or another. An example of this is the fear a mouse innately has when it sees a cat. Through the evolution of genes, a mouse has that inner gut feeling to freeze upon seeing a cat. This reaction is due to the connections found in their synapses. The mouse first sees the cat. This image is then transferred from the optic nerve to the occipital lobe by a pattern of synapses. Once the image is recognized, a chemical signal is sent

through synapses towards the amygdala.[1] A mouse's genes have shaped the connections of neurons to understand that once a cat is recognized, a chemical signal must be sent towards the amygdala to warn the mouse of imminent danger.

This common occurrence that humans rarely think of has to do with genes and their ability to change synaptic connections between neurons. Genes may be the inception of a person's self, but nurture also supports to carve out a person's self.

As philosopher Salman Rushdie once said, "Life teaches us who we are" (LeDoux 9). Our experiences (also known as "nurture") have a major impact in shaping our identities stored in the synapses. Learning and its synaptic result, memory, have a major role in shaping personality together. Without these two very important phenomena, our personalities would be blank. "Our knowledge of who we are, of the way we think about ourselves, of what others think of us, and how we typically act in certain situations is in a large part learned through experiences" (LeDoux 9). Amazingly, the brain learns and stores knowledge in networks that function out of conscious awareness. What we learn and remember from experiences is unconsciously added into our brain and then changes our synaptic connections.

Memory, the synaptic result of learning, plays an even bigger role in constructing our personality. "In order to be yourself, you have to remember who you are" (Ledoux 133). Memory is how we have stored what we've learned. It is the reconstruction of facts and experiences on how they were stored, not on how they occurred. Filmmaker Luis Buñuel states, "We are our memories, and without them, we have nothing" (LeDoux 133). Everything we know about ourselves is recalled from past or present experiences. Memory is divided into two different categories that each use different brain systems: explicit and implicit. Explicit memory is the conscious recollection of events or ideas. It is known as flexible, domain-independent, and declarative. An example of this type of memory is the memory of what someone had for breakfast that morning. Most people can, in a matter of seconds, describe their breakfast. The same does not go for implicit memory. Implicit memory is described as domain-specific, and is stored in the unconscious. There is a direct correlation between this type of memory and our character traits. "Most outward behavior and inner life are controlled by brain systems that store and use information implicitly" (LeDoux 116). Implicit memories are reflected more in the things we do and the way we do them than on the things we know. Our implicit memories unconsciously shape our synapses to form our identities. Buñuel states, "Life without memory is no life at all…. Our memory is our coherence, our reason, our feeling, even our action. Without

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[1] The amygdala is the part of the brain where our fight or flight sense is activated.

it, we are nothing." In order to be ourselves, we need to remember how to think, speak, and act like ourselves. Without this recall, we would not be ourselves.

My Idea of Self

Based on this information, I have come up with my own metaphor to symbolize what "self" is made up of. A person's "self" is a cooking pot filled with soup. This particular soup is loaded with experiences, memories, emotions, and genes. Ingredients can be added to the soup, and others can be taken away. In the context of the metaphor, I imagine the pot as the structure of the body. The body holds our organs, including the brain. Without a body we would not be considered human. The same goes for the pot, the vessel of the soup. It holds the soup together. Without it, there would just be a messy pool floating on a stove. Next in the pot of soup comes the broth. The broth represents the genes of a human. The genetic structure is the starting point of "self." Humans begin as one cell with a combined gene pool. The broth is the basis for the soup. This all-important part creates the underlying general taste or flavor of who a person is or will become. But a soup cannot have only broth; it needs more to become appetizing. The vegetables, meat, or spices that are added to the soup represent the experiences and memories of life. Experiences and memories are thrust upon life, for either the worst or the best. I believe life and experiences are what really make a person. Without experiences we couldn't test ourselves and discover who we really truly are. The same goes for the vegetables, spices, and meats added into the soup. All these ingredients make the soup flavorful. If a stronger ingredient is added it can overtake other ingredients. The same goes for memories. One memory may be stronger than some others and may overtake and direct our choices. As shown through this metaphor, a person's self is a mixture of genes and experiences. There is no formula to make an exact "self." Everyone is unique; without this uniqueness our world would stay the same. No new ideas or views would emerge to shape our global, ever-changing world. The end product of "self" is continually shaped through genes and memories. As Ledoux states we are a "psycho-spiritual-socio-cultural package of protoplasm."

The End Product (Me)

At sixteen, I cannot fully and truthfully answer the question, "Who am I?" I will not know the answer to this question until I am on my deathbed. Every day of someone's life they learn something new about themselves. I am still learning what I believe in and who I want to be. Until recently, I have felt lost, like my inner self was being crushed inside me. But since coming to Oxbow, I have started to realize my potential and have started to uncover who I am. I have created a list of identifiers that reflect who I am…

> Emma Caroline Thompson, only child, sperm-donor child, white, female, cherished, loved, granddaughter, cousin, 3rd generation native Washingtonian, middle-upper class, tax-payer, self-conscious, fashionista, comic, awkward, dreamer, eye-opener, friend, big-thinker, listener, wall-flower, blue-eyes, creeper, lover of the Macabre, fringe holder, quiet, broken but slowly being repaired, organized chaos woman, hidden big personality, caring, artist, movie buff, brain

lover, dancer, music enthusiast, future white rapper, corny, unique, secret One-Directioner, obsessed with the British, Portobello road reveler, niece, 5 ft 8 in, a locked up social butterfly, REBEL, circle, leopard, animal lover, spy, English, ¼ Mexican, Halloween lover, an unknown, serial killer……enthusiast, thrift shopper, protector, caregiver, consumer, not athletic, Episcopalian, elephant lover, broken light bulb, a ready to explode shooting star, singer, imagination filled, wacky, child, unparallel, reader, learner, explorer, fancy eater, food lover, designer, cat, lucky, a mess, actor, homebody, discoverer, skull lover, death innovator, quirky, inflexible, visionary, list maker, honorary bay resident, honorary Californian, hidden writer, mathematician, colorful, not a black ink person, question maker, answerer, obsessed with eyes, over the top, hole, fond of boxes, awkward flirter, model, a mystery, candid, smile, major laugher, basketball star, pop culture enthusiast, future leader NOT follower, revealer of the world, traveler, Latin scholar, extraordinary, language learner, news watcher, roommate, needle pointer, collage artist, sculptor, painter, supporter, informed, crazy crazy, companion, out of the box, star, embraced weirdo, Me.

I am changing. As I learn and grow, some of these identifiers on the list may be erased and others may be added, but hopefully for the better.

Conclusion

I have learned that everyone is a mixture of genes and experiences. A person's personality is a mixture of genetic traits and personal memories, whether they are scientific or psychological. Every person is unique. Genes create the basis for our "self," but experiences and memories are the meat of "who we are." Without these genetic traits and personal memories, we would not realize our "self" and its potential to be great. I am a mixture of genetics and life that, at times, I can't even begin to explain. I learn new knowledge that consciously or unconsciously shape the future me. After learning about the brain and how it creates "self" I ask, "What are other unasked questions about the idea of self and the brain?"

Bibliography

"After Life." *RadioLab*. WNYC, 27 July 2009. Web. 4 Nov. 2012.
   <http://www.radiolab.org/2009/jul/27/>.

"Antonio Damasio: The Quest to Understand Consciousness." *Ted Talk*. TED Conferences, Dec.
   2011. Web. 6 Nov. 2012.
   <http://www.ted.com/talks/antonio_damasio_the_quest_to_understand_consciousness.ht
   ml>.

Aunger, Robert. *The Electric Meme*. New York: Free, 2002. Print.

"Connectome: How the Brains Wiring Makes Us Who We Are." *MIT Video*. Massachusetts
   Institute of Technology, 4 Apr. 2012. Web. 9 Nov. 2012.
   <http://video.mit.edu/watch/connectome-how-the-brains-wiring-makes-us-who-we-are-
   10780/>.

"Connectome: How the Brain's Wiring Makes Us Who We Are." *TED Talk*. TED, n.d. Web. 9
   Nov. 2012. <http://connectomethebook.com/?page_id=1233>.

"Dan Dennett: The Illusion of Consciousness." *TED*. TED Conferences, Apr. 2007. Web. 7 Nov.
   2012. <http://www.ted.com/talks/dan_dennett_on_our_consciousness.html>.

LeDoux, Joseph. *Synaptic Self: How Our Brains Become Who We Are*. New York: Penguin
   Group, 2002. Print.

Seung, Sebastian. *Connectome: How the Brains Wiring Makes Us Who We Are*. New York:
   Houghton, 2012. Print.

"Tony Robbins: Why We Do What We Do." *TED*. TED Conferences, June 2006. Web. 7 Nov.
   2012. <http://www.ted.com/talks/tony_robbins_asks_why_we_do_what_we_do.html>.

"Welcome to Your Brain." *MIT Video*. MIT, n.d. Web. 11 Nov. 2012.

   <http://video.mit.edu/watch/welcome-to-your-brain-12285/>.

"Who Am I?" *RadioLab*. WNYC, July 2007. Web. 6 Nov. 2012.
   <http://www.radiolab.org/2007/may/07/>.

Images

"Cat and Mouse." *The Mina Scope*. GaGenius, 22 Oct. 2010. Web. 2 Dec. 2012.
  <http://theminascope.com/2010/10/22/cat-mouse/>.

"Neural Networks." *G5AIAI - Introduction to Artificial Intelligence*. U of
   Nottingham, 21 Sept. 2001. Web. 2 Dec. 2012. <http://www.cs.nott.ac.uk/
    ~gxk/courses/g5aiai/006neuralnetworks/neural-networks.htm>.