NO REASON TO BE AFRAID: PTSD Research Explores Psychological Disorders

by Mallory Long
Photos by Mallory Long

My whole life I have always been fascinated with the notion that our brain is the very essence of our being. The idea that this complex interconnected mass of circuits is the driving force behind our ability to experience life continuously amazes me. I enrolled at the University of South Carolina to pursue a degree with the notion that our brain is the very essence of our being. The idea that this complex interconnected mass of circuits is the driving force behind our ability to experience life continuously amazes me. I enrolled at the University of South Carolina to pursue a degree in experimental psychology, as I sought to better understand the brain. 

My courses, focusing on neuropsychiatric disorders, provided me with enlightening explanations, which kindled my interests in learning the more detailed mechanisms of these disorders at the biological and molecular level. Many of my courses did not have the time to go into that level of detail, so I sought out research that would provide me with explanations that I wanted.

Initially, I felt overwhelmed because, like many undergraduates, I had no idea where to start. I had asked a few of my friends who were already involved in research how they got started and they told me they emailed a professor they had for a previous course. Unfortunately, my previous professors that I contacted were not currently taking students, so I was still stuck on where to start. Overwhelmed, yet still determined to get involved in research, I heard from other students about the Office of Undergraduate Research and the Getting Started workshop available to students. After attending a workshop, I finally found some direction with how to get involved. The Getting Started workshop provided me with a database comprised of all of the faculty members on campus who are currently conducting research. That is how I found a list of faculty members I knew I wanted to contact. After emailing this list of professors, a week later I had an interview. I was so excited for the consideration and the opportunity to talk to the professor, yet I was plagued with the thought of not being good enough. After all, I had little-to-no previous research experience, and I knew close to nothing about the intricacies of the research the lab was conducting. The moment I sat down in front of the professor for the interview, all of my worries washed away. It didn’t seem to matter that I hadn’t had previous lab experience, or that I didn’t know everything about the research topic of the lab. What seemed to matter the most to him was that I was genuinely interested in research and I had a desire to learn more about the brain.

Following the interview, I was fortunate to have been accepted to work in the laboratory of Dr. David Mott. The Mott lab aims to investigate the underlying mechanisms involved in Post-Traumatic Stress Disorder (PTSD) as well as other fear and emotional disorders. Fear is an essential emotion used to shape behavior for survival, but too much fear can begin to interfere with a person’s life. PTSD is a psychological psychiatric disorder that has the potential to develop in a person who has experienced a traumatic event, such as a car wreck, assault, or near-death experience. PTSD can be characterized by recurring episodes of fear and anxiety as well as recurrent flashbacks. Unfortunately, like many psychological psychiatric disorders, there are a number of complexities involved in the diagnosis and treatment of PTSD. The development of new therapies for fear disorders, such as PTSD, benefits from an understanding of the fear circuits of the brain that underlie the disorder. I was immediately captivated by the opportunity to learn more about the disorders in a way other than sitting in the classroom. In an effort to devote more time and resources to my research, I applied, and was awarded, the Magellan Scholar Grant, a competitive research funding opportunity offered here at USC. Under the guidance of Dr. Mott, I developed my own project investigating the neuronal circuitry of cortical and subcortical brain regions involved in fear. My research project aims to navigate and analyze the anatomical connectivity of a number of brain regions involved in fear processing. The amygdala is commonly known as the emotional processing center of the brain, it receives input from a number of various brain regions, where it is then modulated, and then relayed elsewhere. By investigating the connections of different brain regions into the amygdala, we can begin to observe and further analyze if there are any differences in the circuitry between a control, and a PTSD model. This can help to potentially isolate exactly where the deficits of PTSD are occurring. I am able to define the anatomical connectivity between these brain regions by using a technique called anterograde tract tracing. With this technique, mice are injected into a specified brain region with a genetically modified virus that encodes a fluorescent protein which expresses green under a microscope. The virus works by infecting neurons in the injected brain region, where the fluorescent protein is then transported down the processes of the cell, thus defining the axonal pathways from one brain region to the next. So far, I have observed the neuronal pathways from the prelimbic cortex, the thalamus, the hippocampus, and the basal forebrain, brain regions that each play a unique role in processing the emotion fear. The prelimbic cortex is responsible for providing the amygdala information involving higher order cognitive processes such as goal-directed behaviors and decision making. The hippocampus is associated with aspects of memory and encoding of contextual information. The thalamus receives, interprets, and delivers sensory information to the amygdala. The basal forebrain sends cholinergic projections to the amygdala which in turn modulates the output response through acetylcholine, a neurotransmitter that plays an essential role in learning and memory. Collectively, the information sent from these brain regions plays a cardinal role in the experience of fear.

My work identifying these projection pathways is only a small portion of the overall goal for my lab. My findings provide an anatomical basis for more experiments to be done analyzing the functional significance of how acetylcholine modulates these incoming pathways by using a technique called electrophysiology. Furthermore, investigations are also being conducted in order to observe the various cell types that these brain regions project onto and how acetylcholine differentially regulates the physiological responses of each interneuron subtype. A detailed understanding of the anatomy and functionality of the fear circuit will provide groundbreaking information needed to advance therapeutic research for emotional disorders, like PTSD.

Though, at times, my work can seem
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Below: Mallory presenting her research at Discover USC