

**Summer Internship Report 2017**

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**Psychology Research Assistantship:  
Opiate Addiction  
Sewanee, Tennessee**

**Provide an overview of the organization/research project and a summary of your responsibilities, tasks, and/or projects.**

This summer I worked with Dr. Cammack in the Psychology department on an extensive research project we had been developing and discussing since the beginning of the 2016-17 school year. We put together an addiction model for opiate abuse using mice. Our model was multi-faceted: we assessed sex differences in drug use, abuse, addiction, withdrawal, preference, and relapse/re-exposure to drug of choice. We exposed our mice (a large colony of almost 50 subjects) to 12 days of drug exposure to oxycodone or saline, then had 10 days of withdrawal. During these periods I conducted behavioral observations and assessments; this data is showing some promising sex differences in behavior following exposure, as well as interesting withdrawal differences. In addition to this data set, we mated our female mice to assess the effects of drug exposure on maternal behaviors. Previous research has looked at adolescent exposure in mothers and how this has trans-generational effects, but there is hardly any research on actually changes in the mother. Maternal motivation and behavior were assessed through a series of behavioral batteries; this data set is showing that there may not be as many differences in behavior as one would expect, which may help us answer questions about salience of drugs vs. salience of naturally rewarding factors in life (e.g., children). Finally, we re-exposed our colony to drug (or for saline exposed mice we exposed for the first time)- using conditioned place preference (CPP) we were able to assess previous drug history's effect on drug preference (e.g., if you have drug history do you prefer drug more, less, the same as non-drug history mice?). Our data set is rather large and extensive, it is wonderfully rich and looks to yield promising results and findings. We will continue to work with it this semester to shape it into publishable findings and take it to a possible conference. Over the course of the summer, I learned how to manage a lab, run an experiment, collect behavioral data and observations, analyze data (I would say I became something of an Excel expert), and I learned how to use a monitoring software called AnyMaze. I handled the

day-to-day task associated with our lab, cared for our animals, and completed a lot of literature review to help us better understand and analyze our data and better help us translate our animal model to the human condition. Finally, our study will have some major neuro endpoints; we will use Western Blots to measure the protein levels in our mice brains, this will provide interesting data regarding re-exposure to the drug of choice and drug history. Overall, I felt I had an amazing experience that has data that is relevant to a major issue in America today that asked questions that have yet to be asked, and allowed me a wide range to tackle an extensive study with relative freedom. Obviously Dr. Cammack guided, directed, and really ran the study, and taught me everything this summer, but I felt she really gave me a license to learn: I had the real opportunity to test ideas, discuss ideas, run the experiment, and feel like I had real ownership in what we were doing. It was an amazing investment of sorts, that allowed me to feel like it was a beyond unique experience that wasn't just work, but was and is and will continue to be important work.

**During your internship, what did you accomplish or how did you make a difference? In what ways did you grow in your professional and technical skills?**

I feel like to some extent I answered this above, but here it goes. The work we did this summer is massively important and relevant. 63,000 people died last year due to drug overdoses related to opiates, that's 91 people a day according to the CDC as of 2015. Let those numbers sink in. 91 people A DAY. We have a real problem, and if we are being honest, the problem started decades ago with the birth of oxycodone and its quick ascension into mass marketing as a cure all for all pain. This summer I got a major crash course in the history of the opiate epidemic. I gained an understanding that allowed my view to expand beyond looking at drug use as a choice, an active decision, and instead began to see it as a disease. As a future physician, I had a rude awakening that the opiate problem is being addressed by our healthcare system- in fact our way of providing care has caused it, continues to contribute to it, and exacerbates the issue at hand because we have failed to see the individual. We have failed to understand the psychological and instead have treated the physical needs, and even that has been done poorly because we failed to even research properly the physical and psychological dependence and changes that occur due to use. We have woefully underestimated a chemical we made. We took a natural course of the body (opiates are endogenous) and made it "better" and more "effective" and then marketed it to everyone in pain from a toothache to menstrual cramps to surgery pain. What's worse is that we called it safe because it was prescribed by a doctor. This research looked at the individual. It is trying to answer questions we should've asked long before mass marketing occurred. And while heroin may be the issue now, it began with prescription pills and no one cared to do the research into the long-term effects of heroin because the population that used it when drugs such as hydrocodone and oxycodone hit the market were not what the government, the rich, or the pharma companies were interested in. And to make matters worse, even less research was done into possible gender differences, as research mainly looked at men and the male response, which IS different than the female response to opiates. In fact, women are far more vulnerable to addiction to opiates, possibly due to cross talk between estrogen receptors and opiate receptors. However, no one looked at any of this until later, and even then really only in theory. So to be accurate, our system of care has failed and now we are suffering for it. What I learned from this internship is that we can do better, and we need to strive for better. We looked at sex differences, we looked at individual differences, we looked at drug history, we are going to look at neuroanatomical differences and how all of these affect salience- because that's really the key. What we were trying to ask was simple: how can we make drugs less salient, or better yet, what effects salience development? What are the switchback points that we can know, understand, and in turn possibly change to reverse salience and thus perhaps alleviate the rate of relapse and re-exposure, lessen preference, and perhaps affect the epidemic and turn the tide?

**Describe a problem that you helped to solve at your internship. What skills or knowledge from your education at Sewanee helped you address the problem?**

We were having some trouble getting the correct drugs. On multiple occasions we had to adjust and make corrections in order to stay on track to accomplish what we had set out to study and observe. For example, towards the end of our study we were looking at euthanizing our male mice before the CPP. This would allow us to look at slightly different neuro endpoints after drug re-exposure, however it would also have limited our control groups for the CPP, and we also would have lost the data on gender differences regarding drug preference influenced by drug history. To some extent we had our answer for us because our drug needed to euthanize the mice didn't come in on time, so I got the chance to work with Dr. Cammack to problem solve and devise a way of making all our mice useful by planning the CPP test schedule in a way that worked so that we could test our mice in a time block that didn't have us in the lab till 10pm. However, our drug didn't come in by the time it was time to euthanize all the mice following the preference tests. Now we were in a real pickle, or so it seemed, because our available drug would allow us to euthanize our mice, however it wouldn't allow us to do in a way that made it easy to extract the brain to work with it. Yet, thanks to some of the work and reading and discussing we had done that summer with my other lab partner Paul, I was able to suggest that we could conduct Western Blots (a project that Paul had been proposing and working with over the summer). This method allowed us to measure not newly proliferated cells (as our previous drug would have), but it would allow us to assess protein levels in the brain in specific regions. My classes with Dr. Cammack from last year, as well as the reading we had done this summer before beginning our experiment that acknowledged that G-proteins are activated by opiates in certain regions, but not others, if the G-proteins are activated they may recede (hence the increased need for more drug for the same high). If we could measure the protein levels in regions associated with pleasure and pleasure seeking (hedonic hotspots) we could potentially begin to see if drug history has a neuroanatomical effect on drug preference. Pretty cool stuff!! So I suggested this as an opportunity to utilize what we had available and to continue asking the questions we were looking to answer.

**In what way were your teamwork skills strengthened?**

Working with Paul, my lab partner, this summer was great. It gave me the opportunity to see that lab work isn't all alone; instead, we can throw ideas and interesting subjects around for discussion and, as in the example above, those discussion became vital for the choices and decisions we made along the way as obstacles or unexpected things occurred. Moreover, Paul was great for figuring out how to balance school (since I was taking a course), time in the lab, as well as individual time (being able to go home for a weekend here or there), and my studying (he was awesome as a resource for discussing the MCAT and graduate school).

**How did your internship affect your career plans?**

I want to be a neurosurgeon. A good physician looks at how the beautiful simplicity of science- our rules, our understanding of the world, the body, the brain, etc., how science influences that wonderful complexity that is the individual. What I learned this summer is that we aren't doing that. We aren't begin good physicians, we are failing, our entire system has failed to provide an individualized care. It has helped me to realize how research can impact our future, how lack of it can cause unintended consequences, how we need to be asking the important questions about the drugs we expose our patients to, how the care we provide needs to be better equipped to understand the brain and how it functions as a whole. It also has helped me understand my strengths in research. I enjoy asking the questions, developing the ideas, devising new ways information previous and new can be combined to show patterns and solve problems. Once again, I was amazed to see how complex and unknown the

brain continues to be, and that elusiveness, the mystery how it is only motivation to discover and unravel the hidden secrets it holds. My research this summer has only solidified my ideas to pursue a MD/PhD degree following my education here at Sewanee. My experience this summer, specifically with Dr. Cammack, has taught me that teaching doesn't just occur in a classroom, it can happen in a lab, it can happen at Stirlings, and it all begins with caring about a person and their goals and being excited for their future. That's knowledge I hope I can pass along to other future surgeons, that believing in people is what matters.

**In what ways did your internship cause you to encounter people of different backgrounds from your own? What steps did you take to communicate effectively with such persons? What did you learn from such persons' perspectives?**

I didn't necessarily communicate with anyone from a different background. Instead I had the opportunity to learn about different backgrounds. Opiates don't see color, religion, gender, ethnicity, age, or ability- it has affected the rich and poor, the old and young, the whole nation is waging a war in one way or another against rising overdose rates, rising usage rates, and rising prescribed painkiller rates. It is easy to think that drug user and abusers are the homeless, the poor, or the "dirty" and that it wouldn't affect you, your family, friends, or people you know. But this summer I learned about how many people are affected and that the loss of life doesn't just end with the deceased- it affects children, parents, grandparents, friends, the community. Beyond the rising death rates from accidental overdoses, it is easy to blame the user, to say try harder, work harder, get new friends, get clean, go to rehab. But it is hard to realize without some diligent research into the subject that there are limited resources, limited access to rehab, rehab is expensive, opiates cause biological changes in the brain that take at least a year to return to normal which means a 60-day rehab facility isn't as useful and effective as we believe it is. Small communities in rural areas seem to have an hard problem with whole families using, there can be transgenerational vulnerabilities, neuroanatomical and gender vulnerabilities that we can't even begin to understand, and ease of access to cheaper and more dangerous alternatives to prescription pills, such as heroin and fentanyl. It is easy to put the blame on these people, the users, because it alleviates the burden from the community to address the real question- why do people feel the need to use in the first place? We as a community should be supporting not shunning, we should be offering help not hiding these people away. It is easy to be blind to the problem at hand, but it is only becoming bigger and bigger, louder and louder, and it is time for us to recognize these people are not any different from you, or me. In fact, if circumstances were slightly different, perhaps you or I could be addicted to oxycodone following a routine root canal or after a minor surgery. These people aren't THOSE people, they are OUR people- and it is time we acknowledge them.

**Words of thanks to your internship funding donors:**

Thank you so much! This opportunity was grand! The work we are accomplishing really is world wide significant- it is going to have real impact. Thank you for providing me the opportunity to pursue research an area that is relevant, exciting, and something I'm passionate about!