David St-Amand

University of Texas at Houston

**Statement of purpose**

I’ve always been obsessed about wanting to understand how the brain and mind work. As early as my teenage years, my dream has been to understand the neural circuitry behind our decisions, feelings and perceptions. To fulfill this curiosity is why I got into the fields of psychology and neuroscience. The more I learned about these topics, the more amazed I became at how complex and fascinating the brain is. However, I also learned how distant we are from understanding the computations performed by neural circuitry. While this dream of mine might seem unrealistic today, the field of neuroscience is thriving and I believe how the brain solves complex tasks won’t remain a mystery forever. There will be a day when we understand how the brain manages to transform simple photons on the back of the retina into the perception of a home, or even how our mind decided to buy that house in the first place. I will dedicate my life so I can be one of the many researchers that help us to eventually get there. I am especially interested in neuroplasticity since I believe it is thanks to neuroplasticity that neurons learn to work together to solve complex tasks. Doing my PhD at MD Anderson UT Health would be ideal as I could learn from leading experts about neuroscience and neuroplasticity.

My first real taste of research was in my third year of undergraduate studies, where I was deemed responsible enough to be in charge of my own research project. I rose up to the challenge and my perseverance granted me a first-author publication in the journal of cognitive neuroscience. In this paper entitled **“Modulating episodic memory alters risk preference during decision-making”**,we found that engaging episodic memory processes increased preferences towards risky decisions. Thanks to this project I developed more autonomy and learned how fulfilling it is to carry out my own research. This first paper is what prepared and motivated me to start my Master’s degree and become a graduate student.

My master’s thesis, “**Transient inhibition to light explains stronger V1 responses to dark stimuli”**, aimed to study the mechanisms behind stronger responses to dark than light stimuli in primary visual cortex. We used machine learning to do system identification of recorded V1 neurons. We discover the stronger dark responses found by previous research (Jin et al., 2008; Shapley et al., 2009) to only occur at early latencies, and to be due to slower intracortical inhibition to dark than light stimuli. During this research project, I’ve greatly improved my machine learning skills and learned how to use Tensorflow to build my own custom, biologically-inspired convolutional neural network. I’ve also developed a solid expertise in both visual neuroscience and electrophysiology, on top of learning how to review and understand the literature to relate my results to it. The preprint of this work is currently available as a BioRxiv, and we are working to get it published in a peer-reviewed journal.

During my master’s, I’ve published a paper entitled **“Visual perception of texture regularity: conjoint measurements and a wavelet response-distribution model”** which is a good demonstration of how I can apply my statistical expertise to experimental problems. This psychophysics project studies the effect of jitter, texture size and texture spacing on the regularity perception of stimulus pairs using Maximum-Likelihood Conjoint Measurement (MLCM). While MLCM was previously used to study two variables when comparing stimulus pairs, our study was the first to simultaneously estimate the effect of three different variables. As the group’s statistical expert, I designed a new statistical framework to extend MLCM to test for two and three-way interactions in an experiment with three variables. We ffound the effect of jitter on regularity perception to be strongest at small element spacing and large texture element size, suggesting the visual system uses the edge-to-edge distance between elements as the basis for regularity judgements. This work was published in PL0S computational biology, and received compliments from Kennett Knoblauch, who invented MLCM.

We are rich in knowledge about how neuroplasticity works at the cellular level, but it baffles me how little we understand about how these rules allow neural circuitry to solve complex problems. To make a difference, want the next step in my career to be studying computational models of neuroplasticity. An example project I am interested in would be to use the NMDA-dependent bidirectional plasticity model from Shouval, Bear & Cooper (2002) to study the computational properties of neuroplasticity at the network level. For example, we could test whether inhibitory interneurons in primary visual cortex are more likely to have complex-like receptive-fields (Lauritzen & Miller, 2003) because of their opposite STDP learning rules compared to excitatory neurons (Caporale & Dan, 2008). The University of Texas at Houston has some of the best neuroplasticity researchers in the world, golden opportunity for me to become an expert in neuroplasticity. This includes Dr. Harel Shouval, who does outstanding research by modeling neuroplasticity from calcium-dependent mechanisms. This also includes Dr. Michael Beierlein, who does amazing work at studying neuroplasticity and the early visual system. I am certain doing research for such supervisors would be both fascinating and propel my research career to the next level.