Waves of synchronous spontaneous electrical activity propagate throughout the cerebral cortex of the brain during early stages of development. These waves consist of simultaneous action potential firing across large cell populations, with correlated increases in cellular calcium levels. Specific types of calcium signals mediate different developmental processes in the brain. While calcium signaling is known to regulate activity-dependent developmental programs that help to form essential connections between neurons, the particular function of spontaneous waves in cortical development is unclear. As many types of neurons participate in these waves in the cortex, it is possible that waves serve developmental roles that differ among neuronal subtypes. In this study we investigate the roles of spontaneous waves in the development of one neuronal subtype – inhibitory interneurons. At the time of wave expression, the last interneurons are migrating into the cortical plate and finding their appropriate layer within the cortex. To label inhibitory interneurons we use red fluorescent protein (RFP) under control of the dlx5/6 promoter region to label these cells, and a green calcium indicator to measure single cell activity of these interneurons. By imaging the red and green wavelengths and then analyzing the data, I have found two types of cortical interneurons: (1) Those that participate with other neurons in spontaneous waves; this type of activity is insensitive to blockers of L-type calcium channels, and (2) Those that do not participate in waves but do generate asynchronous activity between waves; this asynchronous activity is blocked by L-type calcium channel blockers. I am now testing the hypothesis that interneurons switch from asynchronous activity to participating in wave activity when they stop migrating and find their appropriate positions within the cortex. Such a finding would indicate a role for waves in determining the layer location of interneurons in the cortex.
neurons. Future studies will begin to address this possibility.

**Rod-Cone Interactions in the Retina**

*Mathew Thomas (Mathew) Summers, Senior, Neurobiology, Biochemistry*

**UW Honors Program**

*Mentor: Fred Rieke, Physiology and Biophysics*

The retina contains a dense web of photoreceptors, interneurons, and retinal ganglion cells. Although much work has been done on interactions between homologous photoreceptors, little has been done to characterize interactions between the two different types of photoreceptor cells: rods and cones. Electrophysiological recordings done in the Rieke lab found that selective activation of rod cells inhibited the response of long wavelength cones within a subsequent time window. The goal of my work was to probe whether this intercellular retinal phenomenon is robust enough so as to actually be perceptible by human observers in psychophysical trials. Using a dual monitor haploscope setup, I was able to present rod or cone isolating visual stimuli with different time offsets to subjects, who then performed a “brightness” matching task. Indeed, my results identified a perceptual suppression of cone mediated signals with a strength and latency comparable to that observed in electrophysiological recordings. This work contributes to our understanding of the neural circuitry underlying vision, particularly under mesopic or moderately dark light levels.

**Identification of Functional Modulators of Acsl in Maintenance of Terminal Dendrites**

*Ashley Tsing Yuen (Ashley) Lau, Junior, Biology (Physiology)*

*Mentor: Jay Parrish, Biology*

*Mentor: Jiae Lee, Biochemistry*

Neurons are specialized cells that receive and relay information throughout an organism, and the compartment that inputs the signal has multi-complex structures known as dendrites. The form of the dendrite is tightly regulated to neuron function; therefore, any abnormality that alters the structure of the dendritic arbor can lead to severe defects in neuronal function. However, the mechanisms of how dendrites develop and maintain their arborization are poorly understood. One mutant allele, *Acsl* (Acyl-CoA synthetase long-chain), leads to a complete loss of terminal dendrites, which carries a two amino acid change that renders the gene product non-functional. Interestingly, *Acsl* is also associated with human X-linked mental retardation (XMR). However, to date, little is known about the signaling pathway that may be involved in this unique function of *Acsl* in neurons. As such, we conducted a modifier screen, which serves to identify functional modulators with genetic interaction of *Acsl* in maintenance of terminal dendrites. Here we report our results of functional signaling (and/or) regulatory genes from this screen. We also conducted comparative GC/MS of the lipid profiles in both whole larval body and brains to identify the specific lipid species being affected by *acsl* mutation. In return, this will reveal to us more about the function and signaling pathway of *Acsl* in maintenance of terminal dendrites. Results from this project will lead to a greater understanding of dendrite abnormalities in neuronal development and of neurodegenerative disorders.

**Fluctuation in the Fundamental Frequency of Zebra Finch Song Syllables Under Constant Light Conditions**

*Kara Elizabeth (Kara) Jackson, Senior, Neurobiology, Linguistics*

**UW Honors Program**

*Mentor: David Perkel, Biology, Otolaryngology*

Songbirds are a model organism of interest to neurobiologists as they are one of a few groups of organisms that display sensorimotor vocal learning, akin to that of humans. Once learned, birdsong is highly stereotyped and while slightly variable, has not been thought to vary systematically from instance to instance. However, biological processes separate from learning mediate the qualities of a bird’s song. It is well known that the amount of singing varies throughout the day with the light cycle, but is not well understood how the acoustics of birdsong vary with light. Recent work has shown that pitch and loudness vary in a consistent manner throughout the day, rising through the morning and early afternoon and falling through the afternoon and evening. Whether these changes in song depend on an internal circadian rhythm or external light cues remains unknown. My project focuses on determining whether finch song is endogenously driven by an internal clock. I collected song data from zebra finches housed under typical light patterns (14 hours of light, 10 hours of dark) and constant light conditions. The fundamental frequency of a sample syllable was analyzed for each bout of singing and then plotted across the span of weeks. Preliminary results suggest that birds under constant light conditions take a few days to unentrain from the light cycle, then sing throughout each 24-hour day, with FF fluctuation around a baseline frequency. I hypothesize that if birdsong acoustics vary according to a circadian cycle, FF fluctuations that occur during constant light conditions are part of a regular pattern that is regulated by an internal clock. Finding that finch song is circadian has implications for understanding how a clock might connect to song system nuclei and demonstrating how complex motor behavior and learning can be influenced by time of day.
The Effect of Control on Tasks Involving Automatic Processing
Sandrine Girard, Senior, Psychology
UW Honors Program
Mentor: Chantal Prat, Psychology
Mentor: Theresa Becker Zolnikov, Institute for Learning and Brain Sciences

Bilinguals outperform monolinguals in tasks measuring executive functions; particularly, in tasks that measure inhibition and flexible behavior (e.g., task-switching), all of which require increased top-down control. One interpretation of this advantage in performance is that bilinguals may approach tasks in a top-down (goal-driven) manner, and given improved performance in certain tasks, top-down control is typically viewed as beneficial. Only one study has investigated the possibility that increased top-down control may result in a cost in terms of the influence on bottom-up (automatic, non-goal-driven) processing. To further explore the potential cost of top-down control on bottom-up processing, this experiment investigated patterns of semantic priming in 50 monolinguals and 50 early bilinguals across three experiments in which the amount of top-down control required varied systematically. If bottom-up processes are impaired as a function of top-down control strategies, we hypothesized that bilingual individuals, who recruit more top-down processes, will exhibit fewer baseline semantic priming effects, and that all participants will exhibit less semantic priming as the top-down requirements of the tasks increase. The lexical decision task was used in isolation to measure baseline differences in automatic, semantic priming between monolinguals and bilinguals. An additional, task-switching paradigm, in which participants either performed a lexical decision task or decided whether the first letter of a word was between A-L or M-Z was created to engender a more top-down approach. Finally, a dual task in which participants identified changes in auditory tones while making lexical decisions, was used to attempt to decrease any top-down influence on the lexical decision task. Preliminary analysis of the data suggests that priming did not change as a function of task or language group. I will discuss the implications of this research for understanding individual differences in executive functioning.

Implications of an Impaired Mirror Neuron System in Individuals with Autism Spectrum Disorders (ASD): A Study of Functional Gesture Quality During a Game of Charades
Michaela Lambert, Senior, Biology, Whitman College
Mentor: Leena Knight, Biology, Whitman College
Mentor: Susan Rivera, Psychology, UC Davis
Mentor: Jen Pokorny, UC Davis

While language delay and speech impairment in individuals with Autism Spectrum Disorders (ASD) have been widely investigated, few studies have analyzed the role that non-verbal forms of communication, such as gestures, may play in augmenting impaired speech in individuals with ASD. One system that has been heavily studied, which has the potential to enhance or inhibit communication, is the Mirror Neuron System (MNS). While the MNS could serve to augment speech, the dysfunction of this system could prove detrimental to those who already possess impaired language skills. If the MNS were to be equally affected by ASD, individuals with this disorder would be unable to compensate for impairments in verbal communication with non-verbal forms of interaction. Although reduced activity in MNS areas in ASD individuals has been identified, the implications of this dysfunction remain unclear. In order to identify if the dysfunction of the MNS impairs non-verbal forms of communication, we recorded 16 typically developing (TD) adolescents and 13 ASD adolescents as they played a game of charades. We utilized charades that were not associated with speech centers, but instead have been shown to rely heavily on an intact MNS and motor cortex to mimic the action. This allowed us to identify whether reduced activation of mirror neurons impacts neural centers that serve to augment language through nonverbal means. Using video footage, two blind coders scored the quality of gestures based upon a 0-8 point scale that was unique to each gesture. Our preliminary results suggest that adolescents with ASD do not have significantly lower scores of functional gesture quality compared to TD individuals. One possible implication of these data is that other regions of the brain may compensate for MNS dysfunction and, importantly, may serve as potential therapeutic targets for strategic interventions to minimize the language impairments associated ASD.