Undergraduate Research Symposium May 16, 2014 Mary Gates Hall

Online Proceedings

Poster Session 2

Commons West, Easel 7

1:00 PM to 2:30 PM

Daily Oscillations in the Rate, Spectral Features and Variability of Gambel's White-crowned Sparrow Song

Darren Hou, Junior, Pre-Sciences
UW Honors Program
Mentor: Tracy Larson, Biology, University of Virginia
Mentor: Eliot Brenowitz, Psychology

The ability to learn and perform complex motor skills varies with the time of day. One complex motor skill that oscillates daily is song produced by songbirds. The study of song is particularly useful for understanding mechanisms driving the learning of vocalizations and the cellular and morphological changes that accompany changes in song production rate and quality. In one such songbird, Gambel's White-crowned Sparrow (*Zonotrichia leucophrys gambelii*), the production of song and the underlying neural circuit that controls this song change dramatically between breeding and nonbreeding seasons. We sought to determine whether song also changed on a daily time scale. We analyzed song production rate, spectral features, and stereotypy of more than 1500 songs produced over the course of two consecutive days by sparrows maintained in breeding conditions. We identified daily patterns in song rate, frequency, entropy, power, and energy of breeding song within both individual birds and pooled bird data. The demonstration of daily oscillations in song rate and spectral features song supports both descriptions of 'the dawn chorus' and growing evidence on the modulation of the song control circuit by the internal circadian clock. Having shown daily changes in song production in white-crowned sparrows, we can now begin to study the relationship between song production, cellular changes like neuronal birth and death that occur within the song circuit, and the endogenous circadian clock.

Session 2F

Brain Development, Injury, Regeneration and Restoration of Function

Session Moderator: Gwenn Garden, Neurology

242 MGH

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Turnover of Adult Born Neurons during Breeding and Nonbreeding Conditions in an Avian Song Control System

Nivretta Murlidharan (Nivi) Thatra, Senior, Neurobiology
Mary Gates Scholar, UW Honors Program
Mentor: Eliot Brenowitz, Psychology
Mentor: Tracy Larson, Biology, University of Virginia

The balance between neuronal birth and death is a fundamental process of adult neural plasticity that mediates the maintenance and production of behavior. Aberration in this balance often coincides with neurodegenerative diseases including Parkinson's, chronic depression, and stroke. Songbirds are an excellent model for exploring the dynamics of neuronal turnover, i.e. the balance between neuronal birth and death, and its effects on behavior, as seasonal production of song is under the control of a well-defined plastic neural circuit. This circuit includes the song control nucleus HVC (proper name) and its target, the robust nucleus of the arcopallium. Seasonal plasticity of HVC in Gambel's white-crowned sparrows (*Zonotrichia leucophrys gambelli*) involves pronounced changes in neuron number; HVC neuron number changes 25% (>68,000 neurons) between breeding and nonbreeding seasons. The dramatic differences in neuron number between breeding and nonbreeding conditions suggest that dynamics between neuronal birth and death also differ between seasons. To determine if there are seasonal differences in neuronal turnover, I labeled two cohorts of new HVC neurons separated by one, two, and four months with two thymidine analogs, BrdU and Edu, in both breeding and nonbreeding condition birds. I determined turnover rate by quantifying the number of new neurons from each cohort that were present in HVC at the different intervals. Preliminary data indicates that in breeding birds more new neurons belonged to the first

cohort, whereas in nonbreeding birds more new neurons belonged to the second cohort. The replacement of first cohort neurons by the second cohort neurons increases with time in non-breeding birds. This suggests that testosterone in breeding birds promotes survival of the first wave of new neurons entering HVC. This study demonstrates that the seasonal changes in HVC neuron number results from a dynamic shifting balance between neuronal birth and death.

POSTER SESSION 3

MGH 241, Easel 165

2:30 PM to 4:00 PM

Deriving the Metallicity of a Selection of Little-Studied Open Clusters

Anthony Paat, Senior, Astronomy, Physics
UW Honors Program
Nancy Thomas, Senior, Astronomy, Physics
Mary Gates Scholar, NASA Space Grant Scholar, Undergraduate Research Conference Travel Awardee, UW Honors Program
Denise Schmitz, Senior, Mathematics (Comprehensive), Physics: Comprehensive Physics, Astronomy
Mary Gates Scholar, Undergraduate Research Conference Travel Awardee, UW Honors Program
Ramon Sudarshan (Ray) Sharma, Senior, Astronomy, Physics: Comprehensive Physics, Mathematics
Undergraduate Research Conference Travel Awardee
Mentor: Ana Larson, Astronomy

Previously, details on the angular diameter, age, reddening, and distance from the sun have been published for 60 open star clusters. This previous research mentioned the metallicity of these clusters, but no results were published with metallicity values. According to the Big Bang theory, the early universe contained mainly Hydrogen with small amounts of Helium. For heavier elements to form, fusion inside a stellar core must take place. When these stars die they then expel heavier elements, called 'metals' by astronomers, into space. These metals will then be present for the next generation of stars that forms. Therefore, if astronomers can derive the metallicity of a star they can figure out the relative age of that star. The University of Washington League of Astronomers club research group wrote a proposal to observe at the Dominion Astrophysical Observatory (DAO) in Victoria, Canada and received eight nights of time on DAO's 1.8 m telescope. We have obtained images of many of the target clusters using Strömgren filters. Observations using these filters will allow us to calculate the metallicity of stars within each of our target clusters. Ultimately, by determining the metallicity of a range of open star clusters within the plane of the Milky Way, we can help constrain the galaxy's metallicity gradient which gives us a better understanding of galactic formation and chemical evolution models.

POSTER SESSION 3

Balcony, Easel 105

2:30 PM to 4:00 PM

The Influence of Endogenous Seasonal Rhythms in Laboratory Controlled Environments on the Song Circuit of Gamble's White-Crowned Sparrow

Marianne Merritt (Marianne) Cole, Junior, Psychology
Mentor: Eliot Brenowitz, Psychology
Mentor: Tracy Larson, Biology, University of Virginia

Circannual rhythms, such as the cycling between breeding and nonbreeding seasons, provide critical timing information for organisms' major life history events including reproduction cycles, courtship, and migratory restlessness, among other physiological and behavioral changes. Photoperiods are particularly useful indicators of seasonal change because of their consistent nature, which allows organisms to predict and prepare for the onset of the short breeding season. The growth and regression of the neural circuits that control the seasonal production of song in Gamble's white-crowned sparrow (Zonotrichia leucophrys gambelii) are one such example of the ability of photoperiods to time changes in brain morphology, organismal physiology, and behavior. As sparrows transition into breeding conditions, testosterone levels increase, driving an increase in the volume and neuron number of one song nucleus HVC (proper name) and an increase in song production rate and stereotypy. These seasonal changes can be replicated in a laboratory environment through strict light, temperature, and hormone regimes. However, variability in HVC volume and neuron number, testosterone levels, and song production of sparrows during the replicated breeding and nonbreeding seasons has been observed. The endogenous seasonal rhythm has been observed to persist in constant laboratory conditions across taxa, and thus may persist in white-crowned sparrows as well. We tested whether endogenous seasonal rhythms may contribute to the observed variability between individuals. By examining the persistence of an endogenous seasonal rhythm the measurement of several morphological and physiological traits associated with breeding seasons in sparrows maintained throughout the year in controlled laboratory nonbreeding conditions was collected. Finding seasonal-like differences in morphology and physiology of birds housed in constant nonbreeding conditions would suggest the need for additional experimental controls in future studies of songbirds in order to prevent variability due to endogenous seasonal rhythms.

POSTER SESSION 4

Balcony, Easel 112

4:00 PM to 6:00 PM

Analyzing Weather Mapping Resources to Create a Beneficial Model Relating the Hydrologic Cycle and Yearly Mountain Snowfall to Available Drinking Water in Western Washington

Forrest Novotny, Sophomore, Atmospheric Science, North Seattle College
Mentor: Tracy Furutani, Earth and Space Sciences, North Seattle Community College

Every year millions of Washingtonians depend on winter snowfall contributing to their main source of drinking water. Seattleites alone make up 22% of the states population, and 70% of those residents use water from the protected Cedar River Watershed in their homes and businesses. I am analyzing and monitoring snow depth and hydrologic sensors in western Washington maintained by the state Department of Ecology to create a graphical and quantitative model of available water resources that will predict the availability of clean water for years to come. My study will provide a model for the maintenance of sustainable usage for our area as population increases and water availability due to climate change over time decreases. The Cascades' annual snowfall is diminishing enough to raise concerns about future availability of water and its effects on daily life. Regions of Washington that depend on ice and snowmelt are the most affected by global warming, and some models predict that western Washington may have a problem with water shortages as early as 2040. I will be providing an independent look at the shortages we can expect to face in the near future based on trends over the last 40 years.