2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Neuroscience

SPECIFIC TITLE OF RESEARCH PROJECT

The Effect of Video Game Training on the Neural Correlates of Cognition

FACULTY SUPERVISING RESEARCH

Name: Kira Bailey, PhD

Department: Neuroscience and Psychology

Campus phone: x 3808

Email user name: kmbailey

ANTICIPATED RESEARCH DATES, (ten weeks): **Requested Number of Students:**

Beginning: May 10th, 2016 one x

Ending: July 15th, 2016 two ____

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

N/A

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

The student must be willing to collect and analyze electrophysiological data (i.e., electroencephalogram and event-related potentials) from human participants. They needn't have prior experience with the procedures, only be willing to learn them. The student should also be comfortable interacting with participants over the telephone and face-to-face.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

A growing body of evidence suggests that action video game (AVG) experience is associated with improvements in visual/spatial attention and executive functioning (Feng, Spence, & Pratt, 2007; Green & Bavelier, 2003, 2006, 2007; Green, Pouget, & Bavelier, 2010; West, Stevens, Pun, & Pratt, 2008). The significance of this finding lies in the implication that the skills acquired in an AVG might be transferred to other contexts (Boot, Blakely, & Simons, 2011; Green & Bavelier, 2003), which is in contrast to findings

from a wealth of training paradigms wherein improvements in performance transfer very narrowly (to highly similar tasks) or not at all (Ball et al., 2002; Hertzog et al., 2009; Owen et al., 2010).

The seemingly broad transfer of skills from AVGs after little to moderate amounts of training (10 to 50 hours) has led some researchers (Bavelier et al., 2012; Green & Bavelier, 2008) to recommend the use of AVGs in training protocols among populations that would benefit from enhanced visual attention and cognition (e.g., older adults pilots, military personnel). These recommendations may be premature, however; other evidence indicates that AVGs are associated with diminished cognitive control (Bailey, West, & Anderson, 2010; Kronenberger et al., 2005; Mathews et al., 2005), increased aggressive behavior (Anderson et al., 2010), disruptions in affective processing (Bailey, West, & Anderson, 2011; Bartholow, Bushman, & Sestir, 2006; Kirsh & Mounts, 2007), and greater risk-taking (Bailey, 2012; Pawlikowski & Brand, 2011). Furthermore, all of the training studies published to date contain methodological flaws that may call the findings into question (see Boot et al., 2011).

The proposed research seeks to conduct a rigorous training study to address the methodological shortcomings in previous work and provide a more thorough investigation of video game effects on executive functioning and perceptual ability, using a combined behavioral and psychophysiological approach with latent variables. The student working on this project will test the hypothesis that 20 hours of training on an AVG changes the neural signatures of cognition, leading to behavioral deficits in tasks requiring the extensive use of cognitive control (e.g., Stroop, Flanker, AX-CPT). The student will learn how to collect, analyze, and interpret electrophysiological and behavioral data.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)
parasitology, entomology, biodiversity, systematics, taxonomy

SPECIFIC TITLE OF RESEARCH PROJECT

Exploring the diversity of parasitic nematodes from millipedes of the Appalachian Mountains

FACULTY SUPERVISING RESEARCH

Name: _____Ramon Carreno_____

Department: ___Zoology_____

Campus phone: __X3893_____

Email user name: ___racarren_____

ANTICIPATED RESEARCH DATES, (ten weeks): **Requested Number of Students:**

Beginning: ____May 9,2016_____ one __X__

Ending: _____July 18,2016_____ two _ __

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

- able to work in the field for moderate outdoor activity
- willingness to do research on invertebrate animals
- should have taken BIOL120 and BIOL122
- background in parasitology and entomology
- background in scanning electron microscopy an asset

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

I am interested in the evolution of parasitism in nematodes. There is a specific group of nematodes, commonly referred to as the pinworms (Order Oxyurida), which parasitize the intestinal tracts of various vertebrate and invertebrate hosts. They are generally not of pathogenic significance in the host. This group of pinworms is of interest because there are representative definitive hosts for both vertebrates and invertebrates across many animal groups, a pattern unique for the Oxyurida (Carreno, 2014). In recent years I have been interested in the systematics of pinworms parasitizing invertebrate hosts and have collected and described species from various localities around the world (Carreno et al., 2011; 2013; Sinnott et al., 2014). One of the most important invertebrate hosts are the millipedes (Order Diplopoda). A great diversity of

nematodes has been reported from millipedes, and yet, the majority of species have not been sampled, including those found in North America. Specific mountain ranges in Tennessee and North Carolina are known to be particularly rich in diversity of millipedes, and the goal of this project is to initiate exploration of the diversity of pinworms found from these hosts. We will make two collecting trips of 1-3 days' duration, one to Knox County, Tennessee, and an additional trip to North Carolina (exact location to be determined). Millipedes will be collected, returned to my OWU lab, and keyed to species. They will then be examined for intestinal parasitic nematodes. The nematodes collected will be examined by light and scanning electron microscopy using our Zeiss EVO LS10 ATLAS STEM. DNA barcodes will also be assembled for representative species in order to provide molecular identification that complements morphological data. The anticipated outcome of this project is to explore a new source of likely high diversity of pinworms that will contribute immensely to discovering the biogeographical history of these parasites. It is also expected that various undescribed species will be discovered from these collections.

Devinn Sinnott, R. A. Carreno, and Henri Herrera. 2015. Distribution of thelastomatoid nematodes (Nematoda: Oxyurida) in endemic and introduced cockroaches on the Galápagos Island archipelago, Ecuador. Journal of Parasitology 101: 445-457.

Carreno, R. A. 2014. The systematics and evolution of pinworms (Nematoda: Oxyurida: Thelastomatoidea) from invertebrates. Journal of Parasitology 100: 553-560.

Carreno, R. A., D. Ordosch, J. K. Koltek, D. R. Hamill, and L. Tuhela. 2013. First United States Records of the rhigonematid genera *Heth* and *Ruizia* (Nematoda: Rhigonematida) from the introduced millipede, *Anadenobolus monilicornis* (Diplopoda: Rhinocricidae) in Key Largo, Florida. Comparative Parasitology 80: 225-232.

Carreno, R. A., and L. Tuhela. 2011. Thelastomatid nematodes (Oxyurida: Thelastomatoidea) from the peppered cockroach, *Archimandrita tesselata* (Insecta: Blattaria) in Costa Rica. Comparative Parasitology 78: 39-55.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Ecology, Mathematical Modeling, Biodiversity and Stability, Freshwater Ecosystems

SPECIFIC TITLE OF RESEARCH PROJECT

Biodiversity and stability in freshwater ecosystems: Combining experimental data with mathematical modeling

FACULTY SUPERVISING RESEARCH

Name: Amy Downing

Department: Zoology

Campus phone: 3890

Email user name: aldownin@owu.edu

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 11, 2015

Ending: July 16, 2015

Requested Number of Students:

one _X

two ___

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Introductory biology course(s)
Willingness to learn to program in Mathematica and / or 'R'.
No prior programming experience is necessary or expected.
These programming languages are easily learned with focused attention and patience.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Background: Ecological stability is important feature of ecosystems given the increasing rate of global change and human-induced disturbances. 'Ecological stability' is a term that encompasses many different aspects of stability, including the resistance and resilience of ecosystems to disturbances, the temporal variability of populations and communities, species' persistence in ecosystems through time, and ecosystem resistance to invasion or extinction(Ives & Carpenter 2007; Donohue et al. 2013). Because ecological stability is such an important and valued aspect of ecosystems, ecologists are keenly interested in understanding what features of ecosystems lead to more stable ecosystems.

Both theoretical work (e.g. mathematical models) and experimental work (e.g. field experiments) have shown that species diversity influences ecological stability. This has become an active and compelling area of research because of the rapid loss of biodiversity globally. However, our understanding of the diversity-stability relationship is hindered for two reasons. First, the diversity-stability relationship varies with the type of stability measured, for example diversity appears to have a different effect on ecosystem resilience after a disturbance than it does on the temporal variability of communities. Second, theoretical studies typically focus on one type of stability (e.g. resistance and resilience to single perturbations) whereas experimental work focuses on a different type of stability (e.g. temporal variability of populations relative to repeated perturbations). This difference in focus has hindered the integration of theory and experiments to further our understanding of diversity-stability relationships (Arnoldi et al. 2016; Ives & Carpenter 2007).

The research project: We will explore the relationship between diversity and two aspects of stability: *temporal variability* of populations and communities (typically the focus of experiments), and the *resistance and resilience* of communities to a perturbation, defined by the eigenvalue of the community matrix derived (typically the focus of theory and models) (May 1972; Pimm 1984; Allesina & Tang 2012). We will use time-series data of zooplankton communities collected from an 80-pond experiment that varied in zooplankton species diversity and composition. With this existing data set, we have shown that more diverse zooplankton communities are temporally more stable (Downing et al. 2014). Using the same data, we will use a multivariate-autogressive modeling approach (MAR) to calculate community matrices (Hampton et al. 2013). The community matrices generated from the MAR approach will allow us to calculate theoretical stability metrics (e.g. resilience / resistance). We can then compare the experimental results and theoretical results to determine if species diversity has the same effect on different types of stability. We will also be able to ask other questions about how other features of communities and ecosystems affect stability.

This project will be entirely lab-based. The experimental work (aquatic field experiment) has already been completed. The student working on this project will learn to work with and manage a very large data set. The student will also learn statistical techniques as well as learn to code in Mathematica, R, or both. Finally, the student will learn to appreciate the power of combining mathematical approaches with biological systems to answer difficult but very important ecological questions such as the relationship between diversity and stability. All of these skills are valuable tools that are transferable to almost any area of scientific research. The student is not expected to have prior experience in any of these areas but needs to have the patience and willingness to learn.

The student working on this project will also have the opportunity to collaborate with an REU student working with Dr. Craig Jackson on more theoretical aspects of this project.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Computational Neuroscience

SPECIFIC TITLE OF RESEARCH PROJECT

Using computational modeling to investigate brain rhythms associated with epileptic seizures

FACULTY SUPERVISING RESEARCH

Name: _____Christian Fink_____

Department: ___Physics_____

Campus phone: __3770_____

Email user name: __tcfink_____

ANTICIPATED RESEARCH DATES, (ten weeks): **Requested Number of Students:**

Beginning: ____May 16_____ one __X__

Ending: ___July 22_____ two ____

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

The student needs to have taken a course in computer programming, or demonstrate sufficient programming aptitude to be able to run numerical simulations. They also need to have taken a course in differential equations.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Characterizing High-Frequency Oscillations in Epileptic Brain Tissue: Christian G. Fink

Epilepsy affects roughly 1% of the world's population [1], with approximately 25% of all people with epilepsy suffering from an intractable form of the disease, untreatable either by medication or surgery. The primary reason for this unfortunate fact is our incomplete understanding of how epileptic seizures are generated, for there are many ways in which electrical activity in the brain may go awry. One important clinical tool for investigating the causes of focal epilepsy is recording electrical activity (known as the local field potential, or LFP) near the part of the brain where seizures are generated (the epileptogenic zone, or EZ). If a patient is resistant to medication, identification of the EZ through analysis of LFP recordings is essential to surgically treating the patient by removing the EZ.

In the last 15 years, a promising new biomarker has emerged that may improve surgical outcomes and shed light on how focal seizures are generated. High-frequency oscillations (HFOs) are oscillations observed in LFP recordings of 100 Hz or more, and oftentimes HFOs occur much more frequently in the EZ than in other regions of the brain [2]. HFOs are typically lumped into two categories based upon their dominant frequency: ripples (100-250 Hz) and fast ripples (>250 Hz). Fast ripples tend to be a more reliable indicator of pathology than ripples, but neither is a perfect epilepsy biomarker, for both ripples and fast ripples have been shown to also occur in normal brain tissue [3, 4]. One of the most pressing questions in the quest to better understand the causes of epilepsy is, “What distinguishes normal HFOs from pathological HFOs?”

In order to answer this question, we will construct a computational model of a brain network (using the program NEURON) and modify various processes and parameters in ways that are known to be either normal or pathological. We will then observe differences in the LFP that result from these modifications, and combine these observations with “Big Data” techniques to determine features of real-world recordings which distinguish normal from pathological HFOs. Real-world comparisons will be made in collaboration with William Stacey, an epileptologist at the University of Michigan. Successful discrimination between normal and pathological activity in real-world human recordings will suggest underlying biophysical mechanisms, based on the computational model, and such knowledge will likely provide insight into the mechanisms underpinning the initiation of epileptic seizures.

REFERENCES

[1] Thurman et. al. “Standards for epidemiologic students and surveillance of epilepsy,” *Epilepsia*, 2011.
[2] Brain et. al. “High-frequency oscillations in human brain,” *Hippocampus*, 1999.
[3] Ylinen et. al. “Sharp wave-associated high-frequency oscillations (200 Hz) in the intact hippocampus: network and intracellular mechanisms,” *J. Neuroscience*, 1995.
[4] Jones et. al. “Intracellular correlates of fast (>200 Hz) electrical oscillations in rat somatosensory cortex,” *J. Neurophysiology*, 2000.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Cognitive Psychology

SPECIFIC TITLE OF RESEARCH PROJECT

Cognitive Aging and Memory

FACULTY SUPERVISING RESEARCH

Name: __Lynda Hall_____

Department: __Psychology_____

Campus phone: __x3810_____

Email user name: __lkhall@owu.edu_____

ANTICIPATED RESEARCH DATES, (ten weeks): **Requested Number of Students:**

Beginning: ___May 16, 2016_____ one _X___

Ending: ___July 22, 2016_____ two ____

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Students must have completed Introduction to Psychology and one other Psychology course. Preference will be given to those who have completed one or more of the following courses: Quantitative Methods, Research Methods, or Cognitive

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Hartshorne and Germine (2015) demonstrated that cognitive abilities peak at different ages. Performance on several tests of short term memory peak in early adulthood, while on other tests of long term memory, such as the Vocabulary tests on the Wechsler Adult Intelligence Scales, performance peaks around age 50. Bahrick, Hall & Baker (2013) showed that the type of information recalled also influences performance; older adults had more difficulty recalling names of famous people than recalling vocabulary from a second language, even when they had not studied the language for many years. I'm interested in exploring further age differences in performance on a variety of memory tasks as well as the implications of these differences for performance on more complex cognitive tasks such as reading comprehension and problem solving.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Experimental Nuclear Physics

SPECIFIC TITLE OF RESEARCH PROJECT

Search for Exotic Shapes in ^{70}Ge

FACULTY SUPERVISING RESEARCH

Name: Bob Haring-Kaye

Department: Physics and Astronomy

Campus phone: x3774

Email user name: rakaye

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 16

Ending: July 22

Requested Number of Students:

one X

two ___

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

A "B" or better in PHYS 280C and 280L (Contemporary Physics class and lab)

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Please see attached statement.

Please save as a pdf and email completed form to ssrp@owu.edu as an attachment (pdf file) with the subject line "Proposal for *faculty name*"

Atomic nuclei with approximately 70 constituent particles (protons and neutrons) are in a region of the nuclear landscape that has been termed the "Wild West" [1] since the structural properties of these nuclei are not as well behaved as those of the heavier deformed ones. Rapid structural changes are common with only slight changes in the number of protons and/or neutrons, and with changes in the angular momentum (spin) of the system. For example, rapid shape changes have been inferred throughout this region of nuclei, and in some cases different shapes have been deduced within the same nucleus depending on the configuration of the constituent protons and neutrons and the magnitude of spin. Recently, this mass region has also served as a testing ground for a variety of exotic shape and structure properties, such as static asymmetric shapes at low energy [2], shapes with tetrahedral symmetry (like a pyramid with rounded corners) [3], and unusual intrinsic configurations of protons and neutrons that drive the nucleus toward deformation [4].

During the summer of 2014, my team of summer research students (including an SSRP participant) and I traveled to Florida State University (FSU) to perform an experiment at their particle accelerator facility to produce nuclei that may be candidates for the exotic shapes mentioned above. These nuclei were populated at relatively high energy and spin, and released sequences of gamma rays as they relaxed to their lowest-energy (ground) state. The gamma rays were recorded by an array of high-resolution detectors and serve as a "fingerprint" of the parent nucleus from which they are emitted, revealing several aspects of the underlying structure.

Future SSRP students are now poised to continue the analysis of the data from this experiment using the techniques of gamma-ray spectroscopy. This summer, we will use these data to study the structure properties of ^{70}Ge, a nucleus that could possess one of the exotic shapes mentioned above. In particular, I anticipate measuring the intensities of the gamma decays from ^{70}Ge as a function of the direction in space in which they were emitted. These results can be used to infer the spin changes involved in the gamma decays, which can yield important clues to understanding the underlying structure associated with these transitions.

The student working on this project will use a Linux workstation running specialized software in order to perform the data analysis. No previous experience with either Linux or the data analysis tools is required. I will teach the student all of the needed system commands and how to use the analysis software. Since the data analysis requires a basic understanding of the techniques of gamma-ray spectroscopy, the student will also be trained on the relevant experimental techniques using a simplified setup in my on-campus research laboratory, which utilizes the same gamma-ray detection technology that was used in the actual experiment at FSU. Additionally, the student will likely travel with me to either FSU, the National Superconducting Cyclotron Laboratory at Michigan State University, or Argonne National Laboratory during the 10-week research period so he or she can become familiar with the operational procedures and technology present at a large-scale particle-accelerator facility, make meaningful contributions to the preparations for future experiments, and possibly assist with the execution of new experiments.

[1] W. Nazarewicz, in *High Spin Physics and Gamma-Soft Nuclei*, edited by J. X. Saladin, R. A. Sorensen, and C. M. Vincent (World Scientific, Singapore, 1991), p. 406.
[2] Y. Toh *et al.*, Phys. Rev. C **87**, 041304(R) (2013).
[3] J. Dudek *et al.*, Phys. Rev. Lett. **88**, 252502 (2002).
[4] R.A. Kaye *et al.*, Phys. Rev. C **83**, 044316 (2011).

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Astrophysics

SPECIFIC TITLE OF RESEARCH PROJECT

Starspots on LO Pegasi

FACULTY SUPERVISING RESEARCH

Name: Robert Harmon

Department: Physics and Astronomy

Campus phone: 3778

Email user name: roharmon

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 16

Ending: July 22

Requested Number of Students:

one

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Successful completion of PHYS 111 Lab

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Even as imaged by the Hubble Space Telescope, stars appear to be featureless pinpoints. As a result, it is necessary to use indirect techniques in order to obtain information about their surface features. This project uses a particular technique for doing that called Light-curve Inversion (LI).

Of particular interest are "starspots," which are analogous to sunspots on the Sun, and are known to be present on certain classes of stars. Like sunspots, starspots are believed to be manifestations of stellar magnetic fields. The study of starspots can thus provide valuable insights into the physics of the magnetic dynamos operating in the Sun and other stars.

If there is a dark spot on the surface, then every time the star's rotation carries the spot into view from Earth, there will be a dip in the star's brightness. If we knew in detail the appearance of the star's surface, a relatively straightforward calculation would allow us to predict the star's brightness as a function of time, i.e., its light curve. With LI we attempt to go in the other direction: knowing the light curve, determine the appearance of the star's surface. This is not a simple matter, because the problem is ill-posed, in that very different surfaces can give rise to nearly identical light curves. This arises because the effects of a large number of small bright and dark patches on the surface would nearly but not completely cancel, such that their presence would impart a low-amplitude, high-frequency "ripple" on the light curve as the star rotates. This ripple would look very similar to random noise, with the result that a straightforward attempt to find the surface which best replicates the observed light curve will produce a surface peppered with spurious bright and dark spots which are merely noise artifacts. LI circumvents this problem by constraining the solution so as to favor surfaces which are "smooth" and thus free of noise artifacts in a well-defined sense.

The student who works on this project will apply LI to a particular star, LO Pegasi, that is particularly well-suited for a summer research project: It is well-placed for observation in June and July, and it has a short 10.153-hour rotation period, making it relatively easy to gather enough data for analysis of its starspots. Images of a star field surrounding LO Pegasi will be obtained using a QSI 632 CCD camera and B, V, R and I photometric filters at OWU's Perkins Observatory. Standard reductions (dark subtraction and flat fielding) will be performed on the images in order to reduce random noise and systematic errors. Then differential aperture photometry will be used to obtain the light curve (plot of intensity vs. time) of the target star as seen through each filter. Using multiple filters significantly improves the latitude resolution of the technique by taking advantage of the wavelength dependence of the limb darkening (center-to-edge dimming) of the stellar surface. The light curve data will then be analyzed via LI to produce maps of the stellar surface. This summer's data will also be compared to data obtained from 2006-2015. In particular, other researchers using a different technique called Doppler imaging have deduced the presence of a large starspot on the rotation pole of LO Pegasi that is inclined towards Earth. A symmetric circular polar spot does not cause rotational variations in the star's brightness since it is always looks the same from Earth, but long-term variations in the average brightness of the star can be explained by changes in the size of the polar spot. Such variations are indeed seen in the earlier data.

It is anticipated that the results will be presented by the student at the national meeting of the American Astronomical Society in Dallas, TX in January 2017.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Coordination Chemistry: Green Chemistry Catalysis

SPECIFIC TITLE OF RESEARCH PROJECT

Preparation of Complexes as Robust Catalytic Oxidants

FACULTY SUPERVISING RESEARCH

Name: ***Kim A. Lance***

Department: ***Chemistry***

Campus phone: ***368-3527***

Email user name: ***kalance***

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: ***May 9, 2016***

Ending: ***July 15, 2016***

Requested Number of Students:

one ___

two X

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Successful completion of Organic Chemistry II (Chem 261)

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Metalloenzymes often catalyze important oxidation reactions by forming reactive intermediates containing high valent middle and later transition metal (MLTM) centers. Several of these intermediates are too reactive to be isolated or thoroughly characterized outside of their biological environments. Thus metalloenzymes have inspired the design of ligand systems for yielding complexes that mimic their catalytic utility and ability to stabilize high valent metal centers.

Our research is focused on developing ligands that stabilize rare high valent MLTM complexes with the goal of using some of these complexes to catalyze reactions of biological, chemical and environmental relevance. We are particularly interested in reactions involving oxidations of various organic substrates with O-atom transfer oxidants such as *tert*-butyl hydroperoxide (TBHP) and iodosylbenzene. These ligands will require resistance toward oxidative degradation and will thus follow previously published ligand design rules.

The ligands that we intend to prepare involve diamide-diamine donors (Figure 1).

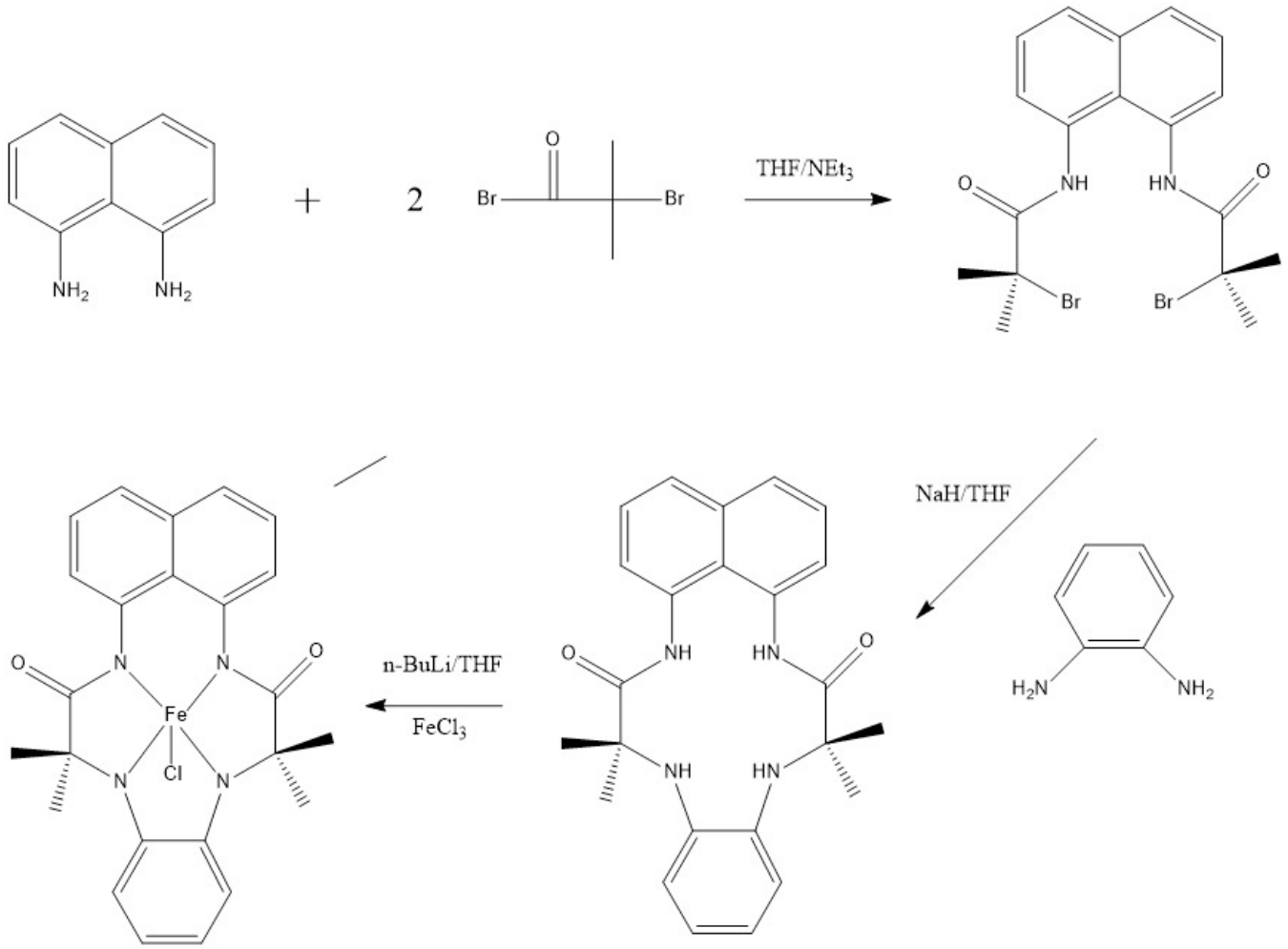

Figure 1. The synthetic scheme for the preparation of a diamide-diamine ligand.

Complexes of this ligand series will be prepared for the first row transition metals Mn, Fe, Co, and Cu. A strong base such as *n*-butyllithium or lithium bis(trimethylsilyl)amide will be added to an anaerobic tetrahydrofuran suspension of the ligand to deprotonate the amides/amines. An appropriate metal salt or complex with labile ligands will be added to insert the desired metals. If the resulting complexes are diamagnetic, they will be characterized by UV/Visible spectroscopy, ^{1}H and ^{13}C spectroscopy, IR spectroscopy, and mass spectrometry. If they are paramagnetic, we will be additionally characterized at Ohio State University with electron paramagnetic resonance (EPR) spectroscopy.

The synthesized metal complexes will be reacted with TBHP or iodosylbenzene in the presence of simple substrates to check for the formation of oxygen atom inserted products similar to those formed in P-450 oxidations. The substrates styrene, ethylbenzene and 2,3-dimethyl-2-butene will be tested initially in an oxidatively robust solvent such as methylene chloride or acetonitrile. The resulting products will be analyzed by gas chromatography and compared to known standards to determine percentage yields.

It is hoped that the diamide-diamine metal complexes can be used to oxidize substrates of environmental concern, such as models of halogenated organics or pesticides. They also can be considered green catalysts for oxidations involving hydrogen peroxide as the oxidant.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Computer Science

SPECIFIC TITLE OF RESEARCH PROJECT

Artificial Intelligence of Modern Board Games

FACULTY SUPERVISING RESEARCH

Name: Sean McCulloch

Department: Mathematics and Computer Science

Campus phone: 3663

Email user name: stmccull

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 16, 2016

Ending: July 21, 2016

Requested Number of Students:

one XX

two ____

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Successful completion of CS210 and Math 250.
More CS or Math classes (especially CS360) are recommended.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

The student will be working with a REU student from another school (pending funding) on developing an intelligent agent for a "modern" board game. The idea is that we would like to exploit some underlying mathematical structure of the game and design an agent that uses that structure, as opposed to classical search.

See the REU project description at https://www.owu.edu/academics/reu/project-descriptions/artificial-intelligence-for-modern-board-games/ for more details.

The OWU student will have several choices in direction for this project:

- They can work with the REU student on a new game, starting from scratch.
- They can work separately from the REU student on a different game, so we would have two agents for two games being created.
- They can work to improve the agents that have been currently created for our Football Strategy and Battle Line programs.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Applied Mathematics – Mathematical Biology

SPECIFIC TITLE OF RESEARCH PROJECT

Dynamics of Neuronal Network Models of Olfaction

FACULTY SUPERVISING RESEARCH

Name: Pamela Pyzza

Department: Mathematics/Computer Science & Neuroscience Program

Campus phone: 740-203-4908

Email user name: pbpyzza

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 16, 2016

Ending: July 21, 2016

Requested Number of Students:

one X

two ___

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

N/A

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Student should have experience working with differential equations and experience programming in Matlab or C++. Course prerequisites include (MATH 280-Differential Equations, CS 110-Introduction to Computer Science and Programming). A basis in neuroscience is helpful but not required and NEUR 300.1 - Introduction to Neuroscience is suggested.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Olfaction is arguably the most primitive sense in that the olfactory systems of a number of insects appear structurally and functionally similar to numerous other animals, including mammals such as humans [1-3]. Thus, we can use mathematical descriptions of neurons to construct models of neuronal networks in insects, such as the honey bee, sphinx moth, and locust, and gain insight into the way a much larger array of animals process early olfactory information.

Experiments suggest that the locust detects odors through receptors on its antennas, which send stimuli to sensory neurons in the antennal lobe, part of the locust analogous to a mammalian olfactory bulb [1]. When stimuli reach the antennal lobe, they trigger a series of synchronous oscillations of the neurons there [4]. The oscillations are then extinguished and followed by slow, stimulus-dependent modulation of the individual neuronal firing-rates, which continue after the stimulus has been turned off [5-7]. This has been modeled in detail using Hodgkin-Huxley equations [6-8]. We will consider a more idealized neuron model, the Integrate-and-Fire (I&F) model, with a focus on understanding the underlying mechanisms behind such network behavior. The I&F model numerically computes a neuron's voltage until the voltage reaches the firing threshold, where the resulting action potential is accounted for, but not computed, and the voltage is reset [9].

Students will simulate a neuron's spiking behavior using the I&F neuron model and numerically solve the associated system of differential equations using common finite differencing schemes, such as Runge-Kutta algorithms. They will use MATLAB or C++ to implement models of individual neurons and neuronal networks, with which they can explore the param-eter space of the model and look for network dynamics, such as oscillations and asynchronous behavior. Students can also write modules for the network model to investigate how its ac-tivity depends on the network's architecture. Studying various parameter sets and network architectures allow us to model properties of different insects in more detail and compare the nuances of each insect's olfactory system.

References

[1] J. G. Hildebrand and G. M. Shepherd, "Mechanisms of olfactory discrimination: con-verging evidence for common principles across phyla," Ann. Rev. Neurosci. 20, (1997): 595–631.
[2] H. L. Eisthen, "Why are olfactory systems of different animals so similar?," Brain Behav. Evol. 59.5-6, (2002): 273–293.
[3] L. M. Kay and M. Stopfer, "Information processing in the olfactory systems of insects and vertebrates," Sem. Cell Dev. Biol. 17, (2006): 433–442.
[4] G. Laurent and H. Davidowitz, "Encoding of olfactory information with oscillating neural assemblies," Science 265, (1994): 1872–1875.
[5] M. Wehr and G. Laurent, "Odour encoding by temporal sequences of firing in oscillating neural assemblies," Nature 384, (1996): 162–166.
[6] M. Bazhenov, M. Stopfer, M. Rabinovich, R. Huerta, H. D. Abarbanel, T. J. Sejnowski, and G. Laurent, "Model of transient oscillatory synchronization in the locust antennal lobe," Neuron 30, (2001): 553–567.
[7] M. J. Patel, A. V. Rangan, and D. Cai, "Coding of odors by temporal binding within a model network of the locust antennal lobe.," Front. Comput. Neurosci. 7, (2013): 50.
[8] E. Sivan and N. Kopell, "Oscillations and slow patterning in the antennal lobe," J. Comput. Neurosci. 20, (2006): 85–96.
[9] A. N. Burkitt, "A review of the integrate-and-fire neuron model: I. homogeneous synaptic input," Biol. Cybern. 95, (2006): 1–19.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Animal Behavior and Communication, Evolution

SPECIFIC TITLE OF RESEARCH PROJECT

Learning to sing and speciate: does learning impede or promote speciation in birds?

FACULTY SUPERVISING RESEARCH

Name: ___Dustin Reichard_____

Department: ___Zoology_____

Campus phone: ___x2890_____

Email user name: ___dgreicha_____

ANTICIPATED RESEARCH DATES, (ten weeks): **Requested Number of Students:**

Beginning: __May 16, 2016_____ one __X__

Ending: ___July 22, 2016_____ two ____

IF REQUESTING TWO STUDENTS: (Please indicate rationale for requesting two students, including willingness to work with just one student, if that is all that can be placed in your project.)

I am only requesting one student.

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Completed BIOL 122, be comfortable using computers, some basic experience managing excel spreadsheets, interest in birds and/or animal communication

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Learning to sing and speciate: does learning impede or promote speciation in birds?

In organisms that reproduce sexually, it is now broadly accepted that speciation occurs most commonly in allopatry when two populations become separated geographically, diverge in isolation, and eventually lose the ability to successfully interbreed. However, many allopatric populations regain contact with one another before sufficient barriers to reproduction can develop, which complicates the final stages of the speciation process. When secondary contact occurs, interbreeding and hybridization may halt speciation completely, or selection for stronger premating barriers to interbreeding can arise through a process known as reinforcement.

The most common premating barriers often result from divergence in courtship signals such as songs and visual ornaments, and the ability of these signals to diverge between two populations will vary depending on how they are inherited. Signals that are learned early in life (e.g., songs, displays) do not experience the rigorous proofreading mechanism that is present with signals that are non-learned and genetically inherited (e.g., coloration, scents). As a consequence, learned traits appear to be more flexible over evolutionary time, and species that rely on learning may diverge more rapidly in allopatry than species with mating signals that are not learned. After secondary contact, however, signal learning may actually impede reinforcement, because learned signals are typically passed directly from the signaler (i.e., the father) to the offspring without experiencing the costly intermediate trait values of non-learned, genetically inherited signals. Conversely, hybrids that do produce costly intermediate traits of non-learned signals will be at a disadvantage in attracting mates from either parent population thereby facilitating reinforcement. Thus, the importance of reinforcement in the process of speciation may depend on whether mating signals are learned or not.

Songbirds (order Passeriformes) present an ideal system for differentiating between the effects of these developmental mechanisms on speciation as they are split into two distinct groups that either learn their songs (oscines) or genetically inherit their songs with limited environmental influence (suboscines). Interestingly, the oscine songbird clade is particularly speciose (~4,000 species), and contains nearly half of the extant bird species (~10,000). Suboscines, in contrast, account for only ~1,000 species, which raises the question of whether or not song learning has contributed to the radiation of the oscine clade. During the Summer Science Research Program, I will collaborate with a student to test the following research question:

> **Is the evidence for speciation via the process of reinforcement stronger in clades with non-learned mating signals (suboscines) than in clades with learned mating signals (oscines)?**

Methodology: For this project, the student will learn techniques from the fields of genetics, cladistics, bioacoustics, and ornithology, and also be given an opportunity to learn how to record the songs and calls from wild birds in the field. We will use a recently published phylogeny of all songbirds to identify sister taxa in the oscine and suboscine clades that have partially overlapping ranges such that song recordings can be analyzed from both sympatric and allopatric populations. We will then calculate the genetic distance separating each pair of sister taxa and match oscines and suboscine pairs according to genetic distance to control for the age of each speciation event. The necessary genetic data for every bird species are available via public databases. After identifying suitable species pairs, we will search for recordings in public archives from sympatric and allopatric populations of each species. We will then analyze each song recording and quantify multiple temporal and spectral characteristics such to create a composite measure of song content. We will then test for the presence of reinforcement by comparing differences in song divergence between allopatric and sympatric populations of each sister taxa pair (oscine v. suboscine) matched for genetic distance.

2016 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 12 January 2016

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Neuroscience

SPECIFIC TITLE OF RESEARCH PROJECT

FACULTY SUPERVISING RESEARCH

Name: Jennifer Yates, PhD

Department: Neuroscience and Psychology

Campus phone: x 3814

Email user name: jryates

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: May 10, 2016

Ending: July 15, 2016

Requested Number of Students:

one ___

two _x_

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

The students must be willing to work with research animals including performing surgeries, behavioral protocols, euthanasia, and tissue harvesting. They needn't have performed these procedures before, only be willing to learn them. The students must also be willing to work some days with odd hours (including occasional weekend days) to cover post-surgical care, behavioral testing and drug administration. Interest in neuroscience, zoology, and/or physiological psychology is imperative.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Animal models of acute spinal cord injury (SCI) have indicated that long-term outcome depends on both direct mechanical damage (in humans, this might come from a car accident or sports injury) and delayed secondary pathologic mechanisms (things that happen AFTER the initial injury that make damage worse). The full contingent of secondary mechanisms has not yet been discovered, but likely includes decreased blood flow to the area (Dohrmann et al, 1972; Senter et al, 1978; Tator and Fehlings, 1991), local tissue swelling (Dohrmann, 1972; Olsson et al, 1992), production of reactive oxygen species which results in destruction of neuron cell membranes (Demopoulos et al, 1982; Hall,

1993), and release of toxic molecules by immune cells responding to the injury (Blight, 1994, Yates et al, 2006).

The guinea pig SCI model implicates activated macrophages (a subtype of inflammatory immune cells) in secondary tissue damage and delayed loss of motor and sensory function (Blight, 1994; Blight et al, 1995; Yates et al, 2006). Specifically, the production of the neurotoxin quinolinic acid (QUIN) by activated macrophages contributes to secondary functional deficits (Blight et al, 1995; Yates et al, 2006). Therapeutic inhibition of QUIN synthesis with 4-chloro-3-hydroxy-anthranilic acid reduces QUIN accumulation in the spinal cord lesion and reduces secondary loss of function (Blight et al, 1995). This therapy can be delivered starting as late as five hours post injury and still reduce secondary functional deficits and double the survival of white matter at the injury site (Yates et al, 2006).

The project that students will undertake this summer will be to evaluate the accumulation of QUIN using a newly available anti-QUIN antibody and determine the effectiveness of 6-Chloro-Tryptophan in blocking that accumulation across time. The behavioral (motor and sensory) consequences of injury and treatment will be evaluated as well. Students will learn animal care, surgical, behavioral, and immunohistological techniques over the course of the project.