2009 East Asia and Pacific Summer Institutes for US Graduate Students

Summer program in Australia for US graduate students in science and engineering

Contents

Introduction

The Australian Academy of Science was delighted to welcome, for the sixth year, a group of twenty outstanding graduate students from the United States of America to participate in the 2009 East Asia and Pacific Summer Institutes (EAPSI) *Summer Program in Australia for US graduate students in science and engineering*.

The program, developed in collaboration with the US National Science Foundation, aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The program started on 22 June 2009 and lasted for eight weeks.

The Academy acknowledges the importance of research collaboration that goes beyond national borders and academic disciplines. The Academy places great importance in strengthening exchanges that are both competitive and cooperative among talented young researchers.

Participants achieved their immediate research goals. From their reports I note that they have accomplished much more. Some students have initiated strong collaborative links that will provide the foundation for lifetime cooperative research. Others have gained a broad perspective of the nature of research in Australia, while others have been enriched by understanding another culture. These graduate students and the young Australians with whom they shared their research will play an important role in advancing cooperative research between Australia and the US in future years.

I would like to extend my thanks to the Australian Government Department of Innovation, Industry, Science and Research for their continued support in funding this program, and of course to our colleagues at the National Science Foundation. Without their kind assistance and cooperation, this important activity could not be sustained.

The Academy looks forward to welcoming a new group of students in 2010.

Professor Kurt Lambeck AO, FAA, FRS
President
Australian Academy of Science

Orientation program

Monday 22 June

10.30 Arrival at Canberra Airport

11.30 Administrative details at Ian Potter House

3.00 Tour of National Museum of Australia

6.30 Dinner at the Cellar Café and Buttery, University House

Tuesday 23 June

8.50 Arrive at the Shine Dome, Australian Academy of Science

9.00 **Official opening**

Professor Graham Farquhar FAA, ***Australian Academy of Science's Secretary of Biological Sciences***

9.05 **Welcome address**

Dr Sue Meek, ***Chief Executive, Australian Academy of Science***

9.10 **Lecture –** ***Australian biodiversity***

Professor David Lindenmayer FAA

10.30 **Lecture –** ***Postdoctoral research opportunities in Australia***

Dr Joe Hlubucek, ***Executive Director, Australian-American Fulbright Commission***

11.30 Lunch at Parliament House

2.00 Attend Question Time at the House of Representatives, Parliament House

3.00 Tour of Parliament House

6.00 Annual dinner at the Shine Dome

Wednesday 24 June

8.30 Depart Canberra

Name:	**Rachell Barker**
University:	University of Texas at El Paso
Research advisor:	Professor Gillian Rhodes
Host institution:	University of Western Australia

Research subject

Cross-race face perception

Research description

The cross-race effect is a well-known phenomenon in which individuals perform better at recognising faces of their own race than they do at recognising faces of a different race. Over 30 years of research has shown the cross-race effect to be a reliable and robust phenomenon (see Meissner and Brigham 2001). However, although the concept itself is reliable, individuals themselves may not be so consistent. In other words, individuals may show the cross-race effect in one setting but not in another. This lack of reliability within individuals has important legal implications. Individuals of one race may be witnesses to, or victims of, a crime committed by an individual of a different race. The reliability of this witness would be of great interest to the courts given our knowledge of the cross-race effect. Russell, Duchaine and Nakayama (2009) have recently coined the term super-recognisers to refer to individuals with extraordinary abilities to recognise faces. These individuals are often able to recognise people they haven't seen for years, even if they are drastically different in appearance. The super-recognisers in Russell et al's (2009) study performed equally well across a variety of tasks; that is, they were highly reliable. This discovery of super-recognisers offers a unique opportunity to assess the reliability of face recognition performance for both own-race and other-race faces.

My research project will attempt to determine how reliable individuals with widely varying levels of face recognition ability are in recognising both own-race and other-race faces. We are also interested in several factors that might affect the cross-race effect, including the level of contact individuals have had with the other race, their memory strategies used in identifying a face, as well as autistic traits. We predict a strong cross-race effect in general and more reliable performance for individuals with greater face recognition ability. We also expect that the amount of contact with the other race will lessen the cross-race effect. Previous research with autistic children has shown that they perform poorly on face recognition tasks, so we also predict that adults with greater autistic characteristics will perform more poorly.

Research activities

The stimuli for my project included 60 Asian and 60 Caucasian male faces. The majority of my time initially was spent preparing these photos in such a way that they were standardised as much as possible. To present my stimuli, I was also required to learn new programming software that I had no prior experience with. These two experiences alone were invaluable to me as a researcher in this area. The help and guidance of the lab members in using these software packages greatly enhanced my knowledge of facial stimuli and programming, which are skills I will be able to draw upon in my future research projects.

After my materials were ready, data collection began. A typical participant would come into the lab and see a series of 30 faces (half Asian, half Caucasian), which they were told to remember for a later memory test. After a brief distraction, the participant would then see 60 faces (half new and half old), each of which the participant had to decide if it was new or old and give a description of their memory for the face. Next, the participant would complete the Cambridge face memory test (Duchaine and Nakayama 2006) as an additional test of face recognition ability. In order to study the reliability of individuals over time, each participant then completed a second recognition task identical to the first, except all new Asian and Caucasian faces were used. Lastly, the participant would answer questionnaires designed to ascertain their level of racial contact (Hancock and Rhodes 2008), and their level of autistic symptoms (Baron-Cohen, Wheelwright, Skinner, Martin and Clubley 2001). Data collection had only just begun as my time was drawing to a close; as a result, the analyses are still on-going. I will continue collecting data from my home university until we reach a satisfactory sample size. We hope that this project will be a starting point for future research and will eventually lead to a publication.

Perspective of research after this program

My research experiences at the University of Western Australia were invaluable professionally. Being able to see how another lab runs, as well as how research is conducted internationally was very beneficial. The high quality and quantity of psychological research being conducted in Australia was very encouraging. Through this experience, I have learned to be a self-reliant researcher and have learned new programs which will benefit my future research. It was enlightening to see the different approaches labs may take, as well as the different structures of psychology programs in Australia. I think it is common for researchers to think that there is only one approach to conducting their research. The experiences gained on this program are great tools for combating this error and producing creative collaborative efforts.

Name:	**Elizabeth Basha**
University:	Massachusetts Institute of Technology
Research advisor:	Dr Raja Jurdak
Host institution:	CSIRO ICT Centre – Queensland Centre for Advanced Technologies

Research subject

Automated irrigation and power management using sensor networks

Research description

Sensor networks provide a system for monitoring the world around us in a distributed fashion; recording large amounts of data automatically and communicating it back to those interested. Yet these networks utilise only the most basic of operations and do not yet take advantage of the computing power existing on each sensor unit (or node) within the network. This research aims to utilise both the sensing already occurring and the computational power available to predict local phenomena of interest. It proposes to develop linear regression-based models that run in a distributed fashion on a sensor network, with each node computing part of the model to enable this prediction.

For the EAPSI project specifically, I examine two very different applications: (1) predicting future soil moisture to enable automated irrigation systems, and (2) predicting future solar charging current (for the battery) to enable better power management of a node. To demonstrate the versatility of the models, I implement them on the CSIRO sensor network.

Research activities

Upon starting my time at CSIRO, I had already developed the models and algorithms necessary to calibrate and run a distributed linear regression model for the application of river flooding and my associated sensor network. CSIRO also had existing work in the form of several data sets collected using their existing sensor network platforms. With this prior work, I first ran simulations of the data sets on the models, verifying the functionality of the regression model for predicting each phenomenon of interest. Having verified the model could work for both applications, we determined that solar current is more predictable so focused our field experiment on that problem. I implemented my algorithms on the CSIRO Fleck sensor platform, which utilises a different processor and operating system than my sensor network. Once the model successfully ran on the Fleck platform, I tested it on a section of the campus sensor network, running a short-term afternoon test as well as leaving a test running long-term while I returned to the US.

Perspective of research after this program

This program helped my own personal research immensely. By utilising my model for a different application and implementing it on a different platform, I proved the versatility and flexibility of the model. This work will comprise a chapter in my thesis and some conference papers.

In a more abstract sense, I also experienced a different approach to research in my field and learned about the field in Australia as a whole through visits to other research institutions. That set of experiences provided me with new ideas for my own research, suggestions for our research group's overall approach and several possible collaborations to leverage both side's strengths.

Advisor's remarks

It was a pleasure having Elizabeth working in our group for two months over the period from June-August 2009. Elizabeth quickly adapted to the work environment at CSIRO by successfully applying her distributed prediction model on our Fleck sensor nodes. This work has the potential of enabling solar energy prediction for many of our sensor node deployments, including the Springbrook Rainforest and Lake Wivenhoe deployment. We are currently discussing with Elizabeth the possibility of extending her work remotely to make the code more general for use in multiple application scenarios. Overall, I believe Elizabeth had a fruitful stay in our lab in Queensland, and I look forward to future interactions and collaborations with her and her home research group at MIT.

Name:	**Miguel Castrence**
University:	University of Hawaii at Manoa
Research advisor:	Dr Stuart Phinn
Host institution:	University of Queensland

Research subject

Object-based image analysis for remote sensing of coral reefs

Research description

This project investigated object-based image analysis (OBIA) for automated mapping of coral reefs with optical remote sensing. The work integrated field data from shallow-water coral reef surveys with multispectral remote sensing data of high spatial resolution. A variety of computer algorithms were tested and implemented for image segmentation and classification to create a map of coral reef benthic zones around Heron Island, southern Great Barrier Reef.

The results of this project could contribute to the development of a systematic methodology for object-based image analysis of coral reef remote sensing data. This study could also provide insight into whether such methods need to be customised for specific types of coral reefs in different geographic regions. Collaboration between researchers from Hawaii and Queensland would promote coordination among scientists working on issues of common concern in countries with coral reefs.

Research activities

I was based at the Centre for Remote Sensing and Spatial Information Science (CRSSIS), a research group in the School of Geography, Planning and Environmental Management at the University of Queensland. Under the guidance of Stuart Phinn and Chris Roelfsema, I used data collected by CRSSIS staff and students from their field site in Heron Island, with the hopes of adapting their methods to my own field sites in Hawaii. In addition to studying image segmentation algorithms developed by CRSSIS researchers, I also worked on methods for integrating field survey data with remote sensing data. Specifically, I created a guide for geotagging, linking GPS data with digital photos so that they can be viewed within GIS software.

Perspective of research after this program

I have gained a lot of insights that I am eager to apply to my own work in Hawaii. Even though I did not have a lot of contact time with my hosts, the time I did have was extremely valuable. While we will always be able to keep in touch via the internet, it was helpful to establish working relationships through face-to-face communications. I especially enjoyed the attitude of open

research and the spirit of collaboration and sharing among CRSSIS researchers. I look forward to future collaborations and I will actively seek opportunities to return to the University of Queensland.

Advisor's remarks

During his visit Miguel was able to initiate a strong linkage with key staff working on object-based image analysis of coral reefs and the integration of this work with georeferenced photographic surveys of the reef taken while snorkelling or diving. Discussion with these groups enabled areas common to our projects and Miguel's to be identified. This was used to establish a small project where he made a significant advance in geotagging photos which will assist his work and our work.

It is clear that Miguel's PhD work and the ongoing reef mapping and monitoring work in my group are highly complementary. This has been an all too brief but highly useful collaboration, which we will pursue. My group would quite happily host Miguel again as his PhD progresses and at a time when we will all be around to contribute!

Name:	**Nancy Chaney**
University:	University of Hawaii at Hilo
Research advisor:	Dr Cynthia Riginos
Host institution:	University of Queensland

Research subject

The relationship between larval development and population structure in Pacific micro-gastropods

Research description

My research project while in Australia was an expansion of my thesis research and involved determining whether the pattern of population connectivity of marine micromolluscs (genus Peristernia and members of the family Columbellidae) found within the main Hawaiian Islands is similar to that found along the east coast of Australia. As part of this project, one of my goals while in Australia was to gain an understanding of the software, techniques and interpretation needed to properly analyse my existing data set from Hawaii, and to take that knowledge back to my home campus.

Research activities

During my first week in Australia I was fortunate to meet with Dr John Healy at the Queensland Museum who let me examine and photograph their collection of my species of interest. In addition, he helped me to determine sites at which to collect micromolluscs. As a result of his assistance, I was able to find and identify three species of micromolluscs in eastern Australia. After collection, I photographed the samples, and preserved them for later molecular analysis.

While in Dr Cynthia Riginos's lab, I worked through the process of a population connectivity analysis with part of my data set from Hawaii. She led me through the entire process, including selection of applicable software, the use and understanding of many pieces of software and the interpretation of the resulting output. This particular data set had been particularly difficult to interpret and was unresolved before going to Australia. Dr Riginos was able to suggest methods that led to not only a clear phylogenetic tree for this species but also a greater understanding of its population connectivity among the Hawaiian Islands. She and the rest of the lab group were very encouraging when reviewing my results and made many suggestions as to how to follow up with future analyses and possible discussion topics that would make for an intriguing publication. I feel much more prepared to successfully complete my thesis project and the associated publication after this assistance, and have learned enough through this process to share my knowledge of population connectivity analysis with fellow students at my home campus.

Perspective of research after this program

I feel as if I have now experienced first-hand the major difference in research culture between a small, teaching-based university (University of Hawaii at Hilo) and a large, research-based one (University of Queensland) while I was in Australia. The EAPSI fellowship allowed me to have a brief period in that environment and to witness what it takes to keep a large research program and multiple graduate students functioning. For my career, the experience of spending two months within such a knowledgeable group is irreplaceable. My thesis work will include a much higher level of understanding and a much more thorough examination of my topic due to my participation in this program.

Advisor's remarks

Nancy Chaney is an enthusiastic student and was a delight to have visit my lab group. Although Nancy and I had initially planned for her to conduct some bench-work during her visit, we both agreed that focusing on analytical techniques would be more fruitful. Indeed, Nancy made great progress in applying new methods to her already gathered data and should be able to efficiently (and self-sufficiently) move forward as she accumulates additional data back at her home lab. I was also greatly impressed by her drive to do field work and she made several collections of her study organisms during her visit. Unfortunately, two months is ultimately a fairly short period of time to make much headway in basic research.

Name:	**Aaron Geller**
University:	University of Wisconsin, Madison
Research advisor:	Dr Jarrod Hurley
Host institution:	Swinburne University of Technology

Research subject

The progeny of stellar dynamics and stellar evolution

Research description

The study of star clusters is at the heart of the principal astrophysical fields of stellar evolution and stellar dynamics. Within these clusters, evolving stars and binary systems undergo complex dynamical dances which modify the binary population and lead to a rich array of new stellar evolution paths and products. These 'anomalous stars' are observed in star clusters over a wide range in age, and pose a difficult problem for stellar evolution theory, as none of these stars follow the standard single star evolutionary sequence. It is thought that the formation of many of these anomalous stars is facilitated by an evolving binary companion and/or dynamical interactions with other stars and binaries within the star cluster environment. Dynamical interactions with binary systems can also modify the characteristics of the binary (or binaries) involved, resulting in an observed population of binaries that differs from the primordial population.

For the past five years I have observed a set of four star clusters within our galaxy in great detail, characterising the anomalous stars and the binary populations. I focused on the old (7 billion year) cluster named NGC 188, and have gained a detailed understanding of the current state of this star cluster. As is the nature of all astronomy observations, we can only take a 'snapshot' in time of a given object, with no way to observe the evolution of the specific object over the billions of years of its life. Recently, with the advent of new hardware and software advances, we have gained the ability to perform highly sophisticated computer simulations of star clusters. These simulations afford us the opportunity to peer inside an evolving star cluster and watch as stars interact dynamically and form the same anomalous stars that we observe.

For my EAPSI project, we utilised the detailed observations that I have made of four galactic star clusters to help guide the most accurate star cluster simulation of a specific cluster to date, creating a model of NGC 188. From this model we are able to study in detail the formation mechanisms of the anomalous stars in NGC 188, and the evolution of the binary population through its entire 7 billion years of evolution. The results from this project show the power of using detailed observations to guide sophisticated computer simulations of star clusters. The NGC 188 model has greatly increased our understanding of the evolution of NGC 188 as well as star clusters in general.

Research activities

The NGC 188 model was created on the substantial computing resources at the Swinburne Centre for Astrophysics and Supercomputing. My specific research involved running, monitoring and analysing the output of multiple star cluster simulations. Each simulation was started with slightly different initial conditions, all based on observations of the young galactic star cluster, M35. Comparisons between each simulation provided significant insights into the evolution of different primordial binary populations and their impact on the evolution of the star cluster as well as formation rates and mechanism for anomalous stars. By guiding the simulations with my observed star clusters, and comparing the simulations at 7 billion years of age to my observed NGC 188 data, I was able to create a highly accurate model of NGC 188, allowing us to study the evolution of the cluster in great detail.

Perspective of research after this program

The EAPSI fellowship gave me the opportunity to explore a new avenue in my research, and strengthened my collaboration with Dr Hurley and his research network. The skills in computer simulations that I have learned through working with Dr Hurley form an ideal counterpart to the observational experience that I have gained throughout the past five years of my thesis. I anticipate that our collaboration will continue throughout the remainder of my PhD and into my postdoc and beyond. This international collaboration has brought new ideas to this project and shown me new methods for problem solving. I have already presented the results in a conference attended by international experts in the field and I intend to publish the results in both my thesis and as articles in refereed journals.

Advisor's remarks

I have been interested in models of star cluster evolution for many years now and more recently I have been keen to make the models more realistic through direct comparison to the open clusters that we observe in our galaxy. However, my initial attempts to do this lacked a true observational perspective. The collaboration with Aaron has importantly provided this perspective so that the latest observations of the binary star populations of actual star clusters can be used to constrain and improve simulations of star cluster evolution. In this respect the EAPSI fellowship has been a huge success, but it has also been successful in terms of career development for Aaron and the benefits that I have gained from working with Aaron.

Working closely together at Swinburne has allowed Aaron to learn the intricacies of star cluster simulation techniques (performed using N-body software) – this is a highly involved process and rapid progress would not have been possible if conducted remotely. Aaron now has first-hand experience in conducting numerical simulations and analysing and presenting the results. So far, the efforts of the fellowship have resulted in constraints being placed on the birth properties of star clusters and on uncertain aspects in the theory of binary star evolution. A landmark simulation, which for the first time included primordial triple stars in a realistic star cluster model, was also performed. As a result, Aaron has created a body of work that will make a very strong contribution to his thesis as well as to the N-body and star cluster communities. We expect two or three papers to be submitted to refereed journals as a direct result of the work already completed. It is also important that we build on this work so I expect our collaboration to continue for many years.

Name:	**Angela Grant**
University:	The George Washington University
Research advisor:	Dr Dmitri Sviridov
Host institution:	Baker IDI Heart and Diabetes Institute

Research subject

Reverse cholesterol transport and HIV infection

Research description

Our laboratory has demonstrated that the human immunodeficiency virus type 1 (HIV-1) impairs ABCA1-mediated cholesterol efflux from macrophages. This likely contributes to plaque formation and thus the increased risk of atherosclerosis seen in HIV-infected patients. Mechanistically, this impairment is mediated by the viral protein Nef. We have demonstrated that Nef interacts with ABCA1, increases ABCA1 plasma membrane localisation at the expense of cytoplasmic ABCA1 and eventually down-regulates ABCA1 protein expression. Overall, Nef modifies ABCA1 localisation, expression, and trafficking patterns. Nef has also been shown to increase the cholesterol content of lipid rafts, regions of the plasma membrane enriched in cholesterol and sphingolipids, from which HIV preferentially buds.

There are two possible mechanisms of the impairment of ABCA1-mediated reverse cholesterol transport by Nef. One possibility is that Nef modifies the ABCA1-dependent cholesterol trafficking/efflux pathway in such a way that instead of delivering cholesterol to the non-raft regions of plasma membrane for cholesterol efflux, it delivers cholesterol to rafts for HIV assembly. A second possible mechanism is that HIV blocks activity of ABCA1, directing transfer of unused cholesterol to rafts via the Nef-dependent, but ABCA1-independent, pathway. We are currently aiming to determine the mechanism of the observed Nef-mediated impairment of ABCA1-dependent cholesterol efflux. The elucidation of the molecular pathways of lipid metabolism affected by HIV infection and the role that these pathways play in HIV biology may lead to new approaches to control HIV replication. These studies may also foster novel ideas on how to treat lipid-related disorders, both those associated with HIV infection and those not.

Research activities

We first analysed the effect of ABCA1 inhibition on Nef-dependent trafficking of cholesterol to lipid rafts. As a method of testing ABCA1 involvement in Nef-mediated effects we used RNAi-dependent silencing of ABCA1. We found that inhibition of ABCA1 results in an increased amount of cholesterol in the plasma membrane. This increase in cholesterol content also correlated with an increased number of lipid rafts in the plasma membrane. We next examined the effect of ABCA1 and Nef expression on the structure of the cell membrane. To do this we

visually examined cultured cells via Laurdan 2-photon microscopy. We found that in the presence of Nef the cell membrane becomes slightly more ordered, whereas ABCA1 significantly decreased the order of the membrane making it more fluid. Expressing both Nef and ABCA1 led to a slightly less ordered membrane.

We also investigated the effects of Nef on ABCA1 localisation. We first confirmed normal ABCA1 localisation to nonraft regions of the plasma membrane through lipid raft isolation and western blot. We then examined ABCA1 localisation in Nef expressing cells and found that plasma membrane ABCA1 remains localised to nonraft regions of the plasma membrane even in the presence of Nef. Overall, these results suggest that Nef does not utilise ABCA1 in cholesterol delivery to lipid raft but is actually blocking the activity of ABCA1. Blocking the activity of ABCA1 may allow for the transfer of unused cholesterol to rafts via a Nef-dependent, but ABCA1-independent, pathway.

Perspective of research after this program

If you were to ask current graduate students if they thought international collaboration is important in the scientific community, the majority would answer yes. However, I think it is hard to fully appreciate the value and overall impact that international collaboration has on the scientific community prior to actually conducting research abroad. Scientifically, international collaboration allows access to cutting-edge technology and research techniques in your field, which is absolutely crucial for innovation. If we do not know or understand where the field is in the present we cannot contribute to moving the field forward. In addition to the technology aspect, cultural, economic and social factors can all influence how we work and think. Thus international collaborations can lead to more innovative solutions and techniques which can advance the field scientifically and also benefit the general population and environment. International collaboration can be undertaken for a variety of reasons, including cost sharing, geographical dependence, technology availability, political agenda, and globalisation. However, one of the main things I personally take away from the EAPSI program is my belief that regardless of the reason for collaborating with international partners the key to success is mutual respect. This includes not only respect for each partner's research priorities but also respect for their culture and way of life. The EAPSI program greatly globalised my perspective of scientific research and truly invigorated my passion for scientific discovery.

Advisor's remarks

Angela Grant spent two months working in my laboratory. Her integration into our research team was very smooth, as if she had always worked with us. She demonstrated determination and dedication, working hard and achieving remarkable results in just two months. Her contribution was not limited to bench-work; she actively participated in discussions on the project and contributed intellectually to the development of the project. In my view Angela's visit was a complete success and she is welcome to come back to my lab at any time. The Australian Academy of Science should be congratulated for supporting such a valuable program and I hope it continues.

Name:	**Jonathan Ito**
University:	University of Southern California
Research advisor:	Professor Liz Sonenberg
Host institution:	University of Melbourne

Research subject

Leveraging belief revision to model self-deception

Research description

My original aim was to utilise methods and approaches in the field of belief revision to model the psychological processes in human decision-making such as self-deception. But since Professor Sonenberg's expertise lies more in the area of negotiation and bargaining, I adjusted my research plan accordingly. I performed work on extending my research in the area of self-deception into the game-theoretic domain and ultimately into a generic model of bargaining and negotiation.

Research activities

1. Extended my model of self-deceptive decision making into the game-theoretic domain.
2. Began to formalise the notion of beneficial self-deception within the game-theoretic domain.
3. Worked on some specific instances of 2x2 games in which self-deception is beneficial.
4. Took some examples of 3x3 games presented by Stahl and Wilson and showed that some of the cases evince beneficial self-deception.
5. Began exploring the idea of extending my experimentation and analysis of the single-shot games to a more complex multi-stage (negotiation) game.
6. Began exploring coloured trails as an implementation of the negotiation problem mentioned above.
7. Spoke with Professor Yoshi Kashima extensively regarding the possibility of future collaboration on creating an agent-based simulation employed to explore various social phenomenon including the mechanisms behind self-reinforcing societies of agents which seem to promote either optimistic or pessimistic behaviour.
8. Met extensively with other graduate students and postdocs from the University of Melbourne, Monash University and RMIT in my direct area of interest.
9. Gave a seminar talk at the University of Melbourne regarding my work (in particular my AAMAS 09 paper).

10. Gave a seminar to a group of postgraduates at Monash University.
11. Received a very interesting (and positive) perspective on the outlook of Australian research from Professor Justin Zobel.

Perspective of research after this program

Overall I had an extremely positive research experience in Australia through the EAPSI program. Not only was I able to extend my previous research into exciting new areas of application but I also established a fruitful rapport with my host Professor Liz Sonenberg. With the cooperation of Professor Sonenberg I was able to generate several possibilities for future collaboration with various other researchers in Australia.

Advisor's remarks

Jonathan settled in very quickly to his academic activities in Melbourne. He gave a seminar in week two, which provided an opportunity for interested colleagues to be aware of his visit, and this provoked a number of productive follow-up conversations. I was impressed with his initiative and endeavour, and was pleased with the level of regular interaction. The work completed while in Melbourne has good potential for publication, and has provided the basis for ongoing interaction –both with myself as direct 'supervisor' for the visit, and with colleagues at Melbourne University with overlapping interests. It has been a pleasure to have had the opportunity to host Jonathan.

Name:	**Jennifer Martin**
University:	Virginia Institute of Marine Science
Research advisor:	Dr Jeff Leis
Host institution:	Australian Museum

Research subject

An Indo-Pacific contribution to the systematics, ontogeny and phylogeny of the ribbonfishes (Lampridiformes, Trachipteridae)

Research description

The Lampridiformes is a morphologically and ecologically diverse group of fishes that includes the families Trachipteridae (ribbonfishes) and their sister-group Regalecidae (oarfishes). They are distributed worldwide throughout the pelagic marine environment with some adult specimens exceeding 10 metres in length. Because of the size and rarity of undamaged adult specimens, relatively few are available in systematic collections; therefore the taxonomy, identification and systematics of this group of fishes are not well-researched and are highly unstable. Additionally, members of this group exhibit extreme morphological transformations throughout ontogeny, confounding taxonomic problems even more. Although any available data from adults is important to incorporate into a systematic analysis, early life history stages (eggs, larvae and juveniles) are much better represented in collections, and the morphology of these specimens and the study of their ontogeny is likely to be phylogenetically informative.

This goal of this research project is to advance the knowledge of the identification, development, biogeography and evolutionary relationships of a unique family of fishes and to examine the role of ontogeny in phylogeny. The results that will be achieved from this project apply not only to the East Asia and Pacific regions, their incorporation into a global synthesis will benefit ichthyologists and fishery biologists worldwide.

Research activities

The Australian Museum in Sydney (AMS) houses one of the world's largest catalogued collections of trachipterids. Specimens found here have been collected throughout Australian waters (Pacific and East Indian Oceans), Indonesia, French Polynesia, West Indian Ocean and the Mediterranean, providing a broad biogeographical range for sampling purposes. A complete morphological examination of more than 70 catalogued trachipterid holdings (larval and adult) at AMS was conducted, with extensive radiographic examination of type-material, among others, to investigate internal skeletal components.

Additionally, uncatalogued and unidentified larval trachipterid material was sorted, examined and catalogued, and is presently being described while on loan from AMS. Some of this material is being used to establish a complete species-level developmental series. This requires the

examination of numerous individual specimens to capture the full ontogenetic continuum of a species and includes specimens from all known geographic locations to 1) attempt to account for population-level or environmentally-induced phenotypic variations and delimit the species and to 2) document biogeographic distributions. The large, geographically wide-ranging collection at AMS will contribute greatly to this much-needed series.

Professional research visits were conducted at CSIRO in Hobart, Tasmania, the Queen Victoria Museum in Launceston, Tasmania, and the National Museum of New Zealand in Wellington to examine the trachipterid holdings and type material housed at these facilities. An additional 60+ specimens (including two type specimens and numerous radiographs) and some molecular data were analysed from these museums and will be used in taxonomic and evolutionary analyses. Lampridiform holdings at all museums were re-identified (which documented range extensions for several previously misidentified families) and inconsistencies in nomenclature were corrected.

Currently, I am revising the taxonomy and systematics of Trachipteridae in Australia and New Zealand and incorporating the ontogenetic data that was collected into a phylogeny for the family. This research will be included in a global evolutionary synthesis for this group of fishes. Once a stable and well-defined taxonomy for these species is established, museum collections will be updated to reflect this nomenclature. Once species descriptions have been revised and specimens properly identified, patterns of biodiversity for this group of unique fishes can be more accurately established.

Perspective of research after this program

This experience greatly reinforced the need for international exchange and collaboration for the completion of successful scientific research. Dr Leis and other Australian colleagues generously provided access not only to unique research material but also provided their expertise in the fields of ichthyology and evolution. The knowledge that I gained through the EAPSI program was essential for the completion of my research and even more valuable to my growth as a scientist.

Advisor's remarks

I was very pleased to have Ms Martin in my lab. She fitted right in with the other staff and from interacting with her and reading her report, it is clear she got a lot out of her internship. She made great progress in her studies of this difficult group of fishes. I will be interacting with her in the future as her studies on the Australian Museum's specimens continue, and I look forward to this and other collaborations. I would be very pleased to have another intern of Ms Martin's calibre in my lab at any time. All in all, I would judge her internship a great success.

Name:	**Michelle Meighan**
University:	Arizona State University
Research advisor:	Dr Michael Breadmore
Host institution:	University of Tasmania

Research subject

Development of an electrophoretic counterflow separations technique for biological analysis

Research description

There are many analytical challenges in separations science; perhaps one of the most difficult is the capability to separate and/or concentrate species from a complex mixture. Traditional techniques, such as 2D gel electrophoresis, have contributed to significant advances in separations science but are unable to effectively characterise such complex samples; therefore, better analytical techniques are needed for more thorough investigation.

Capillary electrophoresis (CE) is a fast, efficient separations technique often utilised in bioanalytical separations, but it suffers from poor limits of detection. The general class encompassing CE, electrophoretic separations, has been investigated in a myriad of ways in order to improve the detection limits. For example, enhancement can be obtained through the application of a counterflow. In a separation with counterflow, the electrophoretic velocity (or product of the electrophoretic mobility of a species and the applied field) is opposed by a bulk solution flow. These techniques have been shown to greatly enhance sensitivity in electrophoretic separations. Additionally, another recently developed electrophoretic technique is termed 'electrokinetic supercharging'. In this method, an electrophoretic technique (isotachophoresis) is combined with a field-amplified injection to obtain enhancement. This method has also been found to be simple yet powerful for online sample preconcentration.

In this work, electrokinetic supercharging was combined with a counterflow in order to study the potential of the method to separate and concentrate non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs, or common over-the-counter drugs such as Aleve (naproxen) and Advil (ibuprofen), were chosen because of their ubiquitous presence in wastewater. These drugs are hard to eliminate from wastewater, so they end up being released into the environment, causing adverse effects to both aquatic and terrestrial organisms.

Research activities

To begin my studies at the University of Tasmania, I familiarised myself with electrophoretic and isotachophoretic separations on a commercial instrument, as well the experimental procedures associated with electrokinetic supercharging. The overall goal was to combine this pressure-

assisted electrokinetic supercharging method with mass spectrometry in order to analyse NSAIDs in wastewater. To accomplish this instrumental coupling, an appropriate buffer had to be chosen as well as experimental conditions optimised. This included determining the best buffer composition, most suitable leading and terminating electrolytes, concentration of buffer and electrolytes, concentration of an organic modifier, and separation conditions (applied potential and duration of potential). These optimisation experiments were successfully completed, and the results indicated that the pressure-assisted electrokinetic supercharging method has good potential as an online sample preconcentration method. However, there were some instrumental issues that prevented the coupling of the technique to mass spectrometry. The potential still exists for the coupling and can be investigated in future research. It is expected that the results gathered will be able to be published in an appropriate separations journal.

Perspective of research after this program

Participating in the EAPSI program has been a truly remarkable experience for me. The opportunity to collaborate with Dr Breadmore has enabled me to learn a new method (electrokinetic supercharging), as well as gain a deeper understanding of electrophoretic separations as a whole through various discussions with several researchers in the Chemistry Department at the University of Tasmania. Additionally, through a presentation of my dissertation work, I was able to engage in many beneficial discussions with my Australian colleagues that have afforded me a fresh perspective on my research. This experience has been invaluable to my development both on a personal and professional level.

Advisor's remarks

Michelle spent a very productive period of time working in our research group within the Australian Centre for Research on Separation Science.

With regard to her research, she was able to construct an original and innovative research project that bridged the gap between her work in the US and our research here on the concentration of environmental pharmaceutical pollutants. She was successful in demonstrating some very promising results that will form the substantial basis of a high impact journal article.

Michelle also had ample opportunity to network with researchers, both graduate students and postdoctoral researchers and academic staff, within our centre and was able to discuss science in many different areas of analytical chemistry, as well as through interaction with researchers within the School of Chemistry (non-analytical chemists). She participated in our group meetings, presenting her research from her PhD as well as some of the results she had obtained here. I know that this led to several discussions by other students who were interested in her work and have stimulated some new research thoughts amongst the students.

It was a positive experience to have Michelle here and I would welcome her back (and other participants of this program) should they wish to come.

Name:	**Christine Moore**
University:	Stanford University
Research advisor:	Dr Ryan Lowe
Host institution:	University of Western Australia

Research subject

The hydrodynamics of fringing reef systems

Research description

The Ningaloo Reef coral ecosystem, located along the North-West Cape of Western Australia, is the largest fringing reef in Australia and is significant for both its size and ecological composition. The reef supports a high biodiversity of more than 500 fish species, over 200 species of coral and 600 species of molluscs. However, Ningaloo Reef is rapidly gaining an international reputation for nature-based tourism, and it is forecast that tourism and population pressures in the Ningaloo area will grow drastically over the next decade. In order to maintain the ecological integrity of the region, an improved understanding of the physical processes operating in this region is vital since many ecological processes are intrinsically linked to hydrodynamics.

Like all coral reefs, the total water motion experienced by Ningaloo Reef is thought to be induced by a combination of both surface waves (oscillatory flow) and mean currents (unidirectional flow). While no study of Ningaloo has been published on the transformation of incident wave energy across this reef at dominant swell periods (~10 seconds), detailed studies of wave transformation on reefs have been reported in the literature. However, much less work has focused on infragravity wave motions of with longer periods (~100-1000 seconds). Although the offshore wave energy incident to such reefs is generally restricted to swell periods, over the shallow reef and lagoon (where swell is absent) some studies have suggested that these infragravity motions could be significant, hence dominating the overall reef-lagoon water motion.

In an initial study on Ningaloo Reef, Dr Ryan Lowe and colleagues at the University of Western Australia conducted a large field experiment to obtain information on the mean currents and hydrodynamics induced by waves, winds and tides within a section of the reef. The obtained data revealed that, as swell breaks and is effectively dissipated on the shallow reef crest (~1 metre mean depth), relatively large infragravity wave motions are established on the reef flat and within the lagoon. These infragravity motions appear to be of similar magnitude to the wave-generated mean flows, indicating that these motions must be considered to eventually develop accurate models of sediment transport and nutrient dynamics in these systems. However, not enough information was acquired from this previous study to determine the full impact of these waves on the overall water motion of the reef. This project therefore was conducted to assess the relative importance of infragravity waves in the overall flow processes of the Ningaloo Reef system.

Research activities

A four-week experiment was conducted on a section of reef located in Sandy Bay in Ningaloo Marine Park from 10 June until 2 July 2009. An array of ten instruments were deployed across the reef flat on a cross-shore transect extending from the forereef to the lagoon. A Nortek AWAC was positioned on the forereef at a depth ~15 metres, providing a measure of incident wave energy due to surface level variability. One Aquadopp profiler was placed on the reef flat to measure high frequency currents and waves. An RD Instrument 1200 kilohertz acoustic Doppler current profiler was strategically placed on the reef flat in approximately 2 metres of water to measure high frequency currents and waves. Two SBE SEAGUAGE wave and current recorders were also positioned in the forereef and the lagoon in order to obtain comparable measurements of pressure fluctuations at these locations. The remaining sites incorporated five Nortek Vector ADVs, measuring at heights low and high in the water column. Each ADV sampled velocity and pressure at 2 hertz, providing directional wave information and current velocities.

Upon retrieval of the instruments, the obtained field data for the central transect was used to calculate the water surface elevation spectral density as a function of frequency for each hourly wave burst. Linear wave theory was then employed to compute the significant wave heights for both the infragravity (0.004-0.05 hertz) and swell (0.05-0.2 hertz) frequency bands. Analysis of this information was able to show that in the forereef, swell waves dominate energy density spectra. However, as waves propagate towards the shore and over the reef flat, infragravity waves become the more dominant forcing mechanism. A significant decrease in both infragravity and swell wave height over the reef flat was also observed, indicating frictional dissipation along the bottom boundary.

Additionally, the mean currents were computed by averaging the obtained values over various specified periods of time. A cross-spectral analysis was also conducted by calculating the cross-spectral pressure densities between adjacent instruments. From these, certain calculations were conducted in order to determine (1) phase spectra, (2) coherence estimates, (3) cross-shore energy fluxes, and (4) bulk reflection coefficients for both the infragravity and swell frequency bands. After a preliminary analysis, it was determined that both the infragravity and swell waves are progressive in nature, as opposed to the assumption that the infragravity frequencies should indicate the presence of standing waves.

In continuing this project, an overall energy budget will be developed to determine the overall energy components for each type of physical mechanism present in the system. Specific analytical methods will also be employed to determine what is leading to the development of infragravity waves on the reef, as well as what type of forcing is occurring at the surf zone of Ningaloo Reef.

Perspective of research after this program

The EAPSI program has exposed me to a completely new aspect of research within my field that I have never been introduced to before. Through this project, I have come to have a better understanding of the different research projects I could conduct during my time as a graduate student over the next several years. I have also gained a great deal of technical knowledge and expertise as a result of this project, and have developed close collaborative ties with several

Australian researchers. Since my research in Australia concluded, I have continued to work on the project and am conducting the next phase of data analysis. I hope to continue collaboration with Dr Ryan Lowe for the remainder of this project as well as for the projects I undertake in the future.

Advisor's remarks

We were very much privileged to have Christine working within our research group. For her research project, Christine was able to participate in a major field study of oceanographic processes at Ningaloo Reef in Western Australia. The strong research background Christine had previously developed at Stanford allowed her to excel in the analysis of the data set she collected, including presentation and communication of her results. Christine's overall research output far exceeded our expectations, given the relatively short time-frame of her visit. In general, Christine's productive visit helped to maintain a long-standing research collaboration between the University of Western Australia and Stanford, and we will be working closely with her over the next several months to submit a journal article describing her impressive results.

Name:	**Adam Nelson**
University:	University of Utah
Research advisor:	Dr Emma Whitelaw
Host institution:	Queensland Institute of Medical Research

Research subject

Testing the adaptive significance of Mup epigenetic regulation

Research description

Non-genomic transgenerational effects occur when phenotypic responses to environmental factors in one generation are transmitted to subsequent generations. Gametic epigenetic inheritance is a type of non-genomic transgenerational effect, where epigenetic modifications of genes in parental gametes determine the phenotype of the offspring. DNA methylation is an important epigenetic modification known to mediate the inheritance of specific phenotypes, including human diseases.

The adaptive value of gametic epigenetic inheritance is currently a matter of speculation. One hypothesis is that transgenerational epigenetic effects can generate adaptive variation to suit environmental conditions on a timescale shorter than that of genetic selection. Certain selective pressures, such as resource availability and population density, may cycle through high and low extremes within just a few generations. An adaptive epigenetic inheritance mechanism that allowed parents to 'prime' their offspring for novel environmental conditions could act faster than Darwinian genetic selection.

Our selection experiment at the University of Utah has shown that – within just a few generations – reintroducing laboratory-reared mice to intensified social complexity produces a male phenotype characterised by increased mating success and increased attractiveness to female mice. Of particular relevance to gametic epigenetic inheritance is the observation that male mice in the social treatment have greater expression of major urinary proteins (Mups) than males in the non-social treatment. Mups belong to a polymorphic, multi-gene family that encode pheromones essential for social communication, and have been previously been shown to be regulated by heritable DNA methylation. However, the adaptive function of such differential methylation remains unknown. Because mouse populations are known to fluctuate rapidly between high and low densities, and because the utility of this costly pheromone signal is expected to be greater in social conditions, we hypothesised that regulation of Mup expression via DNA methylation could be a mechanism of rapid adaptation to a fluctuating social environment.

Research activities

We hypothesised that there was a direct association between increased Mup expression in males of the social treatment and decreased methylation of Mup genomic DNA. We took two approaches to determine the extent of methylation of Mup genes in males of the social and non-social treatments. First, we sought to replicate a previous experiment which had shown epigenetic inheritance of Mup expression through the male germline, using methylation-sensitive restriction enzyme digestion and Southern transfer. We digested genomic DNA with the enzymes HpaII and BamHI. Because HpaII is methylation sensitive, it will only cut if DNA is unmethylated; the HpaII restriction site was located in the promoter of several highly conserved Mup genes. Digested DNA was separated on an agarose gel and analysed by Southern transfer by hybridising with a radio-labelled Mup probe.

Our second approach to assess DNA methylation of Mup genes was bisulfite sequencing of the first 190 nucleotides of the promoter of several highly conserved Mup genes. Here, we treated genomic DNA with sodium bisulfite to convert all non-methylated cytosine to uracil. Bisulfite-treated DNA was then amplified using PCR, and individual PCR products were cloned and sequenced.

Due to complications, the methylation-sensitive restriction enzyme digestion and Southern transfer approach was abandoned early on; however, results from the bisulfite sequencing approach were obtained. These data suggest that increased Mup expression in males of the social treatment does not involve selection on differential, heritable DNA methylation. However, due to a low sample size, more work needs to be done before a statistically robust assessment is made.

Perspective of research after this program

My dissertation research is focused on animal behaviour and genetics. The EAPSI program allowed me to test an epigenetic hypothesis concerning my research that otherwise would have been difficult to address. Little is known about where these fields intersect, and so it was exciting to conduct research in this area. Moreover, being in the Whitelaw lab provided an opportunity to learn about the leading questions and techniques in the study of epigenetics; I enjoyed meeting the members of the lab and learning about their projects. While it appears as though the results generated from this study are negative, I have gained significantly by getting exposure to a molecular genetic lab, learning new techniques, and making international connections with other scientists. I look forward to presenting the results at a meeting in June and, possibly, in a publication.

Advisor's remarks

From my point view the visit was valuable. Adam was at the right stage of his project to gain from the new molecular approaches which we could offer. He was a student who did not need babysitting. He brought new ideas to our lab, raising interesting questions about the possible role of epigenetics in evolution. He went away with a positive feeling about Australian science and scientists which is arguably the most important outcome of programs of this type. As a result of this experience, I would be delighted to host other students via this program in the future.

Name:	**Kyle Pula**
University:	University of Denver
Research advisor:	Dr Ian Wanless
Host institution:	Monash University

Research subject

Transversals of latin squares

Research description

My EAPSI research project concerned the mathematical subject of latin squares. A latin square can be thought of as a square matrix filled with symbols such that each symbol appears exactly once in each row and column. This concept arises in various guises throughout applied, pure and recreational mathematics (for example in the design of experiments, finite geometry, and Sudoku puzzles, respectively). As a subject of academic interest, it dates back at least to the late 1700s in the works of Leonard Euler and continues to garner attention among contemporary mathematicians.

My project focused in particular on transversals of latin squares. A transversal of a latin square is a subset of its cells that contains exactly one cell from each row and column and one cell corresponding to each symbol. Informally, it is the smallest subset of cells that could possibly touch each row, column and symbol. Questions about the existence and quantity of transversals among latin squares have been considered for many years and seem to be particularly resistant to theoretical study.

Research activities

This project sought to understand transversals of latin squares by exploring two related topics. Firstly, we looked at transversals in the context of the particular class of latin squares arising from so called quadratic quasigroups. Secondly, we examined two generalisations of the idea of a transversal: weak and partial transversals.

Informally, a quasigroup based on the elements of some finite field is said to be quadratic if its multiplication operation can be defined coordinate-wise by a quadratic polynomial. For example, the elementary abelian 2-groups are the most basic of all such quasigroups since their operations are simply coordinate-wise addition modulo 2. Cyclic groups of the same order however are typically not quadratic quasigroups: in any polynomial representation of their operation at least one cubic term must appear. When asking questions about transversals, restricting one's attention to the class of quadratic quasigroups is potentially advantageous since, by their very definition, they come equipped with a relatively compact algebraic representation in their polynomial forms.

Guided by my host's observation that squares lacking transversals seem to be disproportionately represented among the quadratic quasigroups of order eight, we sought to identify some pattern in the polynomial representations of those quadratic quasigroups whose corresponding latin squares contained no transversals. We made some progress in using the quadratic polynomial representations to prove the non-existence of transversals in a few particular cases. As we expected, however, a general pattern among these transversal-free squares proved to be more elusive. On this portion of my project, my host and I collaborated with another graduate student of his.

In the second portion of my project, we studied two generalisations of the concept of transversals. A weak transversal is a set of cells, exactly one from each row and column, such that no symbol is selected more than twice. It is known that all latin squares have at least one weak transversal. Our investigation originated from my host's discovery that one of the earlier published proofs of this result was incorrect and my own observation that the topic had some relation to a well-known conjecture in the field.

A final topic we studied was the concept of a partial transversal. A partial transversal is again a selection of cells, precisely one from each row and column. The length of the partial transversal is the number of distinct symbols appearing among the selected cells. In particular, a partial transversal is a transversal exactly when its length coincides with the size of the square. One of the major open questions in the study of latin squares is the following: what is the maximum length of a partial transversal in an arbitrary latin square?

We made some progress in understanding both these generalisations and particularly how they relate to each other. For example, we can now show not only that every latin square has a weak transversal but also that there is always a weak transversal of maximum length when considered as a partial transversal.

For each of the above topics, we have some preliminary results that we hope can be extended over the coming several months to a year and then submitted for publication.

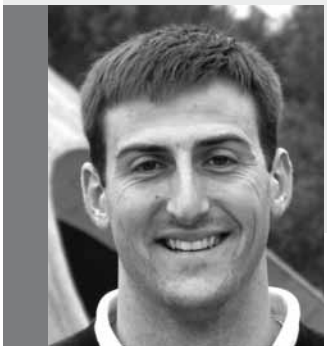
Perspective of research after this program

Prior to my work with the EAPSI program, I was already somewhat aware of my host's research and had some understanding of how to utilise the tools he had developed in the study of latin squares. After working with him directly, however, I have a much better intuition for the substance and techniques of his research. This change represents a major advance for me and one that could not easily have been made without the face-to-face contact provided by my EAPSI experience.

Beyond my own research, my time in Australia also afforded me the opportunity to observe and interact with a wide swath of the Australian mathematics community. I gave a talk at the First Pacific Rim International Mathematics Congress in Sydney, attended the public interviews for the next president of the Australian Mathematical Sciences Institute in Melbourne, and participated in research seminars at Monash University and the University of Melbourne. Through these activities I got to know graduate students, postdocs, and professors from across Australia. These connections gave me insight into the type of research being done in Australia and the advantages and struggles facing both individuals and the profession.

Advisor's remarks

It was a great pleasure to host Kyle. I knew of his work before he came, as he has been bringing some interesting fresh approaches to some long-term unsolved problems. As such I was very excited to have a chance to discuss these face-to-face. We made some useful progress during his visit and fully intend to keep the collaboration going to build on this foundation. I'm confident this will result in some important papers, and I'm very grateful to the EASPI program and the Australian Academy of Science for allowing us the opportunity to get the ball rolling.



Name:	**Brian Roberts**
University:	University of Florida
Research advisor:	Professor Simon Watkins
Host institution:	Royal Melbourne Institute of Technology

Research subject

Morphing control strategy for turbulence compensation

Research description

This project was designed to investigate the feasibility of using morphing control effectors to maintain controllability in the presence of real-world simulated turbulence. The study focused on the dynamic effects that changing the sweep of the wings in the lateral plane will have on reducing the negative impacts that turbulence has on the roll characteristics of micro-air vehicles (MAVs).

Research activities

Time was spent at the beginning of the project researching the structure of turbulence to plan wind tunnel tests that would sufficiently isolate the effects of turbulence on the flight dynamics of both swept and unswept configurations. Wings were manufactured out of expanded polypropylene foam that would hold all variables constant except the leading edge sweep angle. The wings were then mounted to an existing foam model aircraft and a sting was designed and built to place the aircraft in the aft section of the RMIT Industrial Wind Tunnel. Both swept and unswept configurations were tested at a range of sideslip angles and angles of attack in both smooth and turbulent flow to obtain the aircraft dynamic coefficients.

Perspective of research after this program

It is still too early to tell what the direct products of this research project will be. Data analysis is ongoing and some baseline wind tunnel tests are being run to eliminate some of the aerodynamic effects of the sting itself on the data that was collected. However, it is not too early to tell what some of the by-products of the international collaboration are.

I am still collaborating with student researchers in Australia to finish the data analysis and compare results for verification. I believe we will continue to maintain contact, as we both have plans to visit each other in our respective countries. My host researcher and I plan to meet and discuss possible future collaborations and the merits of our research for consideration to go into a paper when we attend an American Institute of Aeronautics and Astronautics (AIAA) meeting in Orlando in January.

Additionally, I believe that the exchanges between my host lab and myself revealed both our strengths and our weaknesses. It is important in research to not only have knowledge, but to also understand the limitations of one's knowledge. I believe my understanding of flight dynamics, control and programming have inspired some of the students in Australia to gain a deeper understanding of these topics to apply to their own research activities. Meanwhile, I learned that I have some learning to do if I want to push my research into the fields of fluids phenomena or apply my research experimentally.

Advisor's remarks

The research undertaken by Brian aligned with and added to our research on MAVs, which is funded by the US Air Force via the Asian Office of Aerospace Research and Development scheme. In particular he started an investigation into the effects of turbulence (ie, gustiness inherent in outdoor atmospheric flows) on wing sweep angle of MAVs.

Brian quickly became immersed in his research project, including utilising our 3 metre x 2 metre x 9 metre industrial tunnel where he conducted testing in both smooth and turbulent flows. Brian showed great initiative and enthusiasm, including manufacturing a series of wings of different sweep angle, some of which were tested in the wind tunnel.

This work is being carried on by an RMIT postgraduate by research candidate and, in collaboration with Brian and the team at the University of Florida, we expect to publish the results in the AIAA *Journal of Aircraft*.

Name:	**Diana Snelling**
University:	University of Texas at Austin
Research advisor:	Professor John Justin Gooding
Host institution:	University of New South Wales

Research subject

In vivo biosensors from porous silicon rugate filters and environmentally responsive hydrogels

Research description

This research aims to utilise environmentally responsive hydrogels as sensing components in novel microscale devices. Hydrogels are excellent biomaterials because they are biocompatible and mimic important qualities of natural tissue. For example, their elastic nature minimises irritation to adjacent tissues and their low interfacial tension discourages cell adhesion and protein adsorption. Hydrogels can be made to respond intelligently to changes in their environment such as temperature, pH and ionic strength. The material's response is a change in its swollen volume, which is predictable and repeatable. These materials, if coupled with the right transducers, provide utility as sensing elements in microscale biosensors.

Professor Justin Gooding and his research group at the University of New South Wales have made significant progress in biosensors utilising porous silicon rugate filters. These filters contain a sinusoidally varying refractive index created by electrochemical etching of a silicon substrate. They have produced these filters to reflect strongly and narrowly at a characteristic wavelength in the near infrared (IR) region. This particular region of reflectance is desirable because near IR light is known to penetrate tissue to a depth of several centimetres. This would enable the monitoring of an implanted sensor by simply irradiating the area with light and collecting the reflectance spectrum with inexpensive and portable equipment.

I hypothesised that environmentally responsive hydrogels could be polymerised within the pores of silicon rugate filters to yield promising biosensors for use in vivo. Since the hydrogel network and porous silicon will both degrade in vivo, this is a particularly novel completely biodegradable sensing device.

Research activities

Silicon was electrochemically etched to yield a porous silicon rugate filter with a reflectance peak in the near IR region. The porous silicon was immediately reacted with nonadiyne to provide chemical stabilisation and enable its use in an aqueous environment. Next, the pores of the filter were filled with monomer solution and hydrogel polymerisation was initiated

within the pores by irradiation with UV light. This yielded a porous silicon rugate filled with poly (methacrylic acid) cross-linked with biodegradable, polycaprolactone diacrylate. The reflectance peak of the filter experienced a red shift after being filled with hydrogel.

The percent reflectivity of the porous silicon rugate filter filled with pH-responsive hydrogel was then measured between 400-1600 nanometres in a range of pH buffers. The reflectance peak was found to shift linearly with pH over the range 2.2 to 8.8. This result shows promise towards the use of porous silicon rugate filters as transducers for environmentally responsive hydrogels.

Perspective of research after this program

My time in the laboratory of Professor Justin Gooding has certainly enhanced my graduate research experience. The laboratory had a very collaborative spirit and helped me to learn a variety of new techniques quickly. The specialised equipment and expertise of this laboratory enabled me to fabricate and test novel sensing devices from porous silicon rugate filters and environmentally responsive hydrogels. I am preparing a paper on the research I conducted while at the University of New South Wales. This research will also be included as a chapter in my dissertation.

Advisor's remarks

Diana made a terrific contribution to our laboratory. Although the time was short she worked very hard and managed to produce some results which we think will be publishable. The program she mapped out was an excellent combination of her skills from the US and ours in Australia. She worked very effectively across both physics and chemistry at UNSW and made excellent contacts with a number of our students. She also contributed very well to group discussions and in research meetings. I know the research students in my group learnt a lot from Diana's chemical knowledge and how she went about doing research. I would regard her visit as a real success for her and us and would welcome her back to my laboratory.

Name:	**Christopher Stapel**
University:	University of Kentucky
Research advisor:	Dr Gordon Waitt
Host institution:	University of Wollongong

Research subject

Migrants or myth? Educational and residential aspirations of rural sexual minority young people

Research description

The overarching objective of my research program is to negotiate tensions between sexuality, place and education among rural young people. To that end, I conducted investigations of 1) the educational aspirations of same-sex attracted non-metropolitan adolescents, 2) the residential migration patterns of Appalachian college graduates, and 3) the impact of the Sydney Gay and Lesbian Mardi Gras on gay and lesbian residents of Townsville, Queensland.

Research activities

1. Using data from the National Longitudinal Study of Adolescent Health and an HIV curriculum evaluation conducted in non-metropolitan eastern Kentucky counties, I constructed a series of logistic regression models that suggested rural sexual minority students have significantly lower educational aspirations than their straight rural peers. When the sexual minority category was disaggregated the models showed that bisexual-attracted females had lower aspirations and grade point averages than exclusively same-sex, exclusively opposite-sex and male bisexual attracted students. This manuscript was submitted to the biennial meeting of the Society for Research on Adolescence.
2. Using data from the Appalachian Region Alumni Outcomes Survey, I conducted a propensity score analysis that identified causal factors leading to migration of college graduates out of the Appalachian region of the US. I was particularly interested in how institutional type (public flagship, private liberal arts) impacted the residential decisions of graduates who lived in Appalachia prior to college. The analysis revealed attendance at a flagship public university was a causal factor associated with migration out of the region. I presented this paper to the Charles Sturt University (Bathurst) School of Teacher Education faculty seminar.
3. Using existing interview data collected by my host, Gordon Waitt, as part of his Home and Away research project, we collaborated to investigate the impact of a large Sydney-based gay and lesbian festival upon the residents of the regional northern Queensland city of Townsville. In doing so, we engaged in a discourse analysis from which several prominent themes emerged, including an incompatibility between the hegemonic gay masculinities in Sydney

and Townsville, a commodification and politicisation of the festival with little relevance to Townsville, a collectivist political project of the festival in conflict with an individualist politics of the everyday privileged by some Townsville residents, and significant gender differences between attendees of the festival. We are preparing this manuscript for submission to the annual meeting of the Association of American Geographers and subsequent publication in the journal *Leisure Studies*.

Perspective of research after this program

My perspective of research expanded in a number of ways as a result of the program. First, under the mentorship of my host and other Australian scholars I acquired valuable qualitative research skills that complement the quantitative tools I favoured prior to this research experience. Not only did I learn to interpret individual narratives, but I also gained experience conducting discourse analyses across actors and texts. Secondly, the cross-cultural experiences of the program – both personal and professional – provided me with an international perspective of research that I previously lacked. I now recognise the potential and challenges of comparative sociological research. Finally, the collaborative and interdisciplinary nature of the experience provided me with a model of successful research collaboration that I hope to replicate with colleagues at home and in regional Australia.

Advisor's remarks

Chris Stapel made a welcome addition to the Human Geography Research Team in the School of Earth and Environmental Sciences. Chris worked under my supervision on an existing data set. He learnt new qualitative data analysis techniques. These skills completed his strong quantitative analytical research skills. His research background enabled him to provide different perspectives and insights. Our analysis and discussions are the basis of a joint publication and future discussions. At a personal level, Chris made an excellent contribution to the social dynamics of the school. Overall, his visit was a highly academically productive and satisfying experience.

Name:	**Rebecca Swab**
University:	University of California, Riverside
Research advisors:	Dr David Keith and Dr Brendan Wintle
Host institutions:	NSW Department of Environment and Climate Change University of Melbourne

Research subject

Increasing realism of extinction risk predictions under global climate change through coupling dynamic bioclimate habitat and stochastic population models

Research description

While bioclimate shifts and range contractions are often considered to be the primary threat to plant species under climate change, in fire-prone ecosystems a changing fire return interval is potentially more harmful to species (Keith et al 2008). To investigate the potential impacts of these threats, I used a functionally important species in the heathland of Australia, *Leucopogon setiger*. I focused on two of the potentially harmful impacts of climate change to the heathland: shifting habitat and changing fire regimes. I am working on testing the hypothesis that a changing fire regime due to climate change or anthropogenic effects impacts *L. setiger* more than increased temperatures or shifting habitat.

Research activities

I investigated this hypothesis by linking a habitat suitability model for *L. setiger*, developed using spatially explicit presence/absence records, to a stochastic age/stage-based population model. Some fieldwork was done to develop the population model. These models will be linked in RAMAS® GIS, following the methods in Keith et al (2008).

Perspective of research after this program

While my primary objective to link and run the models has yet to be done, building the models was accomplished. Preliminary results indicate that this particular species will experience range expansion under climate change. Alternatively, if fire return intervals are to increase, *L. setiger* will experience decline at a population level.

Advisors' remarks

Rebecca quickly became a valued and effective member of our research team. During her stay, she synthesised available data from the literature and our unpublished field studies and undertook carefully designed fieldwork to fill significant gaps in the available data for her project. She quickly learnt and applied demographic analyses and spatial modelling techniques to the data and constructed population and habitat models for her study species. We are looking forward to continuing interactions that will lead to published outcomes of the research. The outcomes of

the project will be of great relevance to the department in planning its climate change response strategies. We very much enjoyed working with Rebecca and wish her well in her studies and future career.

Name:	**Noel Takeuchi**
University:	University of Florida
Research advisor:	Dr Susan Bengtson Nash
Host institution:	University of Queensland

Research subject

Comparative study of trace metal distribution and cellular responses in sirenians

Research description

There is growing concern regarding potential effects of anthropogenic contaminants in the aquatic environment, including trace metals. Elevated levels of trace metals have been found in an increasing number of marine mammal species, with the animals in the Order Sirenia (sirenians) being no exception. My graduate research at the University of Florida examines trace element levels in the endangered Florida manatee (*Trichechus manatus latirostris*) and its environment. Preliminary data collected from manatee health assessments throughout Florida, in collaboration with the United States Geological Survey's Sirenia Project and the United States Fish and Wildlife Conservation Commission, revealed levels of certain elements in whole blood that are significantly higher than most other mammals, though animals were clinically healthy. This raises the question about how manatees regulate trace metal concentrations. Based on literature, the endangered relative the dugong (*Dugong dugon*) also maintains high concentrations of similar elements such as copper and zinc.

My objective for the EAPSI visit was to create an international collaboration in Australia with Dr Susan Bengtson Nash from the National Research Centre for Environmental Toxicology, as well as with other professors in Australia. My specific aims during eight weeks in Australia were:

1. To assist ongoing humpback whale (*Megaptera novaeangliae*) contaminant studies to expand my experience with other marine mammal species. Organochlorines are lipophilic, persistent organic pollutants that are found in the blubber of many marine mammals and bioaccumulate as the trophic level of the organism increases. Humpback whales in the southern hemisphere are a prime study subject of mobilisations of organochlorines: they fast during the long migration distances of 10,000 kilometres from breeding to feeding grounds, are strict krill feeders and are long-lived species.
2. To experience dugong capture, tagging and release.
3. To create international collaboration with sirenian graduate students and professors for future projects and publications. My proposal and possible future publication will be the first study to compare trace metal distribution and regulatory mechanisms in sirenians.

Research activities

Australia offers extraordinary fieldwork opportunities and expertise in the field of marine biology, with the University of Queensland and James Cook University as leading universities in sirenian research.

During the first two weeks in Australia, I was involved in obtaining blubber biopsy samples of humpback whales off North Stradbroke Island under the direction of Susan Bengtson Nash. Using non-destructive methods of biopsy darts, blubber samples were obtained to analyse for organochlorine blubber stratification, lipid composition and cytochrome P450 expression. I was also involved in the capture and tagging of dugongs in Moreton Bay using the 'dugong rodeo' technique. Long-term dugong mark-recaptures have occurred on the resident population in Moreton Bay since 2001, under the supervision of Janet Lanyon. Dugongs are then tagged, measured and photographed, in addition to obtaining skin, faeces and any opportunistic samples.

Perspective of research after this program

This program was extremely beneficial to my research as I have gained international collaborations and met with a number of professors and graduate students in the field of marine mammal biology and aquatic toxicology. It was a great experience being a part of marine mammal fieldwork, working in close contact to humpback whales and dugongs. This time away from my own university and research also provided an opportunity to gain a new perspective on my current project and feel refreshed. I had a great time meeting other international students, in addition to my fellow EAPSI participants, and highly recommend this program to any US graduate students.

Advisor's remarks

Noel joined our research group at the start of a major 2009 field event. The fieldwork can be physically tough and tiring but Noel immediately made herself an invaluable member of the team. Her passion for the subject was evident and this led to many cross-disciplinary discussions and ideas which I found particularly beneficial for my own PhD students.

Back in an office setting, Noel again participated whole-heartedly in the activities of the centre, contributing to ongoing seminar series in-house and at other university departments. Noel enthusiastically followed up ideas and suggestions and I was pleased to have her represent the University of Florida as well as our research group in her travels to Townsville to discuss her research with leading Australian dugong researchers at James Cook University and the Great Barrier Reef Marine Park Authority.

The program was an ideal introduction to a promising young researcher such as Noel and we would welcome another visitor of Noel's calibre in our group. We wish Noel all manner of success with the completion of her program and look forward to following her research trajectory through PhD write-up and beyond.

Name:	**Derick Weis**
University:	Tennessee Technological University
Research advisor:	Professor Douglas MacFarlane
Host institution:	Monash University

Research subject

Inverse design of ionic liquids for the pre-treatment of cellulose

Research description

Cellulose is an abundant, renewable resource available from plants that can be turned into ethanol and help replace fossil fuels. Potential feed stocks for cellulose include waste products like corn stover and sugarcane bagasse, or planting a specific crop of switch grass for harvest. Currently, the cost of cellulosic ethanol is too high for practical consideration. Environmentally friendly solvents, known as ionic liquids, have been identified for a pre-treatment step in the production of cellulosic ethanol as a way to reduce the cost.

Ionic liquids can be formally defined as salts that melt below 100°C, and generally consist of a positively charged organic cation with a negatively charged inorganic anion. In recent years, ionic liquids have received a lot of focus because of the potential to develop environmentally friendly solvents. Some of the favourable characteristics include negligible vapour pressure, non-flammability and thermal stability. The solvation properties can be fine-tuned for a particular application by careful design and selection of the numerous combinations of cation/anion pairs. A computer-aided molecular design (CAMD) technique was applied to help identify potentially new ionic liquids for more effective cellulose pre-treatment. Applying this approach is much quicker, less expensive and allows for a more comprehensive search for the most suitable potential candidates. Currently, because there are only a limited number of ionic liquids in the literature with cellulose solubility data, few options exist for the desired application.

Research activities

My research during the EAPSI program involved synthesis and characterisation of selected ionic liquids, which was a significant change from my previous theoretical background. In order to make this transition, I began by synthesising known ionic liquids to establish the necessary skills. At the same time it was also possible to learn new experimental techniques for measuring melting point, viscosity, conductivity and decomposition temperature. By the end of the program, I was planning and carrying out synthesis schemes for new ionic liquids that allowed for confirmation of melting-point predictions obtained from the CAMD technique. Additional steps were necessary for evaluating cellulose solubility in the new ionic liquids and the work is continuing.

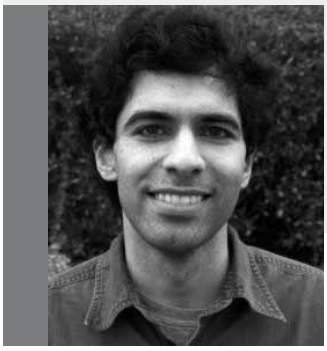
Perspective of research after this program

Having the opportunity to participate in this program significantly benefited me as a researcher. It was a great experience to utilise a theoretical approach to help guide research in the lab. In addition, I learned a lot about the field by attending an international conference specifically about ionic liquids. I would like to thank everyone in the Ionic Liquids Group at Monash University, especially Dr Vijay Ranganathan for taking the time to help me with the fine details of ionic liquids synthesis. A publication from the research performed during this program is expected soon, and I look forward to a continuing productive collaboration in the future.

Advisor's remarks

Derick had a very productive visit to our Ionic Liquids Group at Monash University. He was very fortunate to be able to make his visit coincide with a major international conference in the field that we were hosting in Cairns. This allowed Derick to hear talks from many of the key figures in the ionic liquids area and also to become thoroughly integrated into our group. Back at Monash he undertook the synthesis, guided by Dr Vijay Ranganathan, of a number of compounds designed by his numerical prediction approach. These compounds are designed to have good solvency properties for biomaterials such as cellulose and hence have application in the biofuels industry. Characterisation work on these compounds is continuing and we hope to see these published in the near future.

The social interaction between Derick and other members of the group was terrific and certainly beneficial as a broadening experience for all concerned. Derick is now looking into NSF postdoctoral fellowship opportunities that might allow him to return to work with us after he finishes his degree.



Name:	**Shomir Wilson**
University:	University of Maryland
Research advisor:	Professor Robert Dale
Host institution:	Macquarie University

Research subject

Distinguishing use and mention in natural language

Research description

When humans communicate via natural language, they frequently make use of metalanguage to clarify what they mean and promote a felicitous exchange of ideas. Two key aspects of metalanguage are the mention and quotation of words and phrases. The aim of this research is to find syntactic and semantic characteristics of language-mention that separate it from 'normal' use of language. The findings of this research should contribute to the ability of natural language systems to learn both through and about the input that they process.

Research activities

Language-mention has received little attention in computational linguistics, and it was first necessary to formulate a definition and categories for the phenomenon that would be both meaningful and computationally useful. Following this, Wikipedia was identified as a rich source for sentences containing language-mention, and a subset of articles was mined for those sentences through a combination of manual and automated efforts. The resulting corpus was small, due to the time constraint of the program, but revealing in terms of the syntactic structures that tend to be associated with language-mention, as well as the semantic forms of the phenomenon that tend to occur.

Perspective of research after this program

Though I wish there had been more time to work on this project while at Macquarie University, I now have preliminary results and a much better idea of how to proceed with this work in the future. My host and I have agreed to keep in touch about it, and it is likely that we will collaborate in the future.

Advisor's remarks

It has been a great pleasure to have Shomir Wilson visit the Centre for Language Technology at Macquarie University under the auspices of the EAPSI program. I personally find Shomir's research question – whether it is possible to automatically distinguish instances of language use and mention – a fascinating one, both from the point of view of linguistics and the point of view of natural language processing. I think Shomir's enthusiasm for grappling with what is, as it turns

out, a remarkably hard problem, rubbed off on other group members right from the beginning of his visit here. Shortly after his arrival, Shomir gave a seminar on his project at our weekly group meeting, and he gave another talk on the project just before he left. I believe his thinking about the problem developed substantially while he was here. I'd like to think that we had a significant influence on that development, but what I can say for sure is that Shomir certainly helped me develop my thinking on the problem. Quite apart from his intellectual enthusiasm, Shomir also integrated easily and comfortably into life in our research group. All in all, it was great having Shomir here, and I very much hope we stay in touch.

Name:	**Moriel Zelikowsky**
University:	University of California, Los Angeles
Research advisor:	Dr Bryce Vissel
Host institution:	Garvan Institute of Medical Research

Research subject

Hippocampal and cortical contributions to context-sensitive fear

Research description

Mammals will invariably learn to fear an environment in which they have experienced an aversive event, so long as they have a good representation of that place. In addition, environments or 'contexts' may set the occasion for a particular discrete cue to signal danger or safety, as is the case after fear extinction (the laboratory analogue of exposure therapy in the clinic). The research project proposed here investigates the role of the dorsal hippocampus and infralimbic prefrontal cortex in context-sensitive fear. Using an animal model of fear, this project aims to identify the unique role of these regions using behavioural and immuhistochemistry techniques. An understanding of the standard and compensatory behaviour of these regions may be key to subsequent advances in the novel treatment of various anxiety disorders.

Research activities

Under the guidance of Dr Vissel and the wonderful members of his laboratory at the Garvan Institute, I was fortunate to gain experience in various immunohistochemistry and immunofluorescence techniques, as well as training in advanced microscopy and techniques for cell counting. I focused particularly on the theory and practice of unbiased stereology.

Perspective of research after this program

This program was excellent. As a student, it was a rare chance to dedicate time and intense focus to a particular project. Being able to collaborate with a foreign host was a great way to get a sense of how science in general is conducted in Australia. More specifically, it allowed me to experience a new method of research that deeply broadened the scope of this research. Overall, my perspective has shifted to think of scientific research as much more open to integration and translation among a variety of scientific fields.

Advisor's remarks

What a lovely program. We were very excited to have Moriel in the lab. She was always very open-minded, hard-working and contributive. This collaboration turned out even better than we expected – we were able to share our area of expertise with Moriel and we were also able to

collaborate with her on a number of additional projects in which both our areas of research were integrated. Indeed, we hope that a number of papers will flow from this experience and we greatly look forward to continuing this collaboration.

Australian Government

Department of Innovation Industry, Science and Research

If you are interested in hosting a US graduate student, or would like more information about the program, please contact the International Programs section at the Australian Academy of Science, email: is@science.org.au, phone: (02) 6201 9411 or visit: **www.science.org.au/internat/eapsi.htm**

More information on the Summer Program, including application forms and deadlines, is at the NSF website: **www.nsf.gov/funding/pgm_summ.jsp?pims_id=5284**