brain and cognitive sciences

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Spring 2001

Volume III; Issue 2

MESSAGE FROM THE DEPARTMENT HEAD

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Mriganka in Australia

We began the Spring 2001 semester with a focus on new faculty appointments and the admission of new graduate students. The need to build a sense of community across the entire department, and the growth of BCS faculty and students in a way that enhances this community, have become our biggest challenges, given the establishment of the Center for Learning and Memory (CLM), the McGovern Institute for Brain Research (MIBR), and the Martinos Center for Biomedical Imaging.

The most recent phase of faculty rejuvenation in BCS began in 1994 with the appointments of Matt Wilson and Peter Dayan, and has continued with around two new faculty members joining the department in each subsequent year. The 1995 appointments were Earl Miller and Bart Anderson; in 1996, Guosong Liu and Liz Spelke; in 1997, Nancy Kanwisher; in 1998, Elly Nedivi and Sebastian Seung; in 1999, Anthony Wagner and Pawan Sinha; and in 2000, the appointments were Lera Boroditsky, Morgan Sheng, and Yasunori Hayashi. Thus, one-half of our current faculty has been recruited in the last seven years.

The majority of our new faculty is junior appointees. Our strategy has been to identify brilliant young academics and nurture their careers so that they will develop into pre-eminent researchers and teachers. Only Liz Spelke (developmental cognitive science) and Morgan Sheng (molecular neuroscience) were hired as senior faculty because we felt the need for leaders to anchor key areas. The net result is a department that is broad but with acknowledged strength in each field: molecular/cellular neuroscience, systems neuroscience, computation and cognitive science.

This range of faculty expertise provides the opportunity to shape our field in a unique way. Our research benefits from cross-disciplinary approaches, and we need to creatively utilize the future faculty appointments in MIBR and CLM to strengthen these links.

Graduate students can now choose rotations in any laboratory in their first term regardless of their admission track. The undergraduate Course 9 major has been streamlined and simplified, allowing seamless movement between neuroscience and cognitive science courses.

We need to continue building a sense of community at all levels. The

(continued on page 4)

SPRING CALENDAR OF EVENTS

Friday, May 4 at 4:00 HANS-LUKAS TEUBER MEMORIAL LECTURE
This year's featured speaker will be Wolfram Schultz, Institute of Physiology, University of Fribourg, Switzerland

WEEKLY EVENTS

Mondays – Brain Lunch
Tuesdays – Cog Lunch
Wednesdays – Brains & Machines Lecture Series (http://www.ai.mit.edu/events/brainsMachines.html)
Alternate Thursdays – Plastic Lunch (http://monster.mit.edu/nedivi-lab/plasticlunch.html)
Alternate Fridays - Perceptual Science Seminar Series (http://www-bcs.mit.edu/persci/)
Fridays at 4:00 Departmental Colloquia Followed by tea
(http://web.mit.edu/afs/athena.mit.edu/org/b/bccalendar.html)

Earl Miller is receiving the Young Investigator of the Year Award at the November 2000 Society for Neuroscience meeting.

Earl's career might well have been in medicine not research had it not been for a fortuitous suggestion by his college advisor that he volunteer in a research lab to facilitate his acceptance to medical school. Doing hippocampal slice work changed his goals. He enrolled in a graduate program at Princeton where, under the guidance of Charlie Gross, he studied perceptual problems in monkeys.

Earl went on to the NIH where he worked with Bob Desimone experimenting on memory in awake behaving monkeys. It was the focus on memory that had attracted him to this lab. Prior to this, he had been studying visual perception, and noticed something odd that others had considered merely a nuisance; i.e., habituation, whereby cells decrease the intensity of their response when a stimulus is repeated over and over. Earl felt this was actually an indication that neurons have memory and he wanted to pursue this theory.

At MIT, he went from focusing on the temporal lobe, where long-term memories are formed, to the prefrontal cortex, which is important for high-level cognition. As a result of his endeavors, he was presented with the Society for Neuroscience Young Investigator Award (2000), and the National earlier honors, which include McKnight, Pew, and Merck Scholar Awards. His prime research areas continue to be cognition and memory.

When not in the lab, Earl enjoys obscure, avant-garde, punk, music. He played the trumpet in an orchestra and played guitar, but that's all in the past. Now he just listens. He also has a passion for fine wines and gourmet food (eating, not cooking); weight lifting and running (to balance all the good food). However, he abandoned competitive running and cycling, finding that science is competitive enough for him just now. Favorite vacations are at beaches with luxury hotels; his favorite films are by Scorcese and Kubrik; and he even finds some time for literature.

He and his wife Marlene, a survey researcher, have been married for 10 years, and are the proud servants of Paulie and Raymond, seal point Siamese cats [see photos at http://www.ai.mit.edu/people/miller]. Though he has tended to undergo drastic physical changes about every five years (like the most recent evolution involving shaving his head and growing a beard) - which successfully distinguishes him from his identical twin - he sees his scientific persona for the next five to ten years as being "the way I am

BCS Profile
(including BCS faculty in CLM)

Faculty:	**33**
(including 6 joint appointments from other departments)	
Research Staff:	**41**
Postdocs:	**60**
Other Academic Staff:	**38**
Administrative Staff:	**4**
Support Staff:	**24**

Emilio Bizzi, the first Director of Whitaker College and the first Head of the Department of Brain and Cognitive Sciences, a position he held for 11 years, was grateful to return to his role as researcher and faculty member. However, he feels that he still spends an inordinate amount of time in his office.

Emilio came from a family of doctors, which probably influenced him to study medicine. But in medical school, he discovered that he was far happier doing research. After a few years of practice, he gravitated toward neuroscience because it looked like it was about to take off, and because it looked at what makes us human.

Though most of his life has been devoted to research, he has had tremendous fun playing tennis – though he can't play as often as he'd like – and indulging his artistic soul. Though he claims to lack musical talent, affirming that all of it went to his brother, a professor at the Rome Conservatory and an unsuccessful composer, he is always buying CDs, especially with classical music.

When he travels, he likes it to be where he can see visual arts, especially drawings and watercolors. He particularly admires Renaissance drawings, finding them to be especially spontaneous and, though

they were just preparations for later paintings, he believes they have more life than the paintings that were made from them. In modern times, drawings have a life of their own. Emilio finds that poetry, especially Yeats', is the counterpart of drawing. For him, the experience of poetry is more concentrated, and directly touches you. Unfortunately, he got to read more when he was department head.

Today 90% of his time is spent on research related activities, though he does not find that he is disenchanted. In fact, he is even more excited about his work now because he has more time to think about it than when he was department head. He felt more disconnected in those days. Emilio said that, were he God and could only get 10 years of life, he would choose the years between 50 and 60. Life has too many pressures when you're young. Its' far more interesting now. Today, he feels no pressure to produce. He doesn't have to do anything.

One thing he does envy about people entering the field today is that neuroscience in the next 20 years will have more discoveries than in the past 20. It will equal what physics was in the 1920s and '30s, and what molecular biology was in the 1960s, after Watson and Crick. There was an explosion of knowledge. What we know about the brain now is nothing compared to what we will know shortly. New scientists will be experiencing neuroscience as it explodes. Right now the field is growing in the surface rather than in depth, but that will change.

Emilio's own focal point has been motion, which he finds intellectually exciting and still a mystery, because the brain must to compute so many things simultaneously that it is hard to follow how it does so. He is also attracted to the fact that you can measure the output, so it is potentially something about which you can make a precise statement.

His attention is devoted to studying how the brain acquires new motor skills; how they are encoded; and to understanding how the system works. With his collaborators, he is attempting to develop a model of motor output as a combination of a few motor primitives (modules, each one producing a particular aspect of the movement) that need to be combined.

One result of his research was the formation of a company that produces a device that develops a system of rehabilitation for people who have suffered a stroke. It relates to both motor control and motor learning.

Emilio is very proud of the enormous development of this department which enabled us to secure the support of McGovern and Riken. He had worked hard to set up the basis for this in creating the Department of Brain and Cognitive Sciences in 1986. As Director of Whitaker College he helped transform the psychology department from an assembly of disparate things and, through 6 to 8 key appointments, to steer it to the brain sciences and neurobiology. He worked hard with Tonegawa to create the Center for Learning and Memory. They were successful in getting the funding for that and for the McGovern Institute because the new department offered the basis on which to build. He feels he was instrumental in preparing things for a better future. This would not have happened had the department remained Psychology.

If you would like to be put on the newsletter mailing list, or have information you would like to have published, please contact:

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One of the driving forces in Ted`s life has been a desire to understand his own visual experience. His earliest vision experiments utilized the lenses and prisms his parents bought him to foster his interest in science.He was entranced by rainbows and distorted images that could be projected on the walls.

By junior high, he was engaged in Doc Edgerton styles of photography complete with flashguns and exploding balloons. His summers during high school were spent at a laser company doing various things such as making holograms and and growing crystals. At the same time he was developing an interest in philosophy and perception, and learned about Piaget through his parents (both psychologists).

At Yale, he majored in physics and philosophy, and learned he was not cut out to be a great physicist nor a great philosopher. However, he took a course in cognitive psychology, and was excited by the idea of taking apart human thought through quantitative experiments.

He chose the University of Michigan for his graduate studies because of its strength in the areas of vision and mathematical psychology. His first research was on short-term visual memory, and that led him on to

an interest in rod aftermages. Although afterimages seem like ephemeral subjective phenomena, he found a way to quantify their decay, and was able to relate their fading signal to the physiological responses that were then being measured in rat retinas. The research involved endless hours in pitch darkness, with his head rigidly attached to an optical apparatus by a bite bar. He devised a simpler version of his effects that he could show to colleagues at conferences, using a flashgun and some filters. Since he needed complete darkness, he would drag people into the nearest bathroom and turn off the lights. Many of today˙s vision researchers first met Ted in a dark bathroom.

He also also developed an interest in image processing. Since digital image processing was impossibly expensive at that time, he built a homemade analog image processer using a rotating drum, photodiodes, and an arc lamp.

During Ted˙s graduate school years, AI and machine vision were becoming hot topics. Ted was inspired to pursue work that could connect psychophysical and computational issues. He loaded his possessions onto the roof of his car, and headed for a postdoc at NYU. Working with Tony Movshon, he was able to study motion through a combination of human psychophysics, neurophysiology, and machine vision. He also met Peter Burt and, together, they began work on a multiscale image representation called the Laplacian Pyramid. They showed the utility of pyramids in image data compression, and their scheme is regarded the grandfather of wavelet image coders now coming into wide use.

Next he went to RCA Labs (now Sarnoff labs), in Princeton, to continue his work on human and machine vision. Although the years there were productive, he longed for an academic job in a city with more than two good restaurants. The MIT Media Lab had just been built, and Ted was offered a position there, with a joint appointment in BCS.

At the Media Lab, much of his work involved building digital video coding systems based on characteristics of human vision, including the mid-level representations involving layers , occlusions, and motion. Some of the ideas have been incorporated into the new MPEG-4 digital video standard.

Eventually, Ted wanted more time for basic research and moved from the Media Lab to BCS. Mid-level vision continues to be a major topic in his lab, and the perception of motion, lightness, and transparency are specific areas of interest. Much of this work involves devising new illusions, and as a result he can discuss his work by showing demos. And now he doesn˙t have to find a dark bathroom. His website, www bcs.mit.edu/people/adelson, has links to some of these demos, as well as papers describing them.

Currently Ted is pursuing a new line of research on the perception of materials; i.e., how we can tell that something is shiny, smooth, translucent, metallic, etc., by looking at it. Although much is known about the recognition of objects, little known about how we recognize the materials of which the objects are made. As part of this project, Ted has assembled a large collection of spheres, including ping-pong balls, Christmas ornaments, marbles, beads, and gumballs. The spheres are now being photographed in controlled lighting. This brings him back to his original love of photography.

Prof. Schneider and grad student Rutledge Ellis-Behnke mingle with alums at theBCS Social at the Society of Neuroscience Meeting, November 2000

(continued from page 1 Dept. Head)

administrative and support staff have implemented monthly breakfast meetings to share information and socialize. This is in addition to their annual holiday luncheon, which has been a tradition for several years.

The graduate student-organized weekly Brain Lunch and Cog Lunch series continues to be successful. On a more formal level, our Friday departmental colloquia and teas have also increased in popularity. (Even those who miss the seminar often manage to show up for the socializing afterwards!) In addition, the BCS social at the annual Society for Neuroscience meeting last November was an enormous success, bringing together current members of the department and many of our alumni.

The semi-annual Hans-Lukas Teuber Memorial Lecture last fall featuring Noam Chomsky attracted so many people that we had to make satellite locations available, and we are anticipating similar success with the spring lecture by Wolfram Schultz. Ann Young also proved to be a popular speaker for our third annual Bidwell Lecture in March.

We are a unique department with a unique mission. I look forward to hearing from all of you with suggestions about how to increase our departmental community further, and I welcome a proactive role by our alumni as we shape our future.

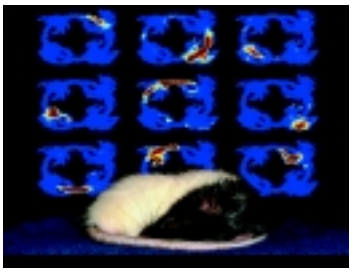
NOTEWORTHY ACTIVITIES OF THE FACULTY

Earl Miller and **Tomaso Poggio**, together with Postdoctoral Associate **Maxmilian Riesenhuber** and graduate student **David J. Freedman** published an article in *Science* based on their research on the neural basis of categories in which they taught monkeys to catgorize a set of computer-generated images as cats and dogs and then found neurons in the monkeys which represented these concepts. The ability to categorize, to assign meanings to what is around us, is critical for thought, yet almost nothing is known about how the brain accomplishes this.

Richard Wurtman and Research Scientist **Judith Wurtman** demonstrated that the mood-altering brain chemical serotonin goes up when we eat carbohydrates and later discovered a serotonin-PMS link. They also found that agents which block serotonin uptake, like Prozac, can improve symptoms of PMS. MIT patented Prozac's use in treating PMDD and it is currently being marketed as Sarafem.

Guosong Liu of BCS and CLM, together with **Shuguang Zhang** of MIT's Center for Biomedical Engineering, and **Todd Holmes** a graduate of BCS now on the faculty of NYU appear to have taken a major step toward regrowing nerves. They created a new biomaterial on which nerve cells were able to grow. This material may be tailored virtually every type of cell in the body, and may prove to be useful for growing nerves.

Matthew Wilson of BCS and CLM and Biology graduate student **Kenway Louie** (the photo illustration is his) found that animals (rats in this instance) have complex dreams and recall long sequences of events while they are asleep. In fact, animals' brains follow the same series of sleeping states as ours do. The ability to analyze the content of dream states, which they were able to do, has the potential of providing a tool for treating memory disorders such as amnesia or Alzheimer's disease, or it may help devise ways for people to learn and memorize more effectively. Their study was published in *Neuron* at the end of January.



HONORS AND AWARDS – GRADUATE STUDENTS

Rutledge Ellis-Behnke, Serkan Oray, and **Tessa Warren** all received the Angus MacDonald Award for Outstanding Teaching Assistance. Rutledge also won a best presentation award from the Asia Pacific Symposium on Neural Regeneration in Xian, China. He presented in-vivo work on functional recovery of vision in hamsters. The work was the result of collaboration between **Jerry Schneider**, former student **Kowk Fai So**, and Chinese neurosurgeon **Si-Wei You** among others.

Wael Asaad, Albert Lee, and **Cynthia Kiddoo** all received the Walle Nauta Award for Outstanding Teaching Assistance

Song-Yee Yoon, who received her Ph.D. in June, won an award for Best Student Paper at the Agents 2000 meeting in Barcelona. The paper was "Motivation Driven Learning for Interactive Synthetic Characters," and was based in part on her thesis. She is currently working with Professor Jerry Schneider preparing research manuscripts for publication

Maximilian Riesenhuber, PhD in Computational Neuroscience, 6/00 ("How a part of the brain might or might not work: a new hierarchical model of object recogntion") received a McDonnell Foundation fellowship and is a postdoctoral fellow in Professor Tommy Poggio's lab.

First year graduate student **Daniel Casasanto** received the Rennick Award from the International Neuropsychological Society (INS) for outstanding research by a graduate student. He worked on using fMRI to predict long-term memory performance in patients undergoing surgery for intractable epilepsy.

Elizabeth Kensinger received a Sigma Xi Grant in Aid of Research for a study entitled "Novel Quantitative Approaches to Time-of-Day Effects in Young and Older Adults."

A review of "Language and the Brain:Quandaries and Prospects" Noam Chomsky's October 2000 Teuber MemorialLecture

by Daniel Casasanto, graduate student

Apropos of Hans-Lukas Teuber's vision that the study of brain and mind are inseparable, Professor Chomsky began by presupposing that "cognitive systems, language included, are parts of the person, rather like other organs of the body," noting that this "biolinguistic approach" is "strenuously rejected in a whole range of related fields" in which language is argued to be an extra-human object. He then outlined a "somewhat skeptical" assessment of prospects for unifying the brain and mind sciences, saying that "current understanding falls well short of laying the basis for the unification," and that "many surprises may lie along the way to what seems a distant goal." Chomsky's skepticism contrasts with the optimistic projections of some scientists, and with announcements by other eminent figures that "the brain-mind problem has been solved," a claim which Chomsky did not dignify with refutation.

The source of much misplaced optimism, according to Chomsky, is the misattribution of novelty to the emergence thesis, stated recently by neuroscientist Vernon Mountcastle as, "things mental, indeed minds, are emergent properties of brains." While Chomsky agrees with this thesis, he argues that it "is not new, and should not be in the least controversial, for reasons understood centuries ago." "What [Hume, Priestly, and Darwin] could not say was how this emergence takes place, nor can we do much better," due to the current state of the sciences, and possibly, Chomsky suggests, to inherent limitations on human conceptual abilities.

Prof. Ann Graybiel's dissection class

Chomsky compares current discussions of mind and brain to the debates over mid-20th-century chemistry and physics, which were unified only after the more fundamental science underwent a radical reconstruction. He warns that unification by reduction is the exception in science, despite one salient example (namely the recent explanation of biology in terms of chemistry). Chomsky calls attention to the revision of the goals of science brought about by Newton's destruction of Cartesian mechanical philosophy. "The standard [of intelligibility] that inspired the modern scientific revolution was abandoned: the goal was intelligibility of theories, not of the world." Perhaps now, as then, "the working scientist can do no better than to try to construct 'bodies of doctrine' for various aspects of the world, and seek to unify them, recognizing that the world is not intelligible to us in anything like the way the pioneers of modern science hoped."

So what are we cognitive and brain scientists to do? By accepting as our goal the construction of theories within each discipline separately, are we dodging the fundamental question of cognitive neuroscience: how do minds emerge from brains? Not necessarily. If our sciences follow the model of chemistry and physics, then proceeding in parallel, the findings from one field constraining and informing work in the other, may be exactly the path to the eventual unification of brain and mind, although it requires that we suspend any immediate sense of consilience. The speculation that humans lack the requisite conceptual sophistication to understand some aspects of brain and mind merits consideration, but who's to say where the limits of human potential lie? Although the emergence thesis had existed for centuries, technologies such as functional neuroimaging that allow unprecedented observation of neural phenomena underlying psychological processes have barely existed for a decade. Time may tell whether, in Hume's words, "Nature's ultimate secrets" regarding the mind and brain are indeed relegated to "that obscurity in which they ever did and ever will remain."

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