Inaugural Science of Learning Symposium & 3rd Annual Symposium on Excellence in Teaching & Learning in the Sciences

January 13th & 14th, 2014
Hodson Hall, Homewood Campus
Johns Hopkins University, Baltimore, MD
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenters</th>
</tr>
</thead>
</table>
| 9:00 - 9:15  | Welcome                                                                 | Robert Lieberman, Provost and Senior Vice President for Academic Affairs, Johns Hopkins University  
               |                                                                          | Barbara Landau, Director of Science of Learning Institute; Vice Provost for Faculty Affairs; and Dick and Lydia Todd Professor of Cognitive Science, Johns Hopkins University  |
| 9:15 - 10:30 | Brain Structure, Function, and Learning I                               | Margaret Livingstone (9:15 - 10:00), Professor of Neurobiology, Harvard University  
               |                                                                          | Michael McCloskey (10:00 - 10:30), Professor of Cognitive Science, Johns Hopkins University |
| 10:30 - 10:45| - Break -                                                               |                                                                          |
| 10:45 - 12:00| Brain Structure, Function, and Learning II                              | Takao Hensch (10:45 - 11:30), Professor of Molecular & Cellular Biology & Neurology, Harvard University  
               |                                                                          | James Knierim (11:30 - 12:00), Professor of Neuroscience and Mind/Brain Institute, Johns Hopkins University |
| 12:00 - 2:00 | - Break/Lunch -                                                         |                                                                          |
| 2:00 - 3:15  | Cognition, Development, and Learning                                    | Luca Bonatti (2:00 - 2:45), ICREA Research Professor of Information and Communication Technologies, Center for Brain and Cognition, Universitat Pompeu Fabra (Barcelona)  
               |                                                                          | Lisa Feigenson (2:45 - 3:15), Associate Professor of Psychological & Brain Sciences, Johns Hopkins University |
| 3:15 - 3:30  | - Break -                                                               |                                                                          |
| 3:30 - 4:45  | Man-Machine Interactions and Learning                                   | Sharon Goldwater (3:30 - 4:15), SICSA Reader in the Institute for Language, Cognition, & Computation, University of Edinburgh  
               |                                                                          | Gregory Hager (4:15 - 4:45), Chair and Professor of Computer Science, Johns Hopkins University |

Monday, January 13th: Learning in Brains, Minds, and Machines
### Overview

**Tuesday, January 14th:** *Learning through Science, Theory and Practice*

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
</table>
| 9:00 - 9:15 | **Opening Remarks**  
- Scott Zeger  
  Vice Provost; Director of Hopkins inHealth; and Professor of Biostatistics, Johns Hopkins University |
| 9:15 - 11:00 | **Math Anxiety, Gender Gap, and STEM Education**  
“Math Anxiety: Who Has It, Why It Develops, and How To Guard Against It”  
- Sian Beilock (9:15 - 10:00)  
  Professor of Psychology, University of Chicago  
“’You Have to be a Genius to Succeed’: Why Some Disciplines Have Large Gender Gaps”  
- Sarah-Jane Leslie (10:00 - 10:45)  
  Professor of Philosophy & Psychology, Princeton University  
**Discussant:**  
- Linda Gorman (10:45-11:00)  
  Director of Undergraduate Studies & Teaching Professor of Psychological & Brain Sciences, Johns Hopkins University |
| 11:00 - 11:15 | **Break** |
| 11:15 - 12:00 | **Peer-Led Team Learning**  
“Peer-Led Team Learning (PLTL): Philosophy, Implementation, and Evaluation”  
- Gina Frey  
  Florence Moog Professor of STEM Education; Associate Professor of Chemistry; Executive Director of the Teaching Center; and Co-Director of Center for Integrative Research on Cognition, Learning, and Education, Washington University of St. Louis |
| 12:00 - 1:30 | **Break/Lunch** |
| 1:30 - 2:45 | **Panel Discussion: Overcoming Key Issues and Challenges in Dissemination, Translation, and Outreach**  
The Panelists and the Discussant will explore how dissemination, translation, and outreach are viewed across basic and applied sciences; how such work is related to scientific and social progress; and how to overcome key challenges.  
**Panelists:** Symposium Speakers  
**Moderator:**  
- Amy Shelton  
  Director of Research, Center for Talented Youth and Professor of Education  
**Discussant:**  
- Martha Zaslow  
  Director of the Office for Policy and Communications Society for Research in Child Development and Senior Scholar for Child Trends |
| 2:45 - 4:00 | **Break** |
| 4:00 - 4:45 | **Human Memory and Learning**  
“Temporal Spacing and Learning”  
- Hal Pashler  
  Distinguished Professor of Psychology, University of California, San Diego |
| 4:45 - 5:00 | **Closing Remarks**  
- David Andrews  
  Dean and Professor of School of Education, Johns Hopkins University |
Basic math skills are important for success in school and everyday life. Yet many people experience apprehension and fear when dealing with numerical information, termed math anxiety. In this talk I will discuss both antecedents and consequences of math anxiety, revealing some surprising insights into its onset, risk factors, and remediation.

Many classic studies on probabilistic and logical reasoning picture humans as thinkers plagued by biases and errors. There is no question that we make many mistakes in reasoning, but should we conclude that the human mind is intrinsically flawed? One way to answer this question is to investigate reasoning as its early stages. I will present evidence suggesting that young infants can reason about probabilistic and logical events. I will argue that their intuitions about such events are surprisingly rich and powerful, suggesting the presence of rational processes at the onset of cognition. I will propose that an understanding of elementary logical forms lie at the origin of these abilities. I will speculate about the origins of some of the most known errors and biases, and about possible ways to reduce them.

Numerical competence predicts success in many aspects of life. But despite its importance, mathematical ability differs widely among individuals. Although educational access and quality play major roles in determining these individual differences, recent evidence suggests that people also differ in the operation of an unlearned, core sense of number that is present in infancy and that is shared with non-human species. This number sense supports the representation of approximate quantities, as well as arithmetic operations over these quantities. Individual differences in the precision of this number sense predict mathematical achievement, raising the possibility that intervening to enhance the number sense may improve math performance. Here I will discuss evidence for this core sense of number and consider its links to school mathematics.

Peer-led team learning (PLTL) introduces students to effective group study by supplementing a lecture course with formalized study groups. The students meet weekly in groups of approximately 8, led by an advanced undergraduate (Peer Leader), to work on problems that are designed by the course instructor. The goals of the PLTL model are to (i) teach students how to solve problems using specific collaborative-learning strategies; (ii) improve students’ problem-solving skills; (iii) provide facilitated help for students in introductory-level STEM courses; and (iv) create an active-learning environment for students.
Computer systems for language-based tasks like automatic translation, speech recognition, and question answering are now widely available and often very useful. Yet these tools must be painstakingly and individually developed for every new language and even different genres within a language. In comparison, human infants are born equipped to learn any language in the world and can do so with apparently little effort. This talk explores why learning language is not as easy as infants make it seem, and how considering both human learning and machine learning might allow us to better understand infants’ abilities and also improve computer language processing systems.

Surgery is a highly skilled task that is taught through an apprenticeship model under the direct tutelage of a skilled mentor. This approach is well established and can be quite effective, but it relies heavily on the availability and quality of mentorship. In this talk, I will present a complementary view whereby data recorded directly from surgical training performance are used to develop models for automated objective assessment of surgical trainees. These models are based on decomposing surgery into a small set of well-identified maneuvers, each of which in turn can be modeled by a small vocabulary of basic hand movements. Through this "language of surgery," we are able to evaluate the style and efficiency of surgical motion and provide targeted feedback for improvement to trainees. These models lead naturally to methods for individualized training and toward methods for augmenting or automating component actions in surgery.

Much of our adult behavior reflects the neural circuits sculpted by experience in infancy and early childhood. At no other time in life does the surrounding environment so potently shape brain function – from basic motor skills, sensation, or sleep to higher cognitive processes like language. Recent research aimed at the interface between cell biology and systems neuroscience has begun to elucidate the molecular triggers and brakes that constrain these early windows of opportunity / vulnerability. How brain plasticity waxes and wanes with age carries an impact far beyond neuroscience, including education policy, therapeutic approaches to developmental disorders or strategies for recovery from brain injury in adulthood.

Extensive damage to the hippocampus results in the inability to form long-term memories of the events of one’s daily life. Current anatomical and physiological research suggests that there are two streams of information processing that project into the hippocampus. One stream provides the hippocampus with information about the organism’s current location in a map-like coordinate frame; the other stream provides information about individual items in the external environment. The hippocampus is thought to combine these two streams into conjunctive representations of experience, explicitly tied to the spatial and temporal context of the experience. These representations form the basis of the rapid and flexible learning and long-term episodic memory associated with hippocampal function.
Sarah-Jane Leslie  
Professor of Philosophy & Psychology  
Princeton University  
What does it take to excel at a particular academic pursuit? Is hard work enough, or is a special unteachable aptitude required? Practitioners of different academic disciplines answer this question in notably different ways. Importantly, disciplines in which hard work is de-emphasized in favor of raw brilliance have the largest gender gaps. Women and girls may be discouraged from participating in certain disciplines (e.g., science and math disciplines) because of these achievement messages.

Margaret Livingstone  
Professor of Neurobiology  
Harvard University  
There are distinct regions of the brain, reproducible from one person to the next, specialized for processing the most universal forms of human expertise. What is the relationship between behavioral expertise and dedicated brain structures? Do reproducible brain structures mean only certain abilities are innate or easily learned, or does intensive early experience influence the emergence of expertise and/or dedicated brain circuits? We found that intensive early, but not late, experience produces category-selective modules in macaque temporal lobe for stimuli never naturally encountered by monkeys, and produces more fluent processing of these stimuli than the same experience later in life. This suggests that, as in early sensory areas, experience can drive functional segregation and that this segregation may determine how that information is processed.

Michael McCloskey  
Professor of Cognitive Science  
Johns Hopkins University  
When the brain is damaged, the ability to read may be disrupted, with devastating consequences for the lives of the affected individuals. My colleagues and I have recently discovered a new and unusual form of reading impairment, in which letters and/or digits appear so blurred or distorted as to be unidentifiable, yet visual perception is otherwise normal. In the context of two cases—a 13-year-old girl and a 61-year-old man—I discuss our attempts to understand how this deficit can arise, and what it can tell us about normal reading, visual perception, and learning. In addition I describe our successes with a novel, yet simple, rehabilitation method.

Hal Pashler  
Distinguished Professor of Psychology  
University of California, San Diego  
Memory researchers have long known that distributing learning effort over time can make a difference. In recent years we have studied the effect of temporal spacing of review on remembering of facts and skills over substantial periods of time. The effects are very large but somewhat complex. Optimal spacing depends in an interesting way upon how long the material needs to be retained. Implications for instructors at all levels will be described, along with recent efforts to develop novel software tools to take advantage of these principles of learning.

Martha Zaslow  
Director of Policy and Communications  
Society for Research in Child Development  
Senior Scholar at Child Trends  
This presentation will help to set the stage for a general discussion of issues in the dissemination of science of learning research for policy and practice, with particular focus on: (1) the need to take into account important differences across key targets for the dissemination of research, (2) the timing of different dissemination efforts in terms of the extent of accumulation of evidence, (3) the underlying principle of “distilling without distorting” the evidence for dissemination and the need for training in this process, and (4) new potential for expanding the range of formats used for dissemination.
The mission of the newly formed Science of Learning Institute is to understand and optimize the most essential part of our human capital: the ability to learn. The Institute supports research and application that seeks to understand learning at all levels of scientific inquiry—including how the brain changes through learning, how development and aging affects our ability to learn, how neurological and psychiatric diseases disrupt or change learning, and why such vast individual differences naturally occur among learners. A central part of the mission is to understand how new technologies such as machine learning and new educational programs can optimize learning—whether it occurs in the informal setting of the playground, the more formal setting of a school, a rehabilitation program, or on-the-job training.

The Gateway Sciences Initiative is a multi-dimensional program to improve and enrich learning in undergraduate and graduate gateway sciences at Johns Hopkins University. Through a grant program, a Symposium on Teaching Excellence, and a new Innovative Instructor blog, the University seeks to improve our understanding of how students learn and to promote pedagogical innovation in courses that form the foundation for, or provide a gateway to, more advanced work in sciences, engineering, and quantitative studies.

A special note of thanks is extended to the Office of the Provost, Johns Hopkins University and the private philanthropic donations for sponsoring the symposia.