Apr 27, 2012

Search committee chair
Department of Neuroscience
Brown University, Providence RI

Dear Dr. Sheinberg,

I am writing to apply for the position of assistant professor in computational neuroscience, as advertised on the visionlist mailing list. I am a post-doctoral scholar working with Angela Yu in Cognitive Science at the University of California, San Diego. I worked with Rajesh Rao for my Ph.D. in Computer Science from the University of Washington. I believe that my research on the computational, cognitive and neural basis of inhibitory control makes me well-suited for the position outlined in your notice.

My current and planned research investigates inhibitory control in healthy and affected individuals using a combination of computational models, neuroimaging, and behavioral experiments. Working with Angela Yu, I developed a computational framework for inhibitory control in the context of the classic stop signal and go-nogo paradigms. We propose that aspects of higher cognitive function such as inhibitory control are well-explained as a *rational* response to external constraints (e.g., gains and losses), given subject-specific cognitive factors (e.g., perceived likelihoods of various outcomes, and sensitivity to reward). We quantify the effect of these factors on subjects' choices, successfully predicting a range of systematic variation observed in behavioral and psychopharmacological studies using these tasks. In collaboration with Jaime Ide and Ray Li at the Yale University School of Medicine, we use model-based fMRI analysis to uncover the neural basis of sequential, anticipatory adjustments in inhibitory control. In collaboration with Martin Paulus at the Department of Psychiatry, UCSD, we are studying behavioral and neural (fMRI) markers predictive of subsequent stimulant abuse in a large cohort of young users. I plan to continue theoretical and experimental investigations into executive function and its dysregulation, as well as the role of learning and experience in affective disorders.

My dissertation work with Rajesh Rao on the topic of brain-computer interfaces provided a strong background in machine learning and statistical modeling techniques, as well as significant expertise in the neuroimaging techniques of EEG and electrocorticography (ECoG). I sought to establish the spatial, spectral, and temporal changes in ECoG signals associated with gross- and fine-grained motor activity. I also designed a variety of interfaces that used EEG and electromyography to control robotic agents and effectors, as well as to cooperatively solve difficult computational problems such as image labeling.

I have included my curriculum vitae, research & teaching statements, and representative publications. I thank you for your consideration, and look forward to hearing from you.

Sincerely,

Pradeep Shenoy

University of California, San Diego
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Pradeep Shenoy

CONTACT INFORMATION

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RESEARCH INTERESTS

I am primarily interested in theoretical neuroscience and cognitive psychology, and their applications to psychiatry and neuropharmacology. I build statistical and control-theoretic models of inhibitory control and other executive function in humans and animals, and use them to probe the neurobiology of healthy and dysfunctional behavior.

For my doctoral dissertation, I designed and built a variety of brain-computer interfaces, exploring the interplay between brain signal decoding and application context. I analyzed and used a variety of biosignals (EEG,ECOG,EMG) for applications in robotics, human-computer interfaces and rehabilitation. I have also worked on a number of problems in database research, including algorithms for indexing and navigation of semistructured data, and query result caching in databases.

EDUCATION

University of Washington, Seattle, WA USA

Ph.D. (Computer Science), 2008

- Dissertation Topic: “Brain-Computer Interfaces for Control and Computation”
- Advisor: Rajesh P.N. Rao

M.S. (Computer Science), 2004

Indian Institute of Technology, Bombay, India

B.Tech (Computer Science), 1999

RESEARCH EXPERIENCE

University of California, San Diego, San Diego, CA USA

Postdoctoral Associate (Mentor: Angela J. Yu) **Jan 2010 - present**

I investigate the computational, cognitive and neurophysiological basis of inhibitory control. I develop computational models for well-studied experimental paradigms (the stop signal task, and the go-nogo task) that probe behavioral inhibition and its deficits. We synthesize experimental evidence from behavioral, neural (EEG, fMRI, single-neuron), and pharmacological experiments from the unifying perspective of our computational framework. I am also working to understand observed performance deficits in individuals with ADHD and substance abuse problems.

University of Washington, Seattle, WA USA

Postdoctoral Associate (Mentor: Rajesh P.N. Rao) **Jun 2008 - Dec 2009**

- Designing an optimality framework to study human and animal behavior in the countermanding task paradigm, in collaboration with Angela Yu at UCSD.
- Modeling decision uncertainty in rats, in collaboration with Adam Kepecs at Cold Spring Harbor Laboratory.

Audited courses in the departments of Neurobiology& Behavior and Psychology.

- NB501: Cellular and Molecular Neuroscience
- NB502: Neuroanatomy
- NB503: Cognitive and Systems Neuroscience
- PSY448a: Topics in Vision (Instructor: Geoff Boynton)
- PSY506: Core Concepts in Cognitive Neuroscience (Instructor: Scott Murray and Lee Osterhout)

- PSY548: Bayesian Reasoning in Psychology (Instructor: John Miyamoto)

Research Assistant **Jun 2002 - May 2008**

- Designed classifier-based techniques and an online system for using electrocorticographic signals in multi-class BCIs.
- Designed an image-based noninvasive brain interface for control of a humanoid robot.
- Developed a system for controlling a robotic arm using Electromyographic signals.
- Applied dynamic Bayesian networks for building models of user behavior in BCIs.

Microsoft Research, Redmond, WA USA

Consulting work (Mentor: Desney S. Tan) **Aug 2007 - May 2008**
Combined and contrasted an EEG-based image labeling system with computer vision algorithms.

Research Intern (Mentor: Desney S. Tan) **Jan - Mar, 2007**
Designed a system for labeling images based on EEG brain responses.

Fraunhofer Institute, Berlin, Germany

Visiting Researcher (Mentor: Klaus-Robert Mueller) **Jul - Oct, 2005**
Developed and evaluated adaptive algorithms for the Berlin Brain-Computer Interface.

Bell Laboratories, Murray Hill, NJ USA

Research Intern (Mentor: Philip Bohannon) **Jun - Sep, 2001**
Worked on novel query processing and optimization techniques for the ROLEX project. The goal of ROLEX is to provide fast on-demand navigational access to relational data via an XML wrapper.

Member of Technical Staff (Mentor: Henry F. Korth) **Nov 1999 - Aug 2000**
Developed novel techniques for indexing semistructured data. I also worked on the AQUA approximate query answering project.

Teaching & Mentoring

University of California, San Diego, San Diego, CA USA

Instructor, COGS118A (Natural Computation) **Winter 2012**
I taught an upper division course on probability theory and statistical methods for undergraduates in cognitive science. The course covered probabilistic modeling tools (regression, classification, Bayesian networks, Kalman filters, HMMs, Markov decision processes, reinforcement learning), as well as various applications in modeling cognitive phenomena. Course materials available online at
`http://thiscourse.com/ucsd/cogs118a/wi12/`
Student evaluations: 100% of the reviews recommend the class, and the instructor, to other students. Detailed evaluation summary available on request.

University of Washington, Seattle, WA USA

TA and Co-Designer, Brain-Computer Interfaces Course **Spring 2006**
With Raj Rao, I developed a seminar-style elective course for seniors & graduate students in CS/EE. I shaped the course structure, reading list and course projects. I coordinated class discussions, gave introductory lectures and supervised student projects. Course material available online at
`http://www.cs.washington.edu/education/courses/cse599e/06sp/`

Research Supervision **2006 - 2007**
Mentored two research assistants in the design of experiments, algorithms, analysis methods and online systems for a variety of brain-computer interface paradigms. Part of this work was published in the Journal of Neural Engineering (2008), and at the Graz conference on brain-computer interfaces (2006).

Mentor for Undergraduate Research **2004 - 2005**

Supervised 3 undergraduate honors theses on topics in Brain-Computer Interfaces. Guided undergraduates through research projects involving development of a novel EMG-based prosthetic interface, and large-margin methods for robust classification of ECoG signals in Brain-Computer Interfaces. Part of this work was extended into a paper at AAAI 2005.

Tutoring for Undergraduates **2003**
Volunteered as tutor for CS undergraduates taking courses in discrete mathematics and theoretical computer science.

Teaching Assistant, CSE 322 **Autumn 2002**
Graded homeworks and exams, conducted office hours and taught guest lectures for an undergraduate course in theoretical computer science.

Teaching Assistant, CSE 142 **Spring 2002**
Taught two weekly sections for a campus-wide introductory computer programming course.

Publications

Neuroscience & Psychology

P. Shenoy, A. J. Yu. (2012 *submitted*). Rational anticipation, norepinephrine, and inhibitory control.

J.S. Ide, P. Shenoy, A.J. Yu, C-S.R. Li. (2012, *submitted*). Bayesian predictions and evaluation in the anterior cingulate cortex.

P. Shenoy, A. J. Yu. (2012, *in preparation*). Time matters: rational impatience underlies the Go bias in Go/Nogo compared to 2AFC decision-making.

P. Shenoy, A.J. Yu, M. Paulus, et al. (2012, *in preparation*). Early stimulant users show altered behavioral and neural adaptation to local context in the stop signal task.

P. Shenoy, S. Jahfari, A. J. Yu. (2012, *in preparation*). Congruence resolution influences behavioral inhibition in the Stop Simon task: a computational account.

P. Shenoy, A. J. Yu (2011). Rational decision-making in inhibitory control. Frontiers in Human Neuroscience 5:48, 2011.

P. Shenoy, R.P.N. Rao, A. J. Yu (2010). A rational decision-making framework for inhibitory control. Advances in Neural Information Processing Systems 23.

Neuroscience Abstracts

Rational decision-making underlies systematic differences in speed and accuracy between 2-alternative forced choice tasks and Go/NoGo tasks. P. Shenoy, A.J. Yu. Society for Neuroscience (SfN) Abstracts, 2011.

A computational model of norepinephrine and inhibitory control. P. Shenoy, A.J. Yu. Society for Neuroscience (SfN) Abstracts, 2011.

Bayesian predictions and evaluation in the anterior cingulate cortex. J.S. Ide, P. Shenoy, A.J. Yu, C-S.R. Li. Society for Neuroscience (SfN) Abstracts, 2011.

Wherefore a race model: Inhibitory control as optimal decision-making. P. Shenoy, A.J. Yu. Computational and Systems Neuroscience (COSYNE) 2011.

Optimal decision-making and inhibitory control in the stop-signal task: Go and stop latencies both depend on go stimulus difficulty. P. Shenoy, J. Schilz, A.J. Yu. Society for Neuroscience (SfN) Abstracts, 2010.

An optimality framework for understanding the psychology and neurobiology of inhibitory control. P. Shenoy, R.P.N. Rao, A.J. Yu. Computational and Systems Neuroscience (COSYNE) 2010.

An optimality framework for understanding inhibitory control in countermanding tasks. P. Shenoy, R.P.N. Rao, A.J. Yu. Society for Neuroscience (SfN) Abstracts, 2009.

Active updating of decision boundaries in rats can be explained using bayesian classifiers. P. Shenoy, E.J. Chastain, A. Kepecs, R.P.N. Rao. Computational and Systems Neuroscience (COSYNE) 2009.

Risk Taking as Exploration in a Fast-Changing World. E.J. Chastain, P. Shenoy, R.P.N. Rao. Computational and Systems Neuroscience (COSYNE) 2008.

2004-2008: Refereed articles on Brain-Computer Interfaces

C.J. Bell, P. Shenoy, R. Chalodhorn, R. Rao (2008). Control of a Humanoid Robot by a Noninvasive Brain-Computer Interface in Humans. J Neural Eng 5, 214-220.

P. Shenoy, K.J. Miller, J. Ojemann, R. Rao (2008). Generalized Features for Electrocorticographic BCIs. IEEE Trans Biomed Engg 55(1) 273-280.

A. Kapoor, D. Tan, P. Shenoy, E. Horvitz (2008). Complementary Computing for Visual Tasks: Meshing Computer Vision with Human Visual Processing. IEEE Intl Conf on Automatic Face and Gesture Recognition.

A. Kapoor, P. Shenoy, D.S. Tan (2008). Combining Brain Computer Interfaces With Vision for Object Categorization. Computer Vision and Pattern Recognition (CVPR) 2008.

P. Shenoy, D. S. Tan (2008). Human-aided Computing: Utilizing Implicit Human Processing to Classify Images. ACM Conference on Human Factors in Computing (CHI) 2008.

D. Grimes, D. Tan, S. Hudson, P. Shenoy, R. Rao (2008). Feasibility and Pragmatics of Classifying Working Memory Load with an Electroencephalograph. ACM Conference on Human Factors in Computing (CHI) 2008.

P. Shenoy, K.J. Miller, B. Crawford, R. Rao (2008). Online Electromyographic Control of a Robotic Prosthesis. IEEE Trans Biomed Engg 55(3) 1128-1135.

K.J. Miller, P. Shenoy, M. den Nijs, L.B. Sorensen, R. Rao, J. Ojemann (2008). Beyond the Gamma Band: The Role of High Frequency Features in Movement Classification. IEEE Trans Biomed Engg 55(5) 1634-1637.

P. Shenoy, K.J. Miller, J. Ojemann, R. Rao (2007). Finger Movement Classification for an Electrocorticographic BCI. IEEE EMBS Conf. Neur Engg 2007.

C.J. Bell, P. Shenoy, R. Chalodhorn, R. Rao (2007). An Image-based Brain-Computer Interface Using the P3 Response. IEEE EMBS Conf. Neur Engg 2007.

K.J. Miller, M. denNijs, P. Shenoy, R. Rao, J. Ojemann (2007). Real-time Functional Brain Mapping using Electrocorticography. NeuroImage 37(2) 504-507.

P. Shenoy, M. Krauledat, B. Blankertz, R. Rao, K.-R. Mueller (2006). Towards Adaptive Classification for BCI. J Neural Eng 3.

M. Krauledat, P. Shenoy, B. Blankertz, R. Rao. K.-R. Mueller. Adaptation in CSP-based BCI systems (book chapter). Toward Brain-Computer Interfacing, MIT Press, 2007.

Beau Crawford, Kai Miller, Pradeep Shenoy, Rajesh Rao (2005). Realtime Classification of Electromyographic Signals for Prosthetics. Association for Advancement of Artificial Intelligence (AAAI) 2005.

Pradeep Shenoy, Rajesh Rao (2004). Dynamic Bayes Networks for Brain-Computer Interfacing. Advances in Neural Information Processing Systems (NIPS).

2000-2003: Refereed articles on database systems

Jayant Madhavan, Philip Bernstein, Kuang Chen, Alon Halevy, Pradeep Shenoy. Corpus-based Schema Matching. Workshop on Information Integration and the Web, IJCAI 2003.

P. Bohannon, S. Ganguly, H.F. Korth, P.P.S. Narayan, P. Shenoy. Optimizing View Queries in ROLEX to Support Navigable Result Trees. VLDB 2002.

Raghav Kaushik, Philip Bohannon, Jeff Naughton, Pradeep Shenoy. Updates for Structure Indexes. VLDB 2002.

Raghav Kaushik, Pradeep Shenoy, Philip Bohannon, Ehud Gudes. Exploiting Local Similarity for Efficient Indexing of Paths in Graph Structured Data. IEEE Int'l Conf Data Engg., 2002.

P. Shenoy, J. Haritsa, S. Sudarshan, G. Bhalotia, M. Bawa, D. Shah. Turbo-Charging Vertical Mining of Large Databases. ACM SIGMOD Int'l Conf. on management of data, 2000.

Professional Service

Reviewer for SIGMOD, VLDB, NIPS (2003), NIPS (2004), NIPS, CHI (2006), NIPS (2007), NIPS, CHI, UIST (2008), NIPS, CHI, AISTATS, UIST (2009).

Ad-hoc reviewer for the IEEE journals on Biomedical Engineering (TBME) and Neural Systems & Rehab Engg (TNSRE) (2006), and Frontiers in Human Neuroscience (2011).

References

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8939 Villa La Jolla Dr. Suite 200, La Jolla CA 92037-0985
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Research Statement
Pradeep Shenoy

I use computational tools to study the psychology and neurobiology of executive function. In particular, I am interested in how factors such as uncertainty, anticipation, and reward affect cognitive control and inhibition. My current research develops a computational framework for inhibitory control, and applies it to well-studied experimental paradigms such as the stop-signal and go-nogo tasks. I am also interested in the study of psychopathology--in ongoing projects, I examine ADHD pharmacology and stimulant dependence using these theoretical models.

Research approach

I develop normative models of decision-making in which human and animal behavior is seen as a *rational* response to external constraints (e.g., gains and losses), given subject-specific factors such as internal expectations of various outcomes and their timing, and sensitivity to reward. I use tools from Bayesian statistical theory and stochastic control theory to model *why* and *how* decisions emerge as the outcome of these factors. By explicitly and quantitatively linking each such factor to observed choice behaviors, we can *infer* the specific factors that lead to individual and group differences in behavior. The resulting theoretical foundation enables the discovery of deep connections between behavior and neurophysiology. This general research approach has achieved substantial progress recently in the areas of perceptual decision-making and reward-based learning, among others. A fundamental goal of my research is to understand how this computational methodology can be used to study higher cognitive functions such as inhibitory control.

Post-doctoral work: rational models of inhibition and cognitive control

Inhibition, computation, and cognition: The ability to modify or cancel preplanned actions, or to restrain oneself from actions that are no longer appropriate, is an important facet of executive function. This inhibitory control is not a unitary construct, but rather depends on many cognitive factors such as behavioral context, sensory uncertainty, and subjective expectation of events and rewards. I worked with my mentor Angela Yu to develop a computational model of the stop signal task, a classic experimental paradigm in behavioral inhibition. In the task, a go response to stimuli (for example a 2-alternative forced choice response) is interrupted on a small fraction of trials by a *stop signal* instructing subjects to withhold their response. Our model predicts the quantitative effects of factors such as stimulus expectation and rewards on task performance, consistent with experimental data [1]. Inhibitory ability in the task is typically quantified with a behavioral measure called the *stop signal reaction time* or SSRT, found to be longer in subjects with ADHD and substance abuse problems. Our model predicts that the SSRT measure is systematically affected by factors such as reward, in agreement with previous experimental results [2]. This characterization of the multiple *causes* affecting SSRT allows us to test which of these factors underlie group differences in inhibitory ability. We also connect our model to previously suggested neural implementations of stopping behavior, and make testable predictions of how the activity profile of task-relevant neurons should vary with task settings [2].

Neural computation and anticipatory control: Our theoretical framework allows us to investigate not only *why* humans behave the way they do, but to pinpoint why and how they sometimes appear to *deviate* from optimal behavior. One particular bias in behavior is sensitivity to *local patterns* in experience--humans tend to anticipate the likelihood and timing of upcoming events based on the recent past, even if these experiences are driven by pure chance. For the stop signal task, if the context-changing stop signal is believed to be more likely, one has to be more vigilant to the need for stopping. Accordingly, we show that trial-to-trial variation in task performance is not just "noise in the machine", but fully rational strategic adjustments contingent on a continually updated expectation of the likelihood of context changes [3,4]. In collaboration with Ray Li and Jaime Ide at the Yale University School of Medicine, we use model-based fMRI analysis to show that the dorsal anterior cingulate cortex (dACC) encodes an absolute prediction error related to stop signal expectancy [3]. The ACC has been well-studied in the context of cognitive control; here we ascribe to it a specific computational function of *expectation violation* that is consistent with, and unifies, a number of other suggested functional roles such as error monitoring, conflict processing, and anticipatory adjustments.

Psychopathology: In ongoing research, we are using our model for the stop signal task to investigate inhibitory dysfunction in ADHD and stimulant use. We propose that the neuromodulator norepinephrine is involved in tracking and representing the likelihood of context changes in the task [4], consistent with previous theoretical work by Dr. Yu. Our model predicts that elevated norepinephrine levels should increase perceived expectation of the context-changing stop signal, and improve measures of stopping performance [4]. Our prediction closely mirrors studies showing beneficial effects of atomoxetine, a norepinephrine reuptake inhibitor, on stopping performance in ADHD patients, healthy humans, and rats. Our results suggest that a potential *mechanism* of atomoxetine's therapeutic usefulness is the elevation of task-relevant event anticipation. We also collaborate with Martin Paulus at the UCSD department of Psychiatry to find behavioral and neural markers predictive of subsequent stimulant abuse. Dr. Paulus has collected fMRI data for the stop signal task performed by 180 individuals with limited exposure to stimulant use, in addition to a full psychiatric evaluation and a 3-year followup study. By studying early stages of use, the confounding effect of cognitive change due to stimulant use is mitigated. At the same time, followup evaluations allow identification of individuals at risk for dependence. Our preliminary results show decreased behavioral sensitivity to experienced history of stimulus type and timing, and hypoactivation of the associated neural circuitry underlying strategic adjustments in stimulant users [5].

Other ongoing and completed projects

Time, space, and attention: The overall research framework outlined above generalizes naturally to the study of other aspects of executive functioning. As an example, I have developed a rational decision-making model of the *go-nogo task* [6], thought to probe an aspect of behavioral inhibition distinct from that of the stop signal task. We show that a rational *impatience* in the go-nogo task (go responses terminate trials, whereas nogo trials require waiting) produces a natural bias towards go responses, and consequently a higher rate of false alarms than misses. In other work, we collaborate with Sara Jahfari at the University of Amsterdam to study interactions between attentional control and behavioral inhibition in a novel task, the *stop Simon task*. The Simon task induces a potential incongruence between stimulus color (which cues a left or right response), and stimulus location (left or right hemifield, irrelevant to response). The stop Simon task uses a Simon stimulus as the *go* stimulus in a stop signal paradigm. We show that responding in the task requires resolving *modal uncertainty* between stimulus color and spatial location, and that the difficulty of resolving this uncertainty influences behavioral inhibition measures (SSRT) in the stop Simon task [6].

Experimental and neuroimaging methodology: In addition to working on fMRI analysis with Dr. Paulus, I collaborate with Scott Makeig at the Swartz Center for Computational Neuroscience on EEG studies to delineate the fine temporal structure and cortical connectivity underlying stopping behavior. In particular, I hope to develop new techniques for model-driven analysis of EEG data in a manner analogous to fMRI. In conjunction, we are conducting behavioral experiments on the stop signal task and the go-nogo task with healthy undergraduate subjects to test novel predictions made by our computational models.

Dissertation work on Brain-computer interfaces: My graduate training was in computer science, where I designed and built a variety of brain-computer interfaces using EEG, electrocorticography, and electromyography. With my Ph.D. advisor Rajesh Rao, I sought to find spatial and spectrotemporal correlates of motor movement in electrocorticography [8-10], and to build expressive, powerful interfaces with the help of robotic agents and effectors [11, 12]. With my mentor Desney Tan at Microsoft Research, I explored the idea of using passive EEG responses as a computational resource. We showed that visually-evoked responses could help distinguish between image categories, and could complement and improve computer-vision algorithms [13,14]. In the course of my graduate career, I gained significant experience in

EEG and electrocorticography as neuroimaging tools, and in statistical methods for modeling behavioral and neural data, along with exposure to computational modeling in psychology and neuroscience. After my Ph.D., I chose to focus my training and energy on new problems that inspire me, in cognitive psychology, neuroscience, and psychiatry.

Career goals

I aim to develop a cohesive theory of executive function by combining mathematical models of decision-making with behavioral experiments and neuroimaging studies. As my current research demonstrates, this multi-pronged approach can yield surprising insights into cognitive, neurophysiological, and psychopathological aspects of executive function. I sketch below some long-term research questions that arise naturally from our progress in modeling behavioral inhibition.

Inhibitory control is exercised in many different ways--to suppress motor movement, resolve information conflict arising from language or memory retrieval, or to focus our attention on relevant sources of information. These diverse aspects of inhibitory control are studied extensively in carefully constrained experimental tasks such as the stop-signal and go-nogo tasks (behavioral inhibition), the Stroop task (cognitive inhibition), and the Eriksen flanker task (spatial attention). Experiments using such paradigms show the influence of shared cognitive factors such as anticipatory adjustments and sensory uncertainty, as well as substantial overlap in neural circuitry. I plan to design a unified framework of rational decision-making to find shared computational and cognitive bases for the different facets of inhibitory control. I will use the framework to drive the design and analysis of within-subject behavioral, fMRI and EEG experiments in multiple tasks. As a specific example, researchers have proposed two distinct aspects of behavioral inhibition--*restraint* (e.g., in the go-nogo task) and *cancellation* (e.g., in the stop-signal task)--in order to explain the differential neural activation and effects of pharmacological interventions observed in studies using these tasks. An immediate goal for my research is to reinterpret these findings from the computational perspective of the common decision-making framework I have used to successfully model behavior in the two tasks.

More broadly, I am interested in computational psychiatry, working under the hypothesis that healthy and altered brain function are different points on a shared spectrum of rational behavior. I believe that rational models of cognitive processing inspired by this hypothesis will lead to a deeper understanding of the cognitive and neural bases of both healthy and affected behavior. These findings may help shape a fine-grained, computationally based nosology of psychiatric illnesses, in turn suggesting focused interventions. My current and planned work, while establishing the basic neuroscience of cognitive control, also has deep connections to theories of impulsivity and inhibitory deficits used to characterize conditions such as ADHD and substance dependence. I hope to make these links more concrete in future collaborations with basic and clinical neuroscientists. From a methodological perspective, my research so far has examined how a rational decision-making framework can transform individual biases and constraints into group differences in behavior. An interesting, related question is how these individual biases may themselves potentially be acquired over a longer timescale of experience in conditions such as depression, and how they may relate to intuitive theories (and animal models) of depression such as learned helplessness. I hope to investigate these issues in future theoretical work.

Related Publications

[1] *A rational decision-making framework for inhibitory control*. **P. Shenoy**, R.P.N. Rao, A.J. Yu. Advances in Neural Information Processing Systems 23, 2011.
[2] *Rational decision-making in inhibitory control*. **P. Shenoy**, A. J. Yu. Frontiers in Human Neuroscience 5:48, 2011.

In Preparation

[3] *Bayesian predictions and evaluation in the anterior cingulate cortex*. J.S. Ide, **P. Shenoy**, A.J. Yu, C-S.R. Li. Society for Neuroscience abstract (2012).
[4] *Rational anticipation, norepinephrine, and inhibitory control*. **P. Shenoy**, A. J. Yu. Society for Neuroscience abstract (2012).
[5] *Early stimulant users show altered behavioral and neural adaptation to local context in the stop signal task.* **P. Shenoy,** A.J. Yu, M. Paulus (2012).
[6] *Time matters: rational impatience underlies the Go bias in Go/Nogo compared to 2AFC decision-making*. **P. Shenoy**, A. J. Yu. Society for Neuroscience abstract (2012).
[7] *Congruence resolution influences behavioral inhibition in the Stop Simon task: a computational account.* **P. Shenoy**, S. Jahfari, A.J. Yu (2012).

Representative publications on brain-computer interfaces

[8] *Generalized Features for Electrocorticographic BCIs*. **P. Shenoy**, K.J. Miller, J. Ojemann, R. Rao. IEEE Trans Biomed Engg 55(1) 273-280, 2008.
[9] *Finger Movement Classification for an Electrocorticographic BCI*. **P. Shenoy**, K.J. Miller, J. Ojemann, R. Rao. IEEE EMBS Conf. Neur Engg 2007.
[10] *Real-time Functional Brain Mapping using Electrocorticography*. K.J. Miller, M. denNijs, **P. Shenoy**, R. Rao, J. Ojemann. NeuroImage 37(2) 504-507, 2007.
[11] *Online Electromyographic Control of a Robotic Prosthesis*. **P. Shenoy**, K.J. Miller, B. Crawford, R. Rao. IEEE Trans Biomed Engg 55(3) 1128-1135, 2008.
[12] *Control of a Humanoid Robot by a Noninvasive Brain-Computer Interface in Humans*. C.J. Bell, **P. Shenoy**, R. Chalodhorn, R. Rao. J Neural Eng 5 (2008), 214-220.
[13] *Human-aided Computing: Utilizing Implicit Human Processing to Classify Images*. **P. Shenoy**, D. S. Tan. ACM Conference on Human Factors in Computing (CHI) 2008.
[14] *Combining Brain Computer Interfaces With Vision for Object Categorization*. A. Kapoor, **P. Shenoy**, D. S. Tan. Computer Vision and Pattern Recognition (CVPR) 2008.

Teaching Statement
Pradeep Shenoy

Statistical and computational approaches are increasingly necessary in psychology and neuroscience, both for an integrative understanding of subject matter, and for significant progress in research. As a teacher, I hope to foster a quantitative approach in students by teaching foundational classes in statistical methods, and by taking a mathematical approach to the study of neuroscience and psychology.

My teaching experiences, much like my own research career, have been wide-ranging and interdisciplinary. I have taught computer programming to novices, topics in neuroscience and neuroimaging to engineers, and statistical methods to cognitive scientists. Through all these experiences, I am sensitive to the challenge of meeting each student at their differing levels of sophistication, and nurturing them along their individual learning paths. At the same time, I have greatly enjoyed the pleasure of designing and teaching classes that synthesize multiple perspectives and tools in a manner accessible and useful to a wide range of students.

I look forward to teaching classes in statistical methods, computational modeling, neuroimaging & data analysis, and programming, as tools for psychology and neuroscience. I hope to demonstrate how these tools relate to the students' interests, and how they can use them to develop their own ideas. I will also design and teach courses that examine classical topics in psychology and neuroscience from the perspective of mathematical models and theories.

Teaching experience

COGS 118A: Natural Computation I, Winter 2012 (University of California, San Diego)
http://thiscourse.com/ucsd/cogs118a/wi12/
Course evaluation appended below.
At the University of California, San Diego, I taught an upper-division elective course on statistical methods for cognitive science undergraduates. As sole instructor, I prepared lectures, theoretical and programming assignments, and exams, in addition to supervising programming projects of the students' choosing. My primary goals were to impart a working knowledge of a broad range of challenging statistical modeling techniques, while simultaneously situating these tools in the context of cognitive science and neuroscience. Topics covered included density estimation, Bayesian regression & classification, graphical models & inference, linear dynamical systems, Markov decision processes, and reinforcement learning. The technical topics were paired with examples of applications in cognitive psychology and neuroscience research.

CSE 599E: Brain-computer interfaces, Spring 2006 (University of Washington)
http://www.cs.washington.edu/education/courses/cse599e/06sp/
At the University of Washington, I worked with my advisor Rajesh Rao to design and run a class on brain-computer interfaces, open to seniors and graduate students in electrical engineering and computer science. We structured the class as a combination of lectures and student-run discussions, with the lectures covering the statistical methods, signal processing, and neurobiology needed to discuss current research in brain-computer interfaces. I presented introductory material, selected weekly readings, guided student-led discussions on the reading, and supervised class projects. In the projects, students designed and ran EEG experiments, worked to decode information from different kinds of brain activity, and used the decoded information to control computer interfaces.

At UW, I also served a teaching assistant for an introductory computer programming course for non-majors (CSE 142, Spring 2002). My duties for that class included teaching two weekly 1-hour sections that expanded on lecture material and provided practice in problem-solving. I designed review material and practice problems, encouraged students to work in groups, and provided individual help when needed.

Mentoring experience

As a graduate student at the University of Washington, I had the privilege of mentoring many talented undergraduate research assistants. I supervised 3 honors theses and other research projects that resulted in 4 publications where the undergraduate students played a significant role and shared authorship. Students initially helped with programming and data analysis as they learned about my research. I subsequently guided them through the process of framing research problems, developing them via experiments, and analyzing and presenting the results. At UCSD, I continue to work with undergraduate students who help me design, implement, refine, and execute behavioral experiments. I also support my post-doctoral mentor, Angela Yu, by serving as a resource to graduate students in our research group. I help students with technical details of modeling and data analysis, as well as with relating their work to the wider literature and presenting their findings in context. This breadth of experience with mentoring undergraduate and graduate students will guide me as I work to support my own students in their academic endeavors.

Appendix: Course evaluation for COGS118A: Natural Computation I (Winter 2012)

100% of responding students recommended the class and instructor to other students. Evaluation scores on teaching quality and course relevance were very high (most scores 4.5+ out of 5). A full evaluation is available at: http://www.cape.ucsd.edu/scripts/detailedStats.asp?SectionId=739081&c=COGS+118A+

Appended below are selected quotes from free-form student responses:

> “While the material for this class is very difficult, Dr. Shenoy does an excellent job of explaining the concepts of the course and giving helpful examples of how [to] apply the material to real-world questions. He is very accessible outside of class for questions and assistance with understanding the course and shows a great deal of concern for the students' learning.”

> “This is a great course and it could have helped if I took this class earlier.”

> “The [text] book and notes were both very useful and complementary of each other. This class is probably one of the only classes I took that the professor lecture notes helped me understand the text book better.”