

CURRICULUM VITAE

GENERAL INFORMATION

Date Prepared: February 3, 2010
Name: Steven Bradley Lowen
Office Address: Brain Imaging Center, McLean Hospital,
115 Mill Street, Belmont, MA 02478
Work Phone: 617-855-2254
Work Email: lowen@mclean.org
Work FAX: 617-855-2770

Education:

1984	B.S.	Electrical Engineering	Yale University
		magna cum laude and with distinction in the major	
1988	M.S.	Electrical Engineering	Columbia University
1992	Ph.D.	Electrical Engineering	Columbia University
		Malvin C. Teich	

Academic Appointments:

1992–1996	Associate Research Scientist	Electrical Engineering	Columbia University
1996–1999	Senior Research Associate	Electrical and Computer Engineering	Boston University
1999–2002	Principal Associate	Psychiatry	Harvard Medical School
2003–	Assistant Professor	Psychiatry	Harvard Medical School

Hospital or Affiliated Institution Appointments:

1999–	Biomedical Engineer	Psychiatry	McLean Hospital
-------	---------------------	------------	-----------------

Other Professional Positions and Major Visiting Appointments:

1983–1984	Laboratory Instructor	Yale University
1984–1986	Staff Engineer	Hewlett-Packard Corporation
1988	Teaching Assistant	Columbia University
1999–2002	Consulting Engineer	St. Jude Medical Center, Sunnyvale, CA
2000–2002	Consulting Engineer	OPTAxSystems, Inc., Burlington, MA
2007–	Consulting Engineer	BioBDx, Inc., Cambridge, MA
2009–	Consulting Engineer	Psymetrix, Inc., Cambridge, MA

Professional Societies:

1986–1997	Institute of Electrical and Electronics Engineers
2004–2008	International Society for Magnetic Resonance in Medicine
2006–	Organization for Human Brain Mapping

Grant Review Activities:

2001–2002	Sensory Systems Ad hoc Member	NSF
2002	Regulatory Biology Ad hoc Member	Binational Science Foundation (US and Israel)
2003	ITR Small Grants Ad hoc Member	NSF

Editorial Activities:

Ad hoc Reviewer

Advances in Complex Systems
American Journal of Physiology
Annals of Biomedical Engineering
Biological Cybernetics
Biophysical Journal
Brain Research
Bulletin of Mathematical Biology
IEEE Transactions on Signal Processing
Journal of the Acoustical Society of America
Journal of the Association for Research in Otolaryngology
Journal of Computational Neuroscience
Journal of Neuroscience Methods
Modeling in Physiology
Nonlinear Biomedical Physics
Pattern Recognition Letters
Physica
Physical Review
Physical Review Letters
SIAM Journal on Scientific Computing
Signal Processing
Tectonics
Transactions of the IEICE (Japan)

Honors and Awards:

1981	Runk Prize	Yale University	Mathematics
1982	Barge Prize	Yale University	Mathematics
1984	Tau Beta Pi	(same)	Undergraduate engineering honor society
1988	Armstrong Memorial Prize	Columbia University	Graduate teaching
1994	Sigma Xi	(same)	Professional engineering honor society

Report of Funded and Unfunded Projects

Funding Information:

Past

1995–2000	P.I.	The Whitaker Foundation	\$250,000
Auditory-nerve-fiber firing patterns, fractal activity, and information transmission			
The major goals of this study were to investigate the fractal characteristics of the firing patterns in VIIIth-nerve fibers, how these fractal aspects are modulated by visual input, and how information about this input is transmitted in the face of the fractal noise.			
2001–2003	Section P.I.	NIDA R01 DA09448	\$107,840
Magnetic resonance, EEG, and behavior after cocaine			
The major goal of this administrative supplement (of which I was section P.I.) was to use wavelet analysis to investigate the role of fractal fluctuations in functional magnetic resonance imaging data, and specifically how drug use modulates these fractal patterns.			
2001–2003	Section P.I.	NIDA R01 DA14178	\$341,641
High-field MR research in drug abuse: a bioengineering partnership			
The major goal of the section for which I was P.I. was to develop objective motion detection and correction in time series functional magnetic resonance imaging experiments.			
2003	Investigator	NIMH R01 DA066222	
Effects of emotional maltreatment on brain function			
The major goals of this study were to assess the effects of verbal and physical abuse on the structure, function, and chemistry of the brain using magnetic resonance imaging. My role was to assist in designing the experiments, and to analyze the functional and structural data.			

2003	Investigator	NIDA R01 DA016934	
Early stress and neural substrates relevant to addiction			
The major goals of this study were to assess the effects of early stress on the structure of key brain regions, and how these sequelae the risk of substance abuse. My role was to assist in designing the experiments, and to analyze the resulting data.			

2003–2009	P.I.	NIDA K25 DA016612	\$788,213
Neurobiological bases of drug abuse: novel techniques			
The major goals of this grant were to train the P.I. to become an independent and interdisciplinary investigator, and to address three technological issues in magnetic resonance imaging: delivery of odor stimuli in the magnet, measurement and amelioration of motion artifacts, and gain a better understanding of fractal noise sources.			

Present

2009–2011	P.I.	NIDA 215 DA027062	\$250,000
fMRI correlates of olfactory and visual cues in tobacco smoking			
The major goals of this grant were to use functional MRI to explore the effects of visual and olfactory cues in cigarette smokers that result in relapse to smoking, and to develop more effective treatment strategies that can be individually tailored.			

Report of Local Teaching and Training

Teaching of Students in Courses

1982	Physics		
High school students	Teacher	50 hrs over a semester	
1983–1984	Electronics		
College students	Lab director	100 hrs/semester	

1988	Electronics	
College students	Teaching Assistant	100 hrs/semester

1988	Probability and Statistics	
Graduate students	Teaching Assistant	100 hrs/semester

Laboratory and Other Research Supervisory and Training Responsibilities:

2004	Supervision of predoctoral student	biweekly meetings for 6 months
------	------------------------------------	--------------------------------

Formally Supervised Trainees:

1993–1996	Bong K. Ryu, PhD	Hughes Labs, CA
Published one technical report, three conference proceedings, and one peer-reviewed paper.		

1997–2002	Prateek Aggarwal, PhD	Inquil (CEO)
Published one peer-reviewed paper.		

Formal Teaching of Peers

2007–2008	(Case histories)	Two presentations
Responsible Conduct of Research	Belmont, MA	McLean Hospital

Report of Regional, National and International Invited Teaching and Presentations

Regional contributions

2001	Fractals in point processes: models and applications	Talk (abstract)
Drexel University, Philadelphia, PA		(None)

2002	Engineering the future: a sesquicentennial symposium	Biotechnology Panelist
Yale University, New Haven, CT		(None)

National contributions

1993	Fractal stochastic processes	Plenary talk (abstract)
International Conference on Stochastic Processes and Biological Applications, Okawville, IL		(None)

1994	Fractal stochastic processes	Talk (abstract)
Naval Command, Control, and Ocean Surveillance Center, San Diego, CA		(None)

International contributions

1996	Toward fractal coding in auditory prostheses	Plenary talk (abstract)
International Workshop on Cochlear Implants, Vienna, Austria		(None)

2000	Analysis of point processes in sensory neurobiology	Talk (abstract)
University of Tokyo, Tokyo, Japan		(None)

Report of Technological and Other Scientific Innovations

Computer Software

<p>Computer Software: Over 500 programs written in C, Perl, Unix Shell, and other languages, with copyrights from 1986 to 2010, performing a wide variety of tasks including: data analysis [human magnetic resonance images (T2, fMRI, and spectroscopy), human psychological testing human activity patterns heartbeat other human cardiopulmonary signals auditory system neural firing patterns visual system neural firing patterns ion channels galvanic skin response vesicular exocytosis fetal sheep movement video images]; simulation of most of the above data; general statistical analysis; evaluation of functional forms; conversion among different data formats; dynamic web design; and system maintenance</p>
(No patents, but see below)
<p>Colleagues have used many programs for various purposes. A suite of programs for analyzing point processes, developed in connection with my book, has been downloaded from my web site dozens of times.</p>

Methods for diagnosing Alzheimer's disease and other forms of dementia
U.S. Patent #6,475,161
As a member of the Teicher lab, I developed the technical aspects of this computerized test for dementia. This and similar patents have been licensed by BioBDx, a company commercializing this test for many patient populations.

Illumination apparatus for simulating dynamic light conditions
U.S. Patent #6,554,439
As a member of the Teicher lab, I developed the technical aspects of this lighting source that can mimic natural light as it changes over time. This has application in seasonal affective disorder, among other conditions.

Enhanced diagnosis of psychiatric disorders with heartbeat data
U.S. Patent #6,554,439
As a member of the Teicher lab, I developed the technical aspects of this technique that takes heart rate variability into account in differential psychiatric diagnoses. This has application in distinguishing between ADHD and anxiety disorder for test subjects who perform poorly on a computerized test for ADHD.

Method for determining fluctuation in attentional state and overall attentional state
U.S. Patent #6,685,652
As a member of the Teicher lab, I developed the technical aspects of this technique that assesses attention as it fluctuates over short time scales. psychiatric diagnoses. This invention forms a key part of an ADHD test sold by BioBDx, a company commercializing this test for many patient populations.

System for conveying musical beat information to the hearing impaired
U.S. Patent #6,694,035
As a member of the Teicher lab, I developed the technical aspects of this technique that allows hearing impaired people to sense a musical beat and therefore dance to music. This can contribute to the quality of life of the hearing impaired.

Color magnetic resonance imaging
U.S. Patent #6,804,384
This method, for which I am sole inventor, presents up to three different aspects of an MRI image simultaneously, using hue, saturation, and brightness (for example). This has broad usefulness in radiology as it yields an image with a value of interest and (for example) its reliability at the same time.

Method for providing optimal drug dosage
U.S. Patent #6,898,455
As a member of the Teicher and Renshaw labs, I developed the technical aspects of this technique which uses functional MRI data to adjust drug dosages. This has application in setting appropriate dosing when behavioral measures are not useful.

Report of Scholarship

Publications

Peer-Reviewed Publications in print or other media

Research investigations

1. S. B. Lowen and M. C. Teich, "Generalised $1/f$ Shot Noise," *Electron. Lett.* **25**, 1072–1074 (1989).
2. S. B. Lowen and M. C. Teich, "Fractal Shot Noise," *Phys. Rev. Lett.* **63**, 1755–1759 (1989).
3. S. B. Lowen and M. C. Teich, "Power-Law Shot Noise," *IEEE Trans. Inform. Theory* **36**, 1302–1318 (1990).
4. S. B. Lowen and M. C. Teich, "Doubly Stochastic Poisson Point Process Driven by Fractal Shot Noise," *Phys. Rev. A* **43**, 4192–4215 (1991).

5. S. B. Lowen and M. C. Teich, "Auditory-Nerve Action Potentials Form a Non-Renewal Point Process Over Short as Well as Long Time Scales," *J. Acoust. Soc. Am.* **92**, 803–806 (1992).
6. S. B. Lowen and M. C. Teich, "Fractal Renewal Processes as a Model of Charge Transport in Amorphous Semiconductors," *Phys. Rev. B* **46**, 1816–1819 (1992).
7. S. B. Lowen and M. C. Teich, "Fractal Renewal Processes Generate $1/f$ Noise," *Phys. Rev. E* **47**, 992–1001 (1993).
8. S. B. Lowen and M. C. Teich, "Fractal Renewal Processes," *IEEE Trans. Inform. Theory* **39**, 1669–1671 (1993).
9. S. B. Lowen and M. C. Teich, "Estimating the Dimension of a Fractal Point Process," *Proc. SPIE* **2036** (Chaos in Biology and Medicine), 64–76 (1993).
10. R. G. Turcott, S. B. Lowen, E. Li, D. H. Johnson, C. Tsuchitani, and M. C. Teich, "A Nonstationary Poisson Point Process Describes the Sequence of Action Potentials over Long Time Scales in Lateral-Superior-Olive Auditory Neurons," *Biol. Cybern.* **70**, 209–217 (1994).
11. M. C. Teich and S. B. Lowen, "Fractal Patterns in Auditory Nerve-Spike Trains," *IEEE Eng. Med. Biol. Mag.* **13**, 197–202 (1994).
12. A. R. Bulsara, S. B. Lowen, and C. D. Rees, "Cooperative Behavior in the Periodically Modulated Wiener Process," *Phys. Rev. E* **49**, 4989–5000 (1994); reprinted in *Origins: Brain and Self Organization*, edited by K. H. Pribam, (Lawrence Erlbaum Associates, Hillsdale, New Jersey, 1994), pp. 352–384.
13. S. B. Lowen and A. R. Bulsara, "Modulated Wiener Process," *Nuovo Cimento D* **17D**, Ser. 1(7–8), 847–854 (1995).
14. A. R. Bulsara, S. B. Lowen, and C. D. Rees, "Coherent Stochastic Resonance in the Presence of a Field — Reply" *Phys. Rev. E* **52**, 5712–5713 (1995).
15. S. B. Lowen and M. C. Teich, "Estimation and Simulation of Fractal Stochastic Point Processes," *Fractals* **3**, 183–210, (1995).
16. A. R. Bulsara, T. C. Elston, C. R. Doering, S. B. Lowen, and K. Lindenberg, "Cooperative Behavior in Periodically Driven Noisy Integrate-Fire Models of Neuronal Dynamics," *Phys. Rev. E* **53**, 3958–3969 (1996).
17. S. B. Lowen and M. C. Teich, "The Periodogram and Allan Variance Reveal Fractal Exponents Greater Than Unity in Auditory-nerve Spike Trains," *J. Acoust. Soc. Am.* **99**, 3585–3591 (1996).
18. C. Heneghan, C. C. Chow, J. J. Collins, T. T. Imhoff, S. B. Lowen, and M. C. Teich, "Information Measures Quantifying Aperiodic Stochastic Resonance," *Phys. Rev. E* **54**, 2228–2231 (1996).

19. M. C. Teich, C. Heneghan, S. B. Lowen, T. Ozaki, and E. Kaplan, "Fractal Character of the Neural Spike Train in the Visual System of the Cat," *J. Opt. Soc. Am. A* **14**, 529–546 (1997).
20. S. B. Lowen, S. S. Cash, M-m. Poo, and M. C. Teich, "Quantal Neurotransmitter Secretion Rate Exhibits Fractal Behavior," *J. Neurosci.* **17**, 5666–5677 (1997).
21. S. Thurner, S. B. Lowen, M. C. Feurstein, C. Heneghan, H. G. Feichtinger, and M. C. Teich, "Analysis, Synthesis, and Estimation of Fractal-Rate Stochastic Point Processes," *Fractals* **5**, 565–596 (1997).
22. B. K. Ryu, and S. B. Lowen, "Point Process Models for Self-Similar Network Traffic, with Applications" *Stochastic Models* **14**, 735–761 (1998).
23. S. Thurner, M. C. Feurstein, S. B. Lowen, and M. C. Teich, "ROC Analysis Reveals Superiority of Scale-Dependent Wavelet and Spectral Measures for Assessing Cardiac Dysfunction," *Phys. Rev. Lett.* **81**, 5688–5691 (1998).
24. S. B. Lowen, L. S. Liebovitch, and J. A. White, "Fractal ion-channel behavior generates fractal firing patterns in neuronal models," *Phys. Rev. E* **59**, 5970–5980 (1999).
25. S. B. Lowen, "Efficient Generation of Fractional Brownian Motion for Simulation of Infrared Focal-Plane Array Calibration Drift," *Meth. Comp. Appl. Prob.* **1**, 445–456 (2000).
26. S. B. Lowen, T. Ozaki, E. Kaplan, B. E. A. Saleh, and M. C. Teich, "Fractal Features of Dark, Maintained, and Driven Neural Discharges in the Cat Visual System," *Methods: A Companion to Methods in Enzymology* **27**, 377–394 (2001).
27. Y. Ke, B. M. Cohen, S. B. Lowen, N. Lange, F. Hirashima, L. Nassar, and P. F. Renshaw, "Bi-exponential Transverse Relaxation (T2*) of the Proton MRS Creatine Resonance in Human Brain," *Magnetic Resonance in Medicine* **47**, 232–238 (2002).
28. C. M. Anderson, A. Polcari, S. B. Lowen, P. F. Renshaw, and M. H. Teicher, "Effects of Methylphenidate on Functional Magnetic Resonance Relaxometry of the Cerebellar Vermis in Children with ADHD," *American Journal of Psychiatry* **159**, 1322–1328 (2002).
29. M. H. Teicher, A. Polcari, C. M. Anderson, S. L. Andersen, S. B. Lowen, and C. P. Navalta, "Rate Dependency Revisited: Understanding the Effects of Methylphenidate in Children with Attention Deficit Hyperactivity Disorder," *Journal of Child and Adolescent Psychopharmacology* **13**, 41–51 (2003).
30. M. H. Teicher, S. B. Lowen, A. Polcari, M. Foley, and C. E. McGreenery, "Novel Strategy for the Analysis of CPT Data Provides New Insight into the Effects of Methylphenidate on Attentional States in Children with ADHD," *Journal of Child and Adolescent Psychopharmacology* **14**, 219–232 (2004).

31. C. M. Anderson, M. J. Kaufman, S. B. Lowen, M. Rohan, P. F. Renshaw, and M. H. Teicher, “Brain T2 Relaxation Times Correlate with Regional Cerebral Blood Volume,” *MAGMA* **18**, 3–6 (2005); erratum p. 170.
32. P. S. Aggarwal, S. B. Lowen, H. S. Colburn, and W. F. Dolphin, “Intrinsic oscillations in spike trains indicate non-renewal statistics due to convergence of inputs in dorsal cochlear nucleus neurons,” *Hearing Research* **200**, 10–28 (2005).
33. M. S. Blumberg, A. M. H. Seelke, S. B. Lowen, and K. Æ. Karlsson, “Dynamics of sleep-wake cyclicity in developing rats,” *PNAS* **102**, 14860–14864 (2005).
34. C. M. Anderson, S. B. Lowen, and P. F. Renshaw, “Emotional task-dependent low-frequency fluctuations and methylphenidate: Wavelet scaling analysis of $1/f$ -type fluctuations in fMRI of the cerebellar vermis,” *Journal of Neuroscience Methods* **151**, 52–61 (2006).
35. S. B. Lowen and S. E. Lukas, “A low-cost, MR-compatible olfactometer,” *Behavior Research Methods* **38**, 307–313 (2006).
36. S. B. Lowen, L. D. Nickerson, and J. M. Levin, “Differential effects of acute cocaine and placebo administration on visual cortical activation in healthy subjects measured using BOLD fMRI,” *Pharmacology, Biochemistry, and Behavior* **92**, 277–282 (2009).
37. I. Elman, S. Lowen, B. B. Frederick, W. Chi, L. Becerra, and R. K. Pitman, “Functional Neuroimaging of Reward Circuitry Responsivity to Monetary Gains and Losses in Posttraumatic Stress Disorder,” *Biological Psychiatry* **66**, 1083-1090 (2009).

Non-peer reviewed scientific or medical publications/materials in print or other media

Proceedings of meetings or other non-peer reviewed research publications

1. S. B. Lowen and M. C. Teich, “Fractal Auditory-Nerve Firing Patterns May Derive from Fractal Switching in Sensory Hair-Cell Ion Channels,” in *Noise in Physical Systems and $1/f$ Fluctuations*, (AIP Conference Proceedings **285**), edited by P. H. Handel and A. L. Chung, (American Institute of Physics, New York, 1993), pp. 781–784.
2. B. K. Ryu and S. B. Lowen, “Modeling, Analysis, and Simulation of Self-Similar Traffic using the Fractal-Shot-Noise-Driven Poisson Process,” *Proc. IASTED Int. Conf. on Modeling and Sim. '95, Pittsburgh, PA, April, 1995*, edited by M. H. Hamza (IASTED-ACTA Press, Anaheim, CA, 1995), pp. 45–48.
3. C. Heneghan, S. B. Lowen and M. C. Teich, “Two-Dimensional Fractional Brownian Motion: Wavelet Analysis and Synthesis,” *Proc. IEEE Southwest Symposium on Image Analysis and Interpretation* (San Antonio, TX, 1996), pp. 213–217.

4. B. K. Ryu and S. B. Lowen, “Point Process Approaches to the Modeling and Analysis of Self-Similar Traffic: Part I — Model Construction”, *Proc. IEEE INFOCOM '96, San Francisco, CA*, pp. 1468–1475.
5. B. K. Ryu and S. B. Lowen, “Point Process Approaches to the Modeling and Analysis of Self-Similar Traffic: Part II — Applications”, *Proc. 5th Int'l Conf. Telecommunications Systems, Modeling, and Analysis, Nashville, TN, March 1997*, pp. 62–70.
6. C. J. Heneghan, S. B. Lowen, and M. C. Teich “Analysis of Spectral and Wavelet-Based Measures Used to Assess Cardiac Pathology,” in *Proc. 1999 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP-99)* (Phoenix, AZ, 1999), paper SPTM-8.2.

Reviews, chapters, monographs and editorials

1. M. C. Teich, R. G. Turcott, and S. B. Lowen, “The Fractal Doubly Stochastic Poisson Point Process as a Model for the Cochlear Neural Spike Train,” in *Mechanics and Biophysics of Hearing*, edited by P. Dallos, C. D. Geisler, J. W. Matthews, M. A. Ruggero, and C. R. Steele (Springer, New York, 1990), pp. 354–361.
2. B. K. Ryu and S. B. Lowen, “Modeling Self-Similar Traffic with the Fractal-Shot-Noise-Driven Poisson Process,” *Cent. for Telecomm. Res., Tech. Rep. 392-94-39*, (Columbia University, New York, 1994).
3. S. B. Lowen, “Refractoriness-modified Doubly Stochastic Poisson Point Process,” *Cent. for Telecomm. Res., Tech. Rep. 449-96-15*, (Columbia University, New York, 1996).
4. S. B. Lowen and M. C. Teich, “Refractoriness-modified Fractal Stochastic Point Processes for Modeling Sensory-system Spike Trains,” in *Computational Neuroscience*, edited by J. M. Bower (Academic, San Diego, 1996), pp. 447–452.
5. C. Heneghan, S. B. Lowen, and M. C. Teich, “Wavelet Analysis for Estimating the Fractal Properties of Neural Firing Patterns,” in *Computational Neuroscience*, edited by J. M. Bower (Academic, San Diego, 1996), pp. 441–446.
6. M. C. Teich, C. Heneghan, S. B. Lowen, and R. G. Turcott “Estimating the Fractal Exponent of Point Processes Using Wavelet- and Fourier-Transform Methods,” in *Wavelets in Medicine and Biology*, edited by A. Aldroubi and M. Unser, (CRC Press, Boca Raton, FL, 1996), pp. 383–412.
7. S. B. Lowen, and M. C. Teich, “Estimating scaling exponents in auditory-nerve spike trains using fractal models incorporating refractoriness,” in *Diversity in Auditory Mechanics*, edited by E. R. Lewis, G. R. Long, R. F. Lion, P. M. Narins, C. R. Steele, and E. Hecht-Poinar (World Scientific, Singapore, 1997), pp. 197–204.
8. S. B. Lowen, S. S. Cash, M-m. Poo, and M. C. Teich, “Neuronal Exocytosis Exhibits Fractal Behavior,” in *Computational Neuroscience: Trends in Research, 1997* edited by J. M. Bower (Plenum, New York, 1997), pp. 13–18.

9. S. B. Lowen, T. Ozaki, E. Kaplan, and M. C. Teich, "Information Exchange Between Pairs of Spike Trains in the Mammalian Visual System," in *Computational Neuroscience: Trends in Research, 1998* edited by J. M. Bower (Plenum, New York, 1998), pp. 447–452.
10. S. B. Lowen and M. C. Teich, "Toward Fractal Coding in Auditory Prostheses," in *Cochlear Implants* edited by Susan B. Waltzman and Noel Cohen (Thieme Medical Publishers, New York, 2000), pp. 57–59.
11. M. C. Teich, S. B. Lowen, B. N. Jost, K. Vibe-Rheymer, and C. Heneghan, "Heart Rate Variability: Measures and Models," in *Nonlinear Biomedical Signal Processing, Vol. 2* edited by M. Akay (IEEE Press, New York, 2000), Ch. 6, pp. 159–213.
12. I. Elman, E. Tschibelu, S. Lowen, and D. Borsook, "Reward and motivational systems in post-traumatic stress disorder," in *Neurobiology of Post-traumatic Stress Disorder* edited by XXX (Nova Science Publishers, New York, 20XX), pp. XXX-XXX.

Books/Textbooks for the medical or scientific community

1. S. B. Lowen and M. C. Teich, *Fractal-Based Point Processes* (Wiley, New York, 2005) ISBN: 0-471-38376-7.

Thesis

1. S. B. Lowen, "Fractal Stochastic Processes," Ph.D. thesis (Columbia University, New York, 1992).

Narrative Report

My long-term goal is to improve people's lives by elucidating various brain, mind, and psychiatric states, focusing mostly on drug abuse. In the service of this mission I apply bioengineering principles to psychiatry in order to develop more objective diagnoses and more effective treatment regimens. Investigation comprises approximately 85% of my time, teaching 10%, and administration 5%.

Area of Excellence: Investigation

Fractal-based point processes: These processes model a wide variety of phenomena in biology and physics; examples include the release of neurotransmitter molecules at a biological synapse, action potentials recorded from a neuron, and the sequence of human heartbeats. I have completed a comprehensive monograph (see **Book**, above) on this topic, to serve as a reference and textbook for this important field, as well as over a dozen publications.

Creatine MRS I developed a method to robustly estimate creatine and phosphocreatine levels based on their differential time decays. This revealed strong changes in these chemicals in cocaine abusers, consistent with bioenergetic changes in brain chemistry induced by chronic drug use.

Odor-induced craving Odors often provide evocative stimuli. I have developed several computer-controlled odor delivery systems for use inside an MRI scanner, that has no metal

parts in the scan room. These devices have been used in two pilot studies and one drug evaluation, and have yielded maps of odor-induced craving in drug-dependent subjects. I have submitted two associated R01 applications, and an R21 that is under review.

T2 maps: I performed a precise analysis of noise in a type of anatomical MRI scan (T2), developed a new scan sequence which halved this noise, and generated a new method for displaying T2 data which includes confidence information.

McLean Motion and Attention Test (MMAT): This test provides objective measures for assisting in ADHD diagnosis. I developed specific algorithmic methods for tracking attentional state through time. I also showed that the history effects of test stimuli extend for six stimuli. Finally, I determined how normative data changes with subject age and sex, and developed functional forms describing these changes.

functional MRI: In addition to the odor-induced craving study mentioned above, I have designed experiments and data analysis streams for three other studies (involving escitalopram, zolpidem, and HIV-related functional brain changes), data analysis for a two (gambling and PTSD, and non-specific cocaine effects), and contributed to data analysis for a sixth (marijuana dependence). Analysis is complete for three studies; one is published, and one has been resubmitted.

Teaching and Education I have supervised three pre-doctoral students, and been primary advisor to one. I have taught a number of courses and lectures at levels from high school to graduate level, winning an award for an undergraduate-level course. Recently I have presented topics at our ethics seminar and our journal club. I also give extensive demonstrations of data analysis methods to both peer scientists to assist them in their analyses, and to research assistants to give them context for their work and to interest them in the field.

Summary I have worked towards a greater understanding of a number of psychiatric conditions, particularly drug abuse, mostly employing magnetic resonance imaging. I am currently involved in five functional MRI studies, with several more under development. I am pleased to be able to contribute in a leveraged manner to psychiatric research, and to play a role in training others.