CURRICULUM VITAE

1. Name/Position: Wilson Truccolo
Assistant Professor (Research), Department of Neuroscience, Brown University
Adjunct Professor, Centre for Theoretical Neuroscience and Department of Systems Design Engineering, University of Waterloo
Research Scientist, Department of Neurology, Massachusetts General Hospital
Biomedical Scientist, Department of Veterans Affairs, RR&D, PVAMC

2. Home Address: Available on request

3. Education:

1996 Undergrad. Universidade Federal do Rio Grande do Sul, Brazil, Department of Mathematics and Department of Psychology.
2001 Ph.D. Florida Atlantic University, Center for Complex Systems. Ph.D. in Complex Systems. Topic: Dynamical Systems and Stochastic Processes in Neuroscience. Advisors: Drs. Mingzhou Ding and Steven Bressler

Post-doctoral training:
2002 – 2005 Brown University, Department of Neuroscience
Topic: Stochastic Modeling of Multivariate Neural Point Processes for Network Dynamics, Encoding and Decoding Analyses.
Mentor: Dr. John P. Donoghue

4. Professional and Academic Appointments

1996 – 2000	Research Fellow. Full Ph.D. Fellowship from the Brazilian Research Council. Center for Complex Systems, Florida Atlantic University.
2000 – 2001	Research Assistant. Center for Complex Systems, Florida Atlantic University.
2002 – 2003	Burroughs Wellcome Fund Post-doctoral Fellow in the Brain Science Program, Brown University.
2004 – 2005	Post-doctoral Researcher, Department of Neuroscience, Brown University
2006 – 2008	Investigator, Department of Neuroscience, Brown University.
2007 – present	Research Scientist, Department of Neurology, Massachusetts General Hospital.
2009 – present	Assistant Professor (Research), Department of Neuroscience, Brown University.
2010 – present	Adjunct Professor, Centre for Theoretical Neuroscience, and Systems Design Engineering, University of Waterloo.
2010 – present	Biomedical Scientist, Department of Veterans Affairs, RR&D, PVAMC

5. Completed Research and Scholarship

A. Book/Monographs: None.

B. Chapters in Books/Monographs

1. Truccolo, W. (2010) **Stochastic models for multivariate neural point processes: Collective dynamics and neural decoding**. In *Analysis of parallel spike trains* (Eds. Grün, S. & Rotter, S.). Springer, New York.

C. Refereed Articles (1,362 total citations in Google Scholar/Harzing's PP; H-index: 13)

1. **Truccolo** W, Donoghue JA, Hochberg LR, Eskandar EN, Madsen JR, Anderson WS, Brown EN, Halgren E, Cash SS. (2011) **Single-Neuron Dynamics in Human Focal Epilepsy**. *Nature Neuroscience,* 14(5): 635 - 641*.*
   Highlighted in Nature Neuroscience 14(5), News & Views; and in Nature Reviews Neurology.
2. **Truccolo**, W., Hochberg, L.R., Donoghue, J.P. (2010) **Collective Dynamics in Human and Monkey Sensorimotor Cortex: Predicting Single Neuron Spikes**. *Nature Neuroscience*, 13(1): 105-111.
   Highlighted in Nature Reviews Neuroscience 11(2), 2010; and in *Neurosurgery 66(6), 2010.*
   55 citations in the Google Scholar Citation Index.
3. Bansal AK, **Truccolo** W, Vargas-Irwin CE, Donoghue JP (2012) **Decoding 3-D reach and grasp from hybrid signals in motor and premotor cortices: spikes, multiunit activity and local field potentials.** *J Neurophysiology* 107: 1337 – 1355.
   "*Editor's Choice" in J Neurophys.*
4. Bansal AK, Vargas-Irwin CE, **Truccolo** W, Donoghue JP (2011) **Relationships among low-frequency local field potentials, spiking activity, and 3-D reach and grasp kinematics in primary motor and ventral premotor cortices.** *J Neurophysiol*ogy 105: 1603 – 1619.
   Selected for Neuro Forum: Witte, J Neurophys, 2011.
5. Malik W, **Truccolo** W, Brown EN, Hochberg LR (2011) **Efficient Decoding with Steady-State Kalman Filter in Neural Interface Systems**. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 19(1): 25-34.
6. Zhuang, J., **Truccolo***, W., Vargas-Irwin, C., Donoghue, J.P. (2010) **Decoding 3-D reach and Grasp Kinematics from High-Frequency Local Field Potentials in Primate Primary Motor Cortex**. *IEEE Transactions on Biomedical Engineering*, 57(7): 1774-1784. *[*Corresponding author.]*
7. Zhuang, J., **Truccolo**, W., Vargas-Irwin, C., Donoghue, J.P. (2010) **Reconstructing Grasping Motions from High-Frequency Local Field Potentials in Primary Motor Cortex**. *IEEE-EMBS Proceeding*s: 4347-4350.
8. Keller, C. J., **Truccolo**, W., Gale, J.T., Eskandar, E., Thesen, T., Carlson, C., Devinsky, O., Kuzniecky, R., Doyle, W., Madsen, J.R., Schomer, D., Mehta, A., Brown, E.N., Hochberg, L.R., Ulbert, I., Halgren, E., Cash, S.S. (2010) **Heterogeneous Neuronal Firing Patterns During Interictal Epileptiform Discharges in the Human Cortex.** *Brain*, 133: 1668-1681.
9. **Truccolo**, W., Friehs, G.M., Donoghue, J.P., Hochberg, L.R. (2008) **Primary Motor Cortex Tuning to Intended Movement Kinematics in Humans with Tetraplegia**. *Journal of Neuroscience,* 28 (5): 1163-1178.

Selected in both the Faculty of 1000-Biology and F1000-Medicine.
95 citations in the Google Scholar Citation index.

10. Nalatore, H., **Truccolo**, W., Rangarajan, G. (2007) **Fast Robust Pattern Classification Algorithms for Real Time Neuro-Motor Prosthesis Applications**. *Journal of the Indian Institute of Science,* 87 (4): 497-509.
11. **Truccolo**, W. & Donoghue, J.P. (2007) **Non-Parametric Modeling of Neural Point Processes via Stochastic Gradient Boosting Regression**. *Neural Computation*, 19(3): 672-705.
12. Chen, Y., Bressler, S.L., Knuth, K.H., **Truccolo**, W., Ding, M. (2006) **Stochastic Modeling of Neurobiological Time Series: Power, Coherence, Granger Causality, and Separation of Evoked Responses from Ongoing Activity**. Special Edition on Stochastic Dynamics of Neural and Genetic Networks, Andre Longtin (Ed.). *Chaos,* 16, 026113 1-8.
This paper was also selected to appear in the Virtual Journal of Biological Physics Research, 12 (1).
13. Knuth, K.H., Shah, A., **Truccolo**, W., Ding, M., Bressler, S.L., Schroeder, C.E. (2006) **Differentially Variable Component Analysis (dVCA): Identifying Multiple Evoked Components using Trial-to-Trial Variability**. *Journal of Neurophysiology*, 95, 3257-3276.
14. **Truccolo**, W., Eden, U.T., Fellows, M.R., Donoghue, J.P., Brown, E.N. (2005) **A Point Process Framework for Relating Neural Spiking Activity to Spiking History, Neural Ensemble and Extrinsic Covariate Effects**. *J. Neurophysiology*, 93, 1074-1089.
318 citations in the Google Scholar Citation Index.
15. Eden, U.T., **Truccolo**, W., Fellows, M.R., Donoghue, J.P., & Brown, E.N. (2004) **Reconstruction of Hand Movement Trajectories from a Dynamic Ensemble of Spiking Motor Cortical Neurons**. *Proceedings of the 26th Annual International Conference of the IEEE EMBS*, San Francisco, CA.
16. Albo, Z., Viana di Prisco, G. Chen, Y., Rangarajan, G., **Truccolo**, W., Feng, J., Vertes, R.P., Ding, M. (2004) **Is Partial Coherence a Viable Technique for Identifying Generators of Neural Oscillations?** *Biological Cybernetics*, 90, 318-326.
17. **Truccolo**, W., Knuth, K.H., Shah, A., Schroeder, C., Bressler, S.L., Ding, M. (2003) **Estimation of Single-Trial Multi-Component ERPs: differentially Variable Component Analysis (dVCA)**. *Biological Cybernetics*, 89, 426-438.
18. **Truccolo**, W.A., Rangarajan, G., Chen, Y., Ding, M. (2003) **Analyzing Stability of Equilibrium Points in Neural Networks: a General Approach**. *Neural Networks*, 16(10), 1453-1460.
19. **Truccolo**, W.A., Ding, M., Knuth, K.H., Bressler, S.L. (2002) **Trial-to-Trial Variability of Cortical Evoked Responses: Implications for the Analysis of Functional Connectivity**. *Clinical Neurophysiology*, 113, 206–226.
125 citations in the Google Scholar Citation index.
20. **Truccolo**, W.A., Knuth, K.H., Bressler, S.L., Ding, M. (2002) **Bayesian Analysis of Single Trial Cortical Event-Related Components**. In Robert L. Fry (Ed.), Maximum Entropy and Bayesian Methods in Science and Engineering. *AIP Conference Proceedings*, 617, 64-73. Melville, NY: American Institute of Physics.
21. Liang, H., Bressler, S.L., Ding, M., **Truccolo**, W.A., Nakamura, R. (2002) **Synchronized Activity in Prefrontal Cortex during Anticipation of Visuomotor Processing**. *Neuroreport,* 13(16), 2011-2015.
22. **Truccolo**, W.A. & Dong, D.W. (2001) **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *Neurocomputing*, 38-40, 993-1001.

23. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2001) **Variability and Interdependence of Local Field Potentials: Effects of Gain Modulation and Nonstationarity**. *Neurocomputing*, 38-40, 983-992.
24. Kaminski, M., Ding, M., **Truccolo**, W.A., Bressler, S.L. (2001) **Evaluating Causal Relations in Neural Systems: Granger Causality, Direct Transfer Function (DTF) and Statistical Assessment of Significance**. *Biological Cybernetics*, 85, 145-157. 396 citations in the Google Scholar Citation index.
25. Knuth, K.H., **Truccolo**, W.A., Bressler, S.L., Ding, M. (2001) **Separation of multiple evoked responses using differential amplitude and latency variability**. In Sejnowski, T.J. (Ed.), *Proceedings of the 3rd International Conference on Independent Component Analysis and Blind Signal Separation*, December, 2001, San Diego, California, USA.
26. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000) **Stability Constraints for Oscillatory Neural Networks**. *Neurocomputing*, 32-33, 585-589.
27. **Truccolo**, W. & Dong, D.W. (2000) **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *Investigative Ophthalmology & Visual Science*, 41 (4): 259B259, Suppl. S MAR 15 2000.
28. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000) **Dynamical Analysis of an Oscillatory Cortical Neural Network**. In Amari et al. (Eds). *Neural Networks*. IJCNN 2000, Proceedings of the IEEE-INNS-ENNS International Joint Conference, Volume: 6, 24-27, pp. 434 – 439.

D. Non-Refereed Journal Articles

1. Sanes, J.N. & **Truccolo**, W. (2003) **Motor "Binding": do Functional Assemblies in Primary Motor Cortex have a Role?** *Neuron*, 38 (1): 3-5.

E. Book Reviews: None.

F. Conference Abstracts

1. Feldman JM, King B, **Truccolo** W, Hochberg LR, Donoghue JP (2011) **Decoding neural representations of action from motor cortex ensembles during action observation in humans with tetraplegia.** Abstr, No. 142.14. *Society for Neuroscience*, Washington, DC.
2. Hochberg LR, Bacher D, Barefoot L, Berhanu E, Black MJ, Cash SS, Feldman JM, Gallivan EM, Homer M, Jarosiewicz B, King B, Liu J, Malik WQ, Masse NY, Perge JA, Rosler DM, Schmansky N, Simeral JD, Travers B, **Truccolo W**, Donoghue JP (2011) **Use of the BrainGate Neural Interface System for more than five years by a woman with tetraplegia.** Abstr, No. 84.23. *Society for Neuroscience*, Washington, DC.
3. Donoghue JA, **Truccolo** W, Hochberg LR, Eskandar EN, Anderson WS, Madsen JR, Halgren E, Cash SS (2010) **Heterogeneous Single-Unit Spiking Patterns during Focal Seizures in Patients with Intractable Epilepsy**. Abstr. No. 150.25. *Society for Neuroscience*, Washington, DC.
4. Menzer DL, Rao NG, **Truccolo** W, Donoghue JP (2010) **Parietal-Frontal Communication during Reach Performance**. Abstr. No. 893.4. *Society for Neuroscience*, Washington, DC.
5. Malik WQ, Stavisky SD, Bacher D, Simeral JD, **Truccolo** W, Brown EN, Donoghue JP, Hochberg LR (2010) **Decoding Multiunit Activity in Neural Interfaces for Individuals with Tetraplegia**. Abstr. No. 899.3. *Society for Neuroscience*, Washington, DC.

6. Zhuang J, **Truccolo** W, Vargas-Irwin C, Donoghue JP (2010) **Decoding Continuous and Discrete States in 3-D Reaching and Grasping Movements from Local Field Potentials in Monkey Primary Motor Cortex**. Abstr. No. 899.5. *Society for Neuroscience*, Washington, DC.
7. Bansal AK, **Truccolo** W, Vargas-Irwin C, Donoghue JP (2010) **Decoding 3-D Reach and Grasp Kinematics from Multi-Scale Spatiotemporal Neural Activity in Primary Motor and Ventral Premotor Cortex**. Abstr. No. 899.6. *Society for Neuroscience*, Washington, DC.
8. Shaikhouni, A. **Truccolo**, W., Friehs, G.M., Donoghue, J.P., Hochberg, L.R. (2008) **Decoding Intended Movement and Somatic Sensory Inputs from Local Field Potentials in Humans with Tetraplegia**. *Society for Neuroscience*, Washington, DC.
9. Kim, S.P., Simeral, J.D., Hochberg, L.R., **Truccolo**, W., Friehs, G.M., Donoghue, J.P. & Black, M.J. **Tuning Analysis of Motor Cortical Neurons in a Person with Tetraplegia during Performance of Visually Instructed Control Tasks**. Abstr. No. 673.16. *Society for Neuroscience*, Washington, DC.
10. **Truccolo,** W., Hochberg, L.R., Eskandar, E., Cole, A., Cash, S.S. (2008) **Multielectrode Array Recordings of Single Unit Activity in Humans with Epilepsy**. Neural Interfaces Conference. Cleveland, OH**.**
11. **Truccolo,** W., Friehs, G.M., Donoghue, J.P., Hochberg, L.R. (2007) **MI Tuning to Intended Kinematics in Humans with Tetraplegia**. Abstr. No. 517.5, *Society for Neuroscience*, Washington, DC.
12. King, B., **Truccolo**, W., Friehs, G.M., Stein, J., Donoghue, J.P., Hochberg, L.R. (2007) **Motor Cortex Local Field Potentials and Multi-Unity Activity during Intended Movements in Humans with Tetraplegia**. Abstr. No. 517.15, *Society for Neuroscience*, Washington, DC.
13. **Truccolo**, W. & Donoghue, J.P. (2006) **Non-Parametric Modeling of Neural Point Processes: Stochastic Gradient Boosting Regression and Bayesian P-Splines**. *COSYNE: Computational and Systems Neuroscience*, Salt Lake City, UT, March 2006.
14. **Truccolo**, W., Vargas, C., Philips, B., Donoghue, J.P. (2005) **M1-5d Statistical Interdependencies via Dual Multi-Electrode Array Recordings**. Abstr. No. 981.13, *Society for Neuroscience*, Washington, DC.
15. **Truccolo**, W., Vargas, C., Philip, B., Fellows, M.R., Donoghue, J.P. (2005). **Simultaneous Multielectrode Recording of Primary Motor (M1) and Parietal (5d) Cortices during Reaching: Analysis of Statistical Interactions**. *The Society for the Neural Control of Movement*, Key Biscayne, FL.
16. **Truccolo**, W., Fellows, M.R., Eden, U.T., Brown, E.N, Donoghue, J.P. (2004). **Primary Motor (MI) and Parietal (5d) Coordination during Reaching: Point Process and LFP Models**. Abstr. No. 421.1, *Society for Neuroscience*, Washington, DC.
17. Wu, W., **Truccolo**, W., Saleh, M., Mumford, D., Donoghue, J.P. (2004) **Decoding Using Fast Oscillations in Local Field Potentials and Neural Firing during Instructed Delay in a Center-Out Reaching Task.** Computational Neuroscience Meeting, July 18-10m Baltimore, MD.
18. Ding, M., Rangarajan, G., **Truccolo**, W., Chen, Y. Donoghue, J.P. (2004). **Spatiotemporal LFP Activity in Macaque Motor Cortex during Instructed Delay**. *Statistical Analysis of Neuronal Data,* organized by Emery N. Brown (Harvard University) and Robert Kass (Carnegie Mellon University), May 21-22, Pittsburgh, PA.
19. **Truccolo**, W., Eden, U.T., Fellows, M.R., Donoghue, J.P., Brown, E.N. (2003). **Multivariate Conditional Intensity Models for MI Spiking Activity**. Abstr. No. 607.11, *Society for Neuroscience*, Washington, DC.

20. Eden, U.T., **Truccolo**, W., Ergun, A., Fellows, M.R., Donoghue, J.P., Brown, E.N. (2003). **Exact and Approximate Point Process Filters for Adaptive Neural Encoding and Decoding**. Abstr. No. 429.2, *Society for Neuroscience*, Washington, DC.
21. Rangarajan, G., **Truccolo**, W., Chen, Y., Donoghue, J.P., Ding, M.D. (2003). **Spatiotemporal Neural Activity in Macaque Motor Cortex during Working Memory and Movement Execution**. Abstr. No. 708.10, *Society for Neuroscience*, Washington, DC.
22. Eden, U.T., **Truccolo,** W., Barbieri, R., Donoghue, J.P., Brown, E.N. **Adaptive Neural Filtering Applied to Hand Movement Coding in Primate Primary Motor Cortex During a Hand Tracking Task**. Poster presentation at the *12th Annual Computational Neuroscience Meeting* Alicante, Spain. July 5-9, 2003.
23. Knuth, K.H., Shah, A., **Truccolo**, W., Ding, M.D., Bressler, S.L., Schroeder, C.E. (2003). **Differentially Variable Component Analysis: dVCA, A New Tool for Understanding Brain Responses**. Abstr. No. 430.19, *Society for Neuroscience* Washington, DC.
24. **Truccolo**, W.A., Saleh, M., Hatsopoulos, N., Donoghue, J.P. (2002). **Relationships between LFPs, Spike Activity and Movement Direction in Primary Motor Cortex**. Abstr. No. 357.3, *Society for Neuroscience,* Washington, DC.
25. Knuth, K.H., Clanton, S.T., Shah, A.S., **Truccolo**, W.A., Ding, M., Bressler, S.L., Trejo, L.J., Schroeder, C.E. (2002). **Multiple Component Event-Related Potential (mcERP)**. Abstr. No. 506.4, *Society for Neuroscience*, Washington, DC.
26. Shah, A.S., Knuth, K.H., **Truccolo**, W.A., Mehta, A.D., Fu, K.G., Johnston, T.A., Ding, M., Bressler, S.L., Schroeder, C.E. (2002). **Estimating Single-Trial Responses in EEG**. Abstr. No. 506.5, *Society for Neuroscience*, Washington, DC.
27. Knuth, K.H., Shah, A.S., **Truccolo**, W.A., Ding, M., Bressler, S.L., Schroeder, C.E. (2002). **Estimating the Single-Trial Characteristics of Event-Related Responses: Evaluation of the MCERP Algorithm**. *Dynamical Neuroscience Satellite Symposium*, Orlando, FL.
28. **Truccolo**, W.A., Knuth, K.H., Ding, M., Bressler, S.L. (2001). **Bayesian Estimation of Amplitude, Latency and Waveform of Single Trial Cortical Evoked Components**. *International Workshop on Bayesian Inference and Maximum Entropy Methods in Science and Engineering (MaxEnt)*, August 4-9, 2001, Johns Hopkins University, Baltimore, MD.
29. Knuth, K.H., **Truccolo**, W.A., Bressler, S.L., Ding, M. (2001). **Separation of Multiple Evoked Responses Using Differential Amplitude and Latency Variability**. *3rd International Conference on Independent Component Analysis and Blind Signal Separation*, December 9-13, 2001, San Diego, CA.
30. **Truccolo**, W.A., Knuth, K.H., Ding, M., Bressler, S.L. (2001). **Bayesian Estimation of Single Trial Cortical Evoked Potential Components: Applications to the Analysis of Functional Connectivity**. Abstr. No. 721.14, *Society for Neuroscience*, Washington, DC.
31. Albo, Z., Viana Di Prisco, G., **Truccolo**, W.A., Vertes, R.P., Ding. M. (2001). **A Study of Neural Interactions Within the Limbic System using Partial Coherence and Direct Transfer Functions Analysis**. Abstr. No. 315.14, *Society for Neuroscience*, Washington, DC.
32. Knuth, K.H., **Truccolo**, W.A., Shah, A.S., Ding, M., Bressler, S.L., Schroeder, C.E. (2001). **Facing Up to Trial-to-Trial Variability of Evoked Responses**. Abstr. No. 721.13, *Society for Neuroscience*, Washington, DC.
33. Shah, A.S., Knuth, K.H., Mehta, A.D., Fu, K.G., Johnston, T.A., Dias, E.C., **Truccolo**, W.A., Ding, M., Bressler, S.L., Schroeder, C.E. (2001). **Functional Connectivity between Visual Structures in Behaving Monkeys**. Abstr. No. 721.3, *Society for Neuroscience*, Washington, DC.

34. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **Variability of Cortical Evoked Responses: Implications for the Analysis of Functional Connectivity**. Abstr. No. 357.3, *Society for Neuroscience*, Washington, DC.
35. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **Dynamical Analysis of an Oscillatory Cortical Neural Network**. *International Joint Conference on Neural Networks (IJCNN)*, Como, Italy.
36. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **On the Variability of Cortical Evoked Responses: Implications for the Correlation and Spectral Coherence Analysis of Local Field Potentials**. *Computational Neuroscience Meeting*, Brugge ,Belgium.
37. **Truccolo**, W.A. & Dong, D.W. (2000). **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *Computational Neuroscience Meeting*, Brugge, Belgium.
38. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **Dynamics of Oscillatory Neural Networks**. *World Conference on Systemics, Cybernetics, and Informatics*, Orlando, FL.
39. **Truccolo**, W.A. and Dong, D.W. (2000). **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *ARVO - The Association for Research in Vision and Ophthalmology*, Annual Meeting, Fort Lauderdale, FL.
40. **Truccolo**, W.A., Ding, M., Bressler, S.L. (1999). **Stability of Oscillatory Neural Networks**. *Dynamic Neuroscience VII, Integration Across Multiple Imaging Modalities, Neuroscience Meeting Satellite Symposium*, NIHM, Boca Raton, FL.
41. **Truccolo**, W.A., Ding, M., Bressler, S.L. (1999). **Variability of Cortical Evoked Responses: Implications for Cross-Correlation and Coherence Measures**. *Dynamic Neuroscience VII, Integration Across Multiple Imaging Modalities, Neuroscience Meeting Satellite Symposium*, NIHM, Boca Raton, FL.
42. **Truccolo**, W.A., Ding, M., Bressler, S.L. (1999). **Dynamical Analysis of Oscillatory Neural Networks**. *5Th Experimental Chaos Conference*, Orlando, Florida.
43. **Truccolo**, W.A., Ding, M., Bressler, S.L. (1999). **Dynamical Analysis of a Generic Cortical Area Model**. *Computational Neuroscience Meeting*, Pittsburgh, PA.
44. **Truccolo**, W.A., Ding, M., Bressler, S.L. (1998). **Information Processing in a Generic Cortical Area Model**. *New England Complex Systems Conference*, Nashua, NH.

G. Invited Talks

1. **Truccolo** (2013) Invited talk at the German Neuroscience Society Meeting, symposium "Practically Profiting from the Complexity of Massively Parallel Electrophysiological Data", March 13 – 16, 2013, Goettingen, Germany.
2. **Truccolo** (2012) Winter School in Neuroengineering. Joint Indian Institute of Science (IIS) and NSF organization, Bangalore, Dec 10 – 21, 2012.
3. **Truccolo** (2012) Workshop on Neural Dynamics. Yukawa Institute for Theoretical Physics, Kyoto University. Organizer: Dr. Shigeru Shinomoto.
4. **Truccolo** (2011) **Collective Dynamics at the Level of Single Neurons in Human Neocortex**. (Swartz Foundation Travel Award.) Conference on *Single Neuron Studies of the Human Brain*. New York University. Organizers: Moran Cerf (NYU), Gabriel Kreiman (Harvard) and Ueli Rutishauser (Max Planck Institute for Brain Research in Frankfurt am Main).
5. **Truccolo**, W (2011) **Collective Dynamics in Neuronal Networks**. Conference on *Statistical Mechanics and Inference*, Trondheim, Norway. Organizers: John Hertz (Nordita/Niels Bohr Institute), Yasser Roudi (Kavli Institute/Nordita) and Sara Solla (Northwestern).

6. **Truccolo**, W (2011) **Single Neuron Dynamics in Human Epilepsy**. *5th International Workshop on Seizure Prediction*, Dresden, Germany.
7. Truccolo, W (2011) **Advances in Microphysiological Recording for Understanding Epilepsy.** *IEEE Engineering in Medicine and Biology Society,* Boston.
8. **Truccolo**, W (2011) **Multi-Scale Dynamics in Networks of the Brain**. Department of Neuroscience, Brown University.
9. **Truccolo**, W (2011) **Neuronal Ensemble Dynamics in Human Focal Epilepsy**. Brown Institute for Brain Science.
10. **Truccolo,** W (2010) **Activity Patterns in Ensembles of Single Neurons during Interictal, Preictal and Ictal States in Human Focal Epilepsy**. *IEEE-EMBS, Buenos Aires.* Chair: Dr. Bradley Greger.
11. **Truccolo**, W (2009) **Stochastic Point Process Models for Multivariate Neuronal Spiking Data: Applications to Neural Interface Systems**. Department of Systems Design Engineering, University of Waterloo, May 2009.
12. **Truccolo,** W (2009) **Intra and Inter-Areal Collective Dynamics in Human and Monkey Neocortex: How Predictable is Single Neuron Spiking?** Department of Neuroscience, Brown University.
13. **Brain Machine Interface: Human Studies**. (2008) Session chair. *Society for Neuroscience*, Washington, DC.
14. **Truccolo,** W. (2008) **Stochastic Models for Computational and Decoding Analyses of Neural Systems**. Program in Neuroscience and Cognitive Science (NACS) at the University of Maryland.
15. **Truccolo,** W. (2007) **Stochastic Modeling of Neural Point Processes: Theory**. Department of Applied Mathematics (ESAM) at Northwestern University.
16. **Truccolo,** W. (2007) **Stochastic Modeling of Neural Point Processes: Applications**. Rehabilitation Institute of Chicago and Department of Physiology at Northwestern University.
17. **Truccolo,** W. (2006) **Non-Parametric Modeling of Neural Point Processes**. Workshop on *Advanced Methods of Neurophysiological Signal Analysis & System Modeling* organized by Dr. Vasilis Z. Marmarelis and The Biomedical Simulations Resource (BMSR), University of Southern California, Los Angeles, June 2006.
18. **Truccolo**, W. (2005) **Computational Problems in Cortical Sensorimotor Control**. *Department of Neuroscience, Brown University, Providence, RI.*
19. **Truccolo**, W. (2001). **Statistical Analysis of Dynamic Interdependence Patterns in the Cortex**. *Department of Neuroscience, Brown University, Providence, RI.*
20. **Truccolo**, W. (2001). **Adaptive Multivariate Autoregressive Modeling of Local Field Potentials**. (Invited Talk) Neuroinformatics Course at the Marine Biological Laboratory, Woods Hole, MA.

H. Paper Read, Invited Colloquia: None.

I. Work in Review

1. Kramer M, **Truccolo** W, et al. **Crossing the Brain's Tipping Point: Spontaneous Seizure Termination Across Spatial Scales.**

J. Work in Progress (manuscripts in active preparation)

1. Rule M, Vargas-Irwin C, Donoghue JP, Truccolo W. Neural Variability, Network Dynamics and Neural Decoding in Motor Cortex.

2. Menzer D, Truccolo W., et al. Communication Between Parietal and Frontal Cortical Areas during Reaching.
3. Feldman J, Truccolo W, et al. Decoding neural representations of action from motor cortex ensembles during action observation in humans with tetraplegia.
4. Ahmed O, Truccolo W, et al. Traveling waves in human epileptic neocortex.

6. Research Grants

A. Current Grants: (as Principal Investigator)

1. **NIH-NINDS R01** (R01NS079533): 2012 – 2017
   Multi-Scale Cortical Dynamics in Human Epilepsy
2. **NIH-NINDS K01** (K01NS057389): 2007 – 2013 (2013, no cost extension, $90K)
   Sensorimotor Computations in M1 & 5d During Online Control of Reaching Movements

B. Current Grants: (as Co-Investigator)

1. **NIH-NINDS R01** (PI: J. P. Donoghue): 2012 – 2017
2. **DARPA** – REPAIR: 2011 – 2014 (PI: Arto Nurmikko, Co-PI: J. P. Donoghue)

Other:
NSF fellowship (Multi-Scale Network Dynamics in Encoding and Decoding in Primate Motor Cortex) to Michael Rule; Role: Ph.D. advisor.

C. Completed Grants: None.

D. Submitted Grants: (as Principal Investigator)

1. **VA Merit Review Award**:
   Multi-Scale Neuronal Dynamics, Seizure Prediction & Detection in Human Epilepsy.
2. **NSF - CRCNS**:
   Multi-Scale Network Dynamics, Encoding and Decoding in Human Cortex

E. Submitted Grants: (as Co-Investigator)

1. **Rhode Island STAC** (PI: R. Crossgrove): 2012 – 2013

Other:
NIH Shared Instrumentation Grant (Role: Participant)

7. Service

Referee

- Neuron
- Journal of Neuroscience
- Neural Computation
- Journal of Neurophysiology
- Neurocomputing

- IEEE Transactions on Neural Systems & Rehabilitation Engineering
- IEEE Transactions on Biomedical Engineering
- Proceedings of the IEEE
- Proceedings of the National Academy of Sciences
- PLOS-One
- PLOS – Computational Biology
- Journal of Neuroscience Methods
- Biological Cybernetics
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Program Committee for the IEEE International Joint Conference in Neural Networks (Hong Kong, 2008)
- NIPS 2010
- COSYNE 2010

8. Honors and Awards

- 2007 – 2012 NIH-NINDS K01 Career Award.
- 2002 – 2003 Burroughs Wellcome Fund Postdoctoral Fellow in the Brain Science Program, Brown University.
- 1996 – 2000 Full Ph.D. Fellowship from the Brazilian Research Council.
- 2000 Newell Award for outstanding doctoral graduate student, FAU.
- 1999 Newell Award for outstanding doctoral graduate student, FAU.

9. Skills

- Expertise in mathematical and statistical modeling of neural systems. Computer simulation of neuronal network models: biophysically detailed neuron models, spiking neuron and mean-field models. Statistical analysis of neural data (neuronal spike trains, high-density local field potentials, ECoG/EEG, fMRI.)
- Expertise in intracortical microelectrode array, subdural electrocortigram array, and depth electrode recordings in human and non-human primates.
- Management of neuromonitoring (electrophysiology) research in various clinical settings, including research in hospital operating rooms, neuro intensive care units and epilepsy monitoring units.
- Experimental design of human and non-human primate neurophysiology studies. Clinical trial studies (BrainGate).
- Training in neurosurgery (microelectrode implantation) in monkeys.
- Programming: C, C++, Matlab, R. Expertise in coding for high-performance computing clusters and distributed/parallel computation.

10. Teaching

Course teaching:

1. Multivariate Signal Processing (Florida Atlantic University, graduate level)
2. Computational Neuroscience (Florida Atlantic University, graduate level)
3. NEUR 1930F Brain Interfaces for Humans (Brown University, guest lecturer)

Student supervision:

1. 2002 – 2005: Project supervision for Dr. Matthew Fellows, graduate student (currently a postdoctoral associate in the Department of Physiology at UCSF).
2. 2002 – 2003: Project supervision for Maryam Saleh, undergraduate student (currently a postdoctoral researcher at the University of Chicago).
3. 2006 – 2009: Project supervision for Ammar Shaikhouni, M.D./Ph.D. graduate student (currently completing medical residency).
4. 2008 – 2010: Project supervision for Arjun Bansal, graduate student (currently a postdoctoral researcher at Harvard).
5. 2009 – 2010: Co-advisor for Jun Zhuang, a visiting graduate from Shanghai Jiao Tong University, Department of Biomedical Engineering. Ph.D. Thesis defended in Aug 2010.
6. 2010: Project supervision for Adrian Bondy, NIH-Brown rotating graduate student.
7. 2011 – present: Fabien Wagner, Ph.D. thesis committee member; project co-supervisor.
8. 2011 – present: Jessica Feldman, Ph.D. thesis committee member; project co-supervisor.
9. 2011 – present: Michael Rule, Ph.D. thesis advisor. (NSF Graduate Research Fellowship Program Award.)

In addition, over the years, I have also provided and continue to provide informal mentorship/consultation in Computational Neuroscience and Statistics to many other students and postdocs across various labs in the Department of Neuroscience, and across other departments at Brown (e.g. students working on Neuroscience related research topics in Computer Science, Engineering and Applied Math.)

Date of document: April 2012.

WILSON TRUCCOLO, PH.D.

RESEARCH STATEMENT

A. Research Interests

I am a computational neuroscientist whose research interests reside at the intersection of basic and translational neuroscience. My long-term goal is to understand the role of the coordinated activity (network dynamics) of neuronal ensembles in both healthy and disease states. This coordinated activity, ranging from interactions of small, localized populations of neurons to interactions among large populations in different cortical areas, is widely thought to be a key mechanism of cognition and adaptive behavior. Consider, for example, the complex representations and computations that underlie goal directed reaching and grasping behavior: the brain must encode the kinematics of moving targets (think of juggling) in retinal coordinates, and translate these coordinates into intrinsic body coordinates to control arm joint angles/torques and muscle activations for precise reach and grasp actions. Major features of representation and computation are thought to be carried in the spatiotemporal patterns (coordinated activity) of spike trains from neuronal ensembles in widely distributed cortical networks. Yet, understanding *how* this coordinated activity encodes and computes information remains one of the most elusive problems in Neuroscience. Similarly, how the coordinated activity in large-scale cortical networks dynamically integrates and segregates information remains a fundamental problem. On the one hand, very little is known about how representations and computations occurring simultaneously in different sensory cortices or modalities (vision, audition, proprioception) are integrated in order to generate coherent actions and a unified experience of the world. On the other hand, how the brain segregates information, i.e. dynamically and selectively routes information through different cortical networks depending on context or task demands remains poorly understood. Understanding the coordination of neural activity, from the level of single neurons to large population networks, is essential not only for understanding function in the healthy brain, but also for understanding and treating neurological disorders that involve cortical neurons. Epileptic seizures, for example, constitute an extreme and dramatic case of coordinated activity going wrong: even though most of the time the epileptic brain is not seizing, during a transition to a seizure, neuronal network dynamics can evolve rapidly into pathological activity patterns that spread across the cortex and abolish most if not all of its normal functions.

Part of the challenge in understanding the role of coordinated neural activity has been the difficulty of recording neural activity simultaneously at multiple scales: from ensembles of single neurons to population activity (e.g. as reflected in high-density local field potentials and electrocorticograms). In addition, understanding the role and inter-relationship of these multi-scale activity patterns requires the development of more sophisticated modeling tools and stochastic (probabilistic) data-driven models. Recent developments in neurotechnology and in experimental and clinical neurophysiology now allow us to study hundreds of single neurons, local field potentials, electrocorticograms and other related neural signals, simultaneously and continuously for several days or weeks, not only in animals but also in the human brain. Supported by these advances, my research in Computational Neuroscience focuses on the development of data-driven stochastic models of cortical dynamics, with the following goals: (a) to understand how representations and sensorimotor transformations necessary for motor plans and actions is encoded in the coordinated activity of populations of neurons distributed across sensorimotor cortex (e.g. Truccolo et al., Nature Neurosci, 2010: Collective dynamics in human and monkey sensorimotor cortex: predicting single neuron spikes); (b) to develop neural decoding approaches that take into account cortical dynamics at multiple scales in order to construct efficient and robust brain-machine interfaces (BMIs) for people with movement and communication disorders (e.g. Truccolo et al., J Neurosci, 2008: Primary motor cortex tuning to intended movement kinematics in humans with tetraplegia), and (c) to understand, predict and control dynamical disorders where the coordinated activity in neuronal ensembles becomes pathological (e.g. Truccolo et al., Nature Neurosci, 2011: Single neuron dynamics in human epilepsy). For this research I have been engaged at the forefront of an emerging wave of human neuroscience, where I have been involved in acute and chronic recordings now possible in both acute (epilepsy monitoring sessions) and human neural interface (BMI) clinical trials.

My research has been funded by a combination of principal and co-investigator grants. I am the principal investigator of a newly funded NIH-NINDS R01 (start date: July 2012; first review, 10th percentile, impact score: 20) and continue to be funded by my NIH Career Award (K01). I am the principal investigator of two 5-year grant applications currently under review: an NSF Collaborative Research in Computational Neuroscience (CRCNS) grant, and a VA Merit Review Award. In addition, I continue my collaboration with Dr. John Donoghue in the study of cortico-cortico computations in nonhuman primates as a co-investigator: NIH-R01 (2012 – 2017) and DARPA-REPAIR (2012 – 2014). I am advising a graduate student in the Department of Neuroscience who just received an NSF doctoral fellowship. My unique combination of skills and expertise (theoretical/computational neuroscience and basic neurobiology, cutting-edge methods for mutli-scale recordings using combined intracortical microelectrode arrays and subdural ECoG arrays in human and non-human primates, a clinical perspective on abnormal neural dynamics) will allow me to continue to contribute meaningfully to the field. My solid publication record in the field (> 20 articles, 1,362 total citations) demonstrates the impact of my work to date.

B. Brief Scientific Biography

In 1996 I was awarded a full doctoral fellowship by the Brazilian National Council of Research to study Dynamical Systems Theory applied to Neuroscience. To meet my research training objectives, I chose an innovative Ph.D. program in Complex Systems at Florida Atlantic University, then co-directed by Drs. Scott Kelso and Herman Haken (a theoretical physicist known for his contributions to nonequilibrium statistical mechanics in physical and biological systems). At the Center for Complex Systems I worked primarily with Dr. Mingzhou Ding (a graduate of the 'Maryland School' of Dynamical Systems, having worked with Edward Ott and James Yorke). Under his direction, I applied stochastic processes and dynamical systems theory to the analysis of neural dynamics models and to the development of new statistical modeling tools for neural systems. Dr. Steven Bressler (a graduate of Dr. Walter Freeman's Lab, Berkeley) was a co-advisor for the Neuroscience component of my Ph.D. research. For my postdoctoral training, I collaborated with experimental neuroscientists who were developing state-of-the-art recordings of large ensembles of cortical neurons in primates. In 2002, I began this training as a Burroughs Wellcome Fund postdoctoral associate in the Donoghue Lab at Brown University. My work focused on the development of a framework to model how cortico-cortico interactions among neuronal populations distributed across sensorimotor areas represent motor plans and compute arm actions. This innovative framework (Truccolo et al., J Neurophys, 2005, > 300 citations) focused on the stochastic modeling of dynamics and neural encoding in spike trains of recorded ensembles of single neurons, i.e. multivariate point processes. It has since been applied by many different research groups to study neural processing in systems that range from the retina (Pillow et al., Nature, 2008), to thalamic nuclei (e.g. LGN, Butts et al., J Neurosci, 2011), to early sensory cortices (e.g. area 3b, Thakur et al., J Neurophys, 2012), to sensorimotor cortex (Hatsopoulos et al., 2007; Saleh et al., J Neurosci, 2012; Truccolo et al., Nature Neurosci, 2010). Besides the mentorship of Dr. Donoghue, I also greatly benefited from close interactions with researchers in the Departments of Applied Mathematics and Computer Science (Drs. Stu Geman, Elie

Bienenstock and Michael Black), and with Drs. Leigh Hochberg (Brown & Harvard-MGH), Emery Brown (MIT & Harvard-MGH) and Sydney Cash (Harvard-MGH). During this period, I also trained in neuroelectrophysiology, monkey neurosurgery, experimental design, and became proficient in microelectrode array recordings in both monkeys and humans. Since then, I have managed neuroelectrophysiology research in humans in various clinical settings, including hospital operating rooms, neuro intensive care units and epilepsy monitoring units. I was promoted to the rank of Investigator in the Department of Neuroscience at Brown in 2006, and to Assistant Professor (Research) in 2009. I have been a principal investigator at Brown since receiving an NIH Career Award (K01) in 2007.

A significant part of my current and planned work is based on a very promising new research model that will further our understanding of human brain function at the level of ensembles of single neurons. It involves intracortical microelectrode array recordings from (a) people with paralysis enrolled in BMI clinical trials (e.g. Truccolo et al., Nature Neurosci, 2010), and (b) people with epilepsy undergoing pre-surgical assessment for potential resection of epileptic brain tissue (e.g. Truccolo et al., Nature Neurosci, 2011). I am part of the BrainGate clinical trial research team, and in 2007 helped to extend the same neurotechnology to the first study of ensembles of single neurons in human epilepsy at Massachusetts General Hospital. I am also part of the team of investigators that has recently brought the same research capability to Brown & Rhode Island Hospital; I helped coordinate the first implant/recordings in April 2012. Given the multidisciplinary requirements of this type of research, collaboration among researchers with different kinds of expertise is not only a desirable feature, but also a necessity. In this multidisciplinary environment, I have been leading the effort in Computational Neuroscience.

C. Specific Research Interests

1. Theoretical/Computational Neuroscience

- **Understanding the functional role of multi-scale network dynamics in cortex: Neural representation and computation.** My work in stochastic modeling is integrated with experimental questions related to cortical sensorimotor representation and computation. My goal is to understand how the coordinated activity of neuronal ensembles, in both intra- and inter-areal networks in sensorimotor cortex, is involved in the control of voluntary movements in human and nonhuman primates **[1,3,10,15,22**; see Publications section below**]**. To achieve this goal, I have been developing data-driven stochastic models that express the activity of single neurons as a function of (a) their own past history (intrinsic biophysics/dynamics) (b) the activity of other neurons in the ensembles (network dynamics), and (c) extrinsic covariates related to the ensemble's representation of sensory stimuli and motor behavior (e.g. tuning functions). In **[1,15]** I introduced a framework for the modeling and analysis of multivariate neural point processes. I extended this framework to a non-parametric approach based either on approximation in function space via stochastic boosting regression or on hierarchical Bayesian penalized-splines **[12,3]**. In **[1]** I applied this point process framework to demonstrate intra- and inter-areal collective dynamics in neuronal ensembles in parietal, motor and premotor areas, as well as to examine the relationship of these dynamics to reach/grasp kinematics. I am currently further developing this approach for estimation of computations performed by a given neuronal population on input spike trains. Computation in this sense can be seen as transformation on input spike trains, i.e. system identification on input-output point process systems. In this regard, the framework in **[1,15]** provides a principled way to implement Volterra kernel identification of point process neural systems **[3]**. My research at the level of ensembles of single neurons is embedded in a broader, multi-scale perspective based on my previous and ongoing work with other types of neurophysiological signals, such as LFPs, ECoGs and EEGs. I have worked on the stochastic modeling of multivariate intra-cortical local field potentials to analyze functional/effective connectivity and 'information flow' (e.g. Granger causality) in cortical networks. This work involves approaches based on both time and spectral domain analyses **[13,14,17,18,20,21,24,25,26]**. To continue my research in this direction, I have submitted as a PI an NSF-CRCNS grant application (Multi-Scale Network Dynamics, Encoding and Decoding in Human Cortex). In addition, I am a co-investigator on an NIH R01 (PI: Donoghue) that aims at understanding the role of cortico-cortico computations in premotor and primary motor cortical areas.

- **Dynamical Systems in Neuroscience.** Understanding the nature of the dynamics in neuronal networks is fundamental to revealing the potential role these dynamics play in neural representation and computation. For this reason, I am also interested in dynamical systems analysis of neuronal networks, as demonstrated by my work on stability and bifurcation analysis of oscillatory networks with complex dynamics (large systems of 2^{nd}-order nonlinear differential equations) **[19,23,27,28,29]**. I am currently extending my previous work to stochastic networks in order to take into account neural noise and uncertainty, arising from such sources as ion channel noise and failure in synaptic vesicle release, and from the huge undersampling of cortical activity in current experimental setups (e.g. typically we simultaneously measure only on the order of ~ 100 out of hundreds of millions of single neurons in large-scale cortical networks.) In addition, I am developing dynamical system models (based on data-driven state-space models) that capture low-dimensional manifold 'neural trajectories' in ensembles of single neurons recorded simultaneously from interacting areas in primary motor and premotor cortices **[3]**. My work in Computational Neuroscience has included neuronal models across a broad range of complexity: from mean-field and simplified models (e.g. integrate-and-fire neurons), to detailed biophysical models. For example, in **[23]** I used Hodgkin-Huxley neuron models with T-type Ca^{++} channels to propose how top-down V1 inputs could modulate, in a gradual fashion, the tonic-bursting mode of activity in LGN relay cells in order to achieve signal processing (temporal decorrelation) of natural moving scenes.

2. Translational Neuroscience

- **Role of network dynamics in neural decoding: Efficient and robust neural decoding approaches for brain-machine interfaces.** Variability in neural responses is thought to arise in large part from fluctuations in ongoing cortical network activity, which encompasses various spatiotemporal scales (e.g. local field potential transients in different frequency bands). Yet, the role of these dynamics on neural encoding/decoding is unknown. In addition, the role of shared covariation in neural activity in representation and computation remains a fundamental question. I began to address these problems in **[1,3,15]** and currently have an NSF-funded graduate student working with me on this topic.

  I am also developing new state-space (dynamical system) models to infer intended behavior (e.g. hand kinematics) and neural states from observed neuronal ensemble activities. The state-space formulation used in this neural decoding approach is based on Bayesian probabilistic models which can be seen as nonlinear, non-Gaussian extensions of Kalman filter theory (e.g. based on Laplace approximations) to include point process observations **[3,10,15,16]**. For nonparametric models such as those derived in **[12]**, neural decoding also involves a state-space formulation, but inference typically relies on sequential Monte Carlo algorithms such as particle filters. In addition, I am also developing neural decoding algorithms based on hybrid signals, i.e. combinations of neuronal spikes, multiunit activity and LFPs **[4,5,6,7,8,11]**. From a general and formal perspective, my interest is in the development of generalized state-space models that involve (a) point and real valued stochastic processes and (b) nonlinear/non-Gaussian intrinsic dynamics. Part of this research (e.g. **[10]**) is done in collaboration with Drs. Donoghue and Hochberg in the BrainGate pilot clinical trial, with the long-term goal of developing cortico-motor neuroprosthetic devices for patients with damaged descending motor pathways.

- **Role of network dynamics in neurological disorders: modeling, prediction and control of pathological network dynamics.** In addition to studying the role of network dynamics in healthy cortex, I am also interested in the cases where these dynamics become pathological. Epilepsy is one of the most common neurological disorders. Fifty million people worldwide, 3 million in the US alone, suffer from epilepsy. Furthermore, 25-35% of patients with epilepsy continue to have seizures despite maximal medical therapy. Progress thus far has been hampered by the challenge of monitoring the activity of ensembles of single neurons. Most studies have been limited to intracranial electroencephalograms (iEEGs). However, epilepsy is not a disorder of EEGs, but of neurons and their interactions, i.e. their coordinated activity. Therefore, understanding the disease at the neuronal level is critical. Animal models have been used as an alternative approach, but it remains an open question how well these models capture mechanisms underlying human epilepsy. Extending work in basic neuroscience, recent efforts in the past few years for seizure prevention systems based on neocortical or deep brain abortive electrical stimulation have entered clinical trials (E.g. NeuroPace, completed clinical trial, > 200 patients; Medtronic, also completed trial). In particular, a new approach towards controlling focal seizures is based on closed loop (responsive) neurostimulation systems that rely on implanted electrodes for early seizure detection/prediction based on ECoG signals and abortive stimulation. However, initial reports indicate only limited effectiveness (NeuroPace clinical trial). I expect that a deeper understanding of neural activity at the single neuron level and its relationship to neural population activity at various spatial scales (MU, LFP, iEEG) during interictal, preictal and ictal stages may provide the basis for novel and more effective therapies for people with epilepsy and would have profound implications for therapeutic approaches based on neuromodulation (closed-loop prediction/control)

  The long term goal of this component of my research is thus to advance the understanding of the multi-scale neurophysiology of human epilepsy and provide the foundation for new therapies and new approaches to seizure prevention based on closed-loop neuromodulation. In collaboration with Dr. Sydney Cash at Massachusetts General Hospital - Harvard Medical School and as part of the PI research team at Rhode Island Hospital, I am extending the application of the modeling framework developed in **[1,12,15]** to brain monitoring, prediction, neuromodulation and control in different neurological disorders. In particular, I am studying continuous recordings (24hrs/day, ~ 1 week) from 10X10 microelectrode arrays cortically implanted in patients with epilepsy during pre-resection surgery recordings. Preliminary results on the evolution of neuronal synchrony, pre-ictal to ictal state transitions and seizure prediction appeared in **[2]**, and on the relationship between interictal discharges and single neuron activity in **[9]**. The first step is to develop phenomenological models of network dynamics underlying epileptiform activity and to formulate general dynamical system principles for how neural activity transitions into seizures, or, on the other hand, for how seizures self-terminate **[30]**. At a later stage, the goal is to develop more biophysically detailed models of the phenomena. I am the PI of an NIH-R01 research grant that focuses on the modeling of interictal and ictal dynamics. This R01 plans for the acquisition of data from 15 new patients. In parallel, I am also developing a computational framework for predicting impending focal seizures well in advance such that a closed-loop control system could then be used to prevent seizure occurrence. I am the PI of a recently submitted VA Merit Review Award, which focuses on the development of a seizure prediction framework based on these multi-scale data.

D. Publications (1,362 total citations in Google Scholar/Harzing's PP; H-index: 13)

1. **Truccolo**, W., Hochberg, L.R., Donoghue, J.P. (2010). **Collective Dynamics in Human and Monkey Sensorimotor Cortex: Predicting Single Neuron Spikes**. *Nature Neuroscience*, 13(1): 105-111.
   Highlighted in Nat Rev Neurosci 11(2), 2010; and in *Neurosurgery 66(6), 2010.*
   53 citations in the Google Scholar Citation Index.
2. **Truccolo** W, Donoghue JA, Hochberg LR, Eskandar EN, Madsen JR, Anderson WS, Brown EN, Halgren E, Cash SS. (2011) **Single-Neuron Dynamics in Human Focal Epilepsy**. *Nature Neuroscience,* 14(5): 635 - 641*.*
   Highlighted in Nature Neuroscience 14(5, News & Views, and in Nature Reviews Neurology.
3. **Truccolo**, W. (2010) **Stochastic models for multivariate neural point processes: Collective dynamics and neural decoding**. In Analysis of parallel spike trains (Eds. Grün, S. & Rotter, S.). Springer, New York.
4. Bansal AK, **Truccolo** W, Vargas-Irwin CE, Donoghue JP (2012) **Decoding 3-D reach and grasp from hybrid signals in motor and premotor cortices: spikes, multiunit activity and local field potentials.** *J Neurophysiology* 107: 1337 – 1355.
   "*Editor's Choice" in J Neurophys.*
5. Bansal AK, Vargas-Irwin CE, **Truccolo** W, Donoghue JP (2011) **Relationships among low-frequency local field potentials, spiking activity, and 3-D reach and grasp kinematics in primary motor and ventral premotor cortices.** *J Neurophysiol*ogy 105: 1603 – 1619.
   Selected for Neuro Forum: Witte, J Neurophys, 2011.
6. Malik W, **Truccolo** W, Brown EN, Hochberg LR (2011) **Efficient Decoding with Steady-State Kalman Filter in Neural Interface Systems**. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 19(1): 25-34.
7. Zhuang, J., **Truccolo***, W., Vargas-Irwin, C., Donoghue, J.P. (2010). **Decoding 3-D reach and Grasp Kinematics from High-Frequency Local Field Potentials in Primate Primary Motor Cortex**. *IEEE Transactions on Biomedical Engineering*, 57(7): 1774-1784. *[*Corresponding author.]*
8. Zhuang, J., **Truccolo**, W., Vargas-Irwin, C., Donoghue, J.P. (2010). **Reconstructing Grasping Motions from High-Frequency Local Field Potentials in Primary Motor Cortex**. *IEEE-EMBS Proceedings*: 4347-4350.
9. Keller, C. J., **Truccolo**, W., Gale, J.T., Eskandar, E., Thesen, T., Carlson, C., Devinsky, O., Kuzniecky, R., Doyle, W., Madsen, J.R., Schomer, D., Mehta, A., Brown, E.N., Hochberg, L.R., Ulbert, I., Halgren, E., Cash, S.S. (2010). **Heterogeneous Neuronal Firing Patterns During Interictal Epileptiform Discharges in the Human Cortex.** *Brain*, 133: 1668-1681.
10. **Truccolo**, W., Friehs, G.M., Donoghue, J.P., Hochberg, L.R. (2008). **Primary Motor Cortex Tuning to Intended Movement Kinematics in Humans with Tetraplegia**. *Journal of Neuroscience,* 28 (5): 1163-1178.
    *Selected in both the Faculty of **1000-Biology** and **F1000-Medicine**.*
    95 citations in the Google Scholar Citation index.
11. Nalatore, H., **Truccolo**, W., Rangarajan, G. (2007) **Fast Robust Pattern Classification Algorithms for Real Time Neuro-Motor Prosthesis Applications**. *Journal of the Indian Institute of Science,* 87 (4): 497-509.

12. **Truccolo**, W. & Donoghue, J.P. (2007). **Non-Parametric Modeling of Neural Point Processes via Stochastic Gradient Boosting Regression**. *Neural Computation*, 19(3): 672-705.

13. Chen, Y., Bressler, S.L., Knuth, K.H., **Truccolo**, W., Ding, M. (2006). **Stochastic Modeling of Neurobiological Time Series: Power, Coherence, Granger Causality, and Separation of Evoked Responses from Ongoing Activity**. Special Edition on Stochastic Dynamics of Neural and Genetic Networks, Andre Longtin (Ed.). *Chaos,* 16, 026113 1-8.
This paper was also selected to appear in the Virtual Journal of Biological Physics Research, 12 (1).

14. Knuth, K.H., Shah, A., **Truccolo**, W., Ding, M., Bressler, S.L., Schroeder, C.E. (2006). **Differentially Variable Component Analysis (dVCA): Identifying Multiple Evoked Components using Trial-to-Trial Variability**. *Journal of Neurophysiology*, 95, 3257-3276.

15. **Truccolo**, W., Eden, U.T., Fellows, M.R., Donoghue, J.P., Brown, E.N. (2005). **A Point Process Framework for Relating Neural Spiking Activity to Spiking History, Neural Ensemble and Extrinsic Covariate Effects**. *J. Neurophysiology*, 93, 1074-1089.
318 citations in the Google Scholar Citation Index.

16. Eden, U.T., **Truccolo**, W., Fellows, M.R., Donoghue, J.P., & Brown, E.N. (2004). **Reconstruction of Hand Movement Trajectories from a Dynamic Ensemble of Spiking Motor Cortical Neurons**. *Proceedings of the 26th Annual International Conference of the IEEE EMBS*, San Francisco, CA.

17. Albo, Z., Viana di Prisco, G. Chen, Y., Rangarajan, G., **Truccolo**, W., Feng, J., Vertes, R.P., Ding, M. (2004). **Is Partial Coherence a Viable Technique for Identifying Generators of Neural Oscillations?** *Biological Cybernetics*, 90, 318-326.

18. **Truccolo**, W., Knuth, K.H., Shah, A., Schroeder, C., Bressler, S.L., Ding, M. (2003). **Estimation of Single-Trial Multi-Component ERPs: differentially Variable Component Analysis (dVCA)**. *Biological Cybernetics*, 89, 426-438.

19. **Truccolo**, W.A., Rangarajan, G., Chen, Y., Ding, M. (2003). **Analyzing Stability of Equilibrium Points in Neural Networks: a General Approach**. *Neural Networks*, 16(10), 1453-1460.

20. **Truccolo**, W.A., Ding, M., Knuth, K.H., Bressler, S.L. (2002). **Trial-to-Trial Variability of Cortical Evoked Responses: Implications for the Analysis of Functional Connectivity**. *Clinical Neurophysiology*, 113, 206–226.
125 citations in the Google Scholar Citation index.

21. **Truccolo**, W.A., Knuth, K.H., Bressler, S.L., Ding, M. (2002). **Bayesian Analysis of Single Trial Cortical Event-Related Components**. In Robert L. Fry (Ed.), Maximum Entropy and Bayesian Methods in Science and Engineering. *AIP Conference Proceedings*, 617, 64-73. Melville, NY: American Institute of Physics.

22. Liang, H., Bressler, S.L., Ding, M., **Truccolo**, W.A., Nakamura, R. (2002)**. Synchronized Activity in Prefrontal Cortex during Anticipation of Visuomotor Processing**. *Neuroreport,* 13(16), 2011-2015.

23. **Truccolo**, W.A. & Dong, D.W. (2001). **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *Neurocomputing*, 38-40, 993-1001.

24. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2001)**. Variability and Interdependence of Local Field Potentials: Effects of Gain Modulation and Nonstationarity**. *Neurocomputing*, 38-40, 983-992.

25. Kaminski, M., Ding, M., **Truccolo**, W.A., Bressler, S.L. (2001). **Evaluating Causal Relations in Neural Systems: Granger Causality, Direct Transfer Function (DTF) and Statistical Assessment of Significance**. *Biological Cybernetics*, 85, 145-157.
396 citations in the Google Scholar Citation index.

26. Knuth, K.H., **Truccolo**, W.A., Bressler, S.L., Ding, M. (2001). **Separation of multiple evoked responses using differential amplitude and latency variability**. In Sejnowski, T.J. (Ed.), *Proceedings of the 3rd International Conference on Independent Component Analysis and Blind Signal Separation*, December, 2001, San Diego, California, USA.

27. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **Stability Constraints for Oscillatory Neural Networks**. *Neurocomputing*, 32-33, 585-589.

28. **Truccolo**, W. & Dong, D.W. (2000). **Dynamic Temporal Decorrelation: Information Theoretic and Biophysical Model of the Functional Role of the Lateral Geniculate Nucleus (LGN)**. *Investigative Ophthalmology & Visual Science*, 41 (4): 259B259, Suppl. S MAR 15 2000.

29. **Truccolo**, W.A., Ding, M., Bressler, S.L. (2000). **Dynamical Analysis of an Oscillatory Cortical Neural Network**. In Amari et al. (Eds). *Neural Networks*. IJCNN 2000, Proceedings of the IEEE-INNS-ENNS International Joint Conference, Volume: 6, 24-27, pp. 434 – 439.

30. Kramer M, **Truccolo** W, et al.(*under review*) **Crossing the Brain's Tipping Point: Spontaneous Seizure Termination Across Spatial Scales.**

WILSON TRUCCOLO, PH.D.

TEACHING STATEMENT

Teaching Philosophy

My general teaching philosophy is to first develop students' intuitions about concepts, theory and methods and to follow this with exposition that promotes a more formal and rigorous understanding. The assignment of regular homeworks is fundamental, which include (a) computer simulations of neuronal/network models of various complexity, (b) development of data-driven models and simulations, and (c) exercises involving formal derivations, to further develop students' analytical skills and expertise. In terms of exposition of theoretical topics, often a review (and sometimes an introduction) of the underlying mathematical concepts and ideas is necessary to make the topics accessible to students with different backgrounds. Also, students taking courses in Computational Neuroscience typically fall into two groups: those whose goal is to obtain a good, broad introduction to the field but whose research will not necessarily require a deeper level of expertise, and those whose research has an essential component in Computational Neuroscience. An approach to address the needs of these two different groups is to provide, for example, homeworks/exams/projects with two different levels: a basic level to be satisfied by all students, and a more advanced level for students who need more in-depth understanding and skills. In order to ensure that students have essential skills for moving forward, it is also important to familiarize them with the use of high-performance computing clusters and elementary parallel/distributed computation. Distributed computation is becoming a common tool for model simulations and statistical analyses.

Teaching Interests

The following are examples of 1-2 semester courses that my background and research have prepared me to teach:

- **Theoretical/Computational Neuroscience**:
  One semester course at the introductory level for undergraduate and/or graduate students based for example on a primary textbook such as Theoretical Neuroscience (Dayan & Abbott), and complemented with specific topics from Methods in Neuronal Modeling: from Ion Channels to Networks (Koch & Segev), Mathematical Foundations of Neuroscience (Ermentrout & Terman), Computational Modeling Methods for Neuroscientists (De Schutter et al.), Spikes (Rieke et al.), and more recent research from published articles. A more advanced course could follow for graduate students.
- **Modeling & Statistical Analysis of Neural Data**:
  This course would target students and researchers working with analysis and modeling of single neuron and ensemble recordings, local field potentials, EEG and MEG, fMRI, and other imaging data. Beyond undergraduate and Ph.D. students in the Department of Neuroscience, this course should also be of interest to students in other departments working on neural data, such as the Department of Cognitive, Linguistic and Psychological Sciences or departments in the Brown Medical School (Psychiatry, Neurosurgery). Undergraduate and graduate students from Statistics, Computer Science and Applied Math could also benefit from this course. This course could eventually expand into a second semester focused on more advanced topics.
- **Systems Neuroscience**
- **Introduction to Neuroscience**

Teaching Experience

My teaching experience during my doctoral and postdoctoral training, and current Faculty position has involved three components: (a) formal teaching of undergraduate/graduate courses, (b) coordination of regular graduate seminars and (c) both formal and informal student supervision.

More specifically:

1. **Undergraduate/Graduate School Courses**:

- **Multivariate Signal Processing** (FAU): 2 semesters, taught by advisor Dr. Ding. My teaching responsibilities in the first two courses involved providing recitation sections, occasional lectures, and grading for classes of about 15 graduate students.
- **Computational Neuroscience** (FAU): 2 semesters, taught by Dr. Dawei Dong, a graduate from Dr. John Hopfield's lab (Caltech), based on the same lectures/homeworks as the Caltech course. My teaching responsibilities in the first two courses involved providing recitation sections, occasional lectures, and grading for classes of about 15 graduate students.
- **NEUR 1930F Brain Interfaces for Humans** (Brown University, guest lecturer)

2. **Seminars**: 2004 – 2008. I coordinated a weekly seminar on "Dynamics and Computation in Sensorimotor Cortical Networks". The participants in this seminar included graduate students, postdocs and faculty.

3. **Student Supervision**: one of my responsibilities has been to supervise research projects of students in the Donoghue Lab:

- 2002 – 2005: Project supervision for Dr. Matthew Fellows, graduate student (currently a postdoctoral associate in the Department of Physiology at UCSF).
- 2002 – 2003: Project supervision for Maryam Saleh, undergraduate student (currently a postdoctoral researcher at the University of Chicago).
- 2006 – 2009: Project supervision for Ammar Shaikhouni, M.D./Ph.D. graduate student (currently completing medical residency).
- 2008 – 2010: Project supervision for Arjun Bansal, graduate student (currently a postdoctoral researcher at Harvard).
- 2009 – 2010: Co-advisor for Jun Zhuang, a visiting graduate from Shanghai Jiao Tong University, Department of Biomedical Engineering. Ph.D. Thesis defended in Aug 2010.
- 2010: Project supervision for Adrian Bondy, NIH-Brown rotating graduate student.
- 2011 – present: Fabien Wagner, Ph.D. thesis committee member; project co-supervisor.
- 2011 – present: Jessica Feldman, Ph.D. thesis committee member; project co-supervisor.
- 2011 – present: Michael Rule, Ph.D. thesis advisor. (NSF Graduate Research Fellowship Program Award.)

In addition, over the years, I have also provided and continue to provide informal mentorship/consultation in Computational Neuroscience and Statistics to many other students and postdocs across various labs in the Department of Neuroscience, and across other departments at Brown (e.g. students working on Neuroscience related research topics in Computer Science, Engineering and Applied Math.)