Curriculum Vitae

Mengsen Zhang

Brain Dynamics Lab
Department of Psychiatry and Behavioral Sciences
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Education

2013-2018 **Ph.D.** in Complex Systems and Brain Sciences, Florida Atlantic University
2013 Complex System Summer School, Santa Fe Institute
2011-2012 **M.S.** in Criminology, University of Pennsylvania
2007-2011 **B.S.** in Psychology, Peking University
B.S. in Pharmaceutical Sciences, Peking University

Research Experience

2019- **Postdoctoral Scholar**, Brain Dynamics Lab, Department of Psychiatry and Behavioral Sciences, Stanford University.
Supervisor: Dr. Manish Saggar
Project: develop new computational methods for characterizing complex neural dynamics using topological data analyses, by both theoretical and empirical means, with applications to psychiatric disorders.

2013-2018 **Doctoral Research**, the Human Brain and Behavior Laboratory, Center for Complex Systems and Brain Sciences, Florida Atlantic University
Mentors: Drs. Emmanuelle Tognoli and J.A. Scott Kelso.
Dissertation: The Coordination Dynamics of Multiple Agents (**Zhang, 2018**).
Projects:
Experimental: (1) I designed a new experimental paradigm to observe and manipulate coordinative behavior in ensembles of eight people (agents) and identified in a subsequent experiment the forms of coordination at dyadic, group, and ensemble levels of description (**Zhang et. al, 2018**); (2) I studied human emotional responses during social coordination with a Virtual Partner (behavior driven by a mathematical model of human social coordination, based on the "Human Dynamic Clamp" paradigm; **Zhang et. al, 2016; Dumas et al 2018**); (3) I currently study neural dynamics (EEG and fMRI) during human social coordination with a Virtual Partner whose coupling strength towards human was parametrically manipulated (**Stefanescu et al, SfN 2018; Zhang et al., *work in progress***).
Theoretical Physics: (1) I developed a scalable model of nonlinearly coupled oscillators for multiagent rhythmic coordination, which successfully captured key observations of eight-person coordination in the human experiment from (**Zhang et al, 2018**) at multiple levels of description and reconciled well-studied, empirically validated models of small- and large-scale coordination (**Zhang et al, *2019*;** also Chapter 3 of **Zhang, 2018**); (2) built a preliminary theoretical framework for the classification of micro spatiotemporal patterns generated by coupled oscillators based on their topological complexity (Section 3.2.6 and Chapter 5 of **Zhang, 2018; Zhang et al, *in prep*[a]**).
Applied Mathematics: (1) developed a new data-analytic tool for detecting transitions between complex coordination patterns generated by multiple interacting agents, based on computational algebraic topology (Chapter 4, **Zhang, 2018; Zhang et al, *in prep*[b]**); (2) studied static and dynamic pattern formation of reaction-diffusion systems (Schnakenberg, Gierer-Meinhardt Kinetics, and Brusselators) on growing and irregular domains with Finite Element Method. (3) studied rigorous computation (computer assisted proof) of stable/unstable manifolds of nonlinear ODEs (Aizawa attractor).
Engineering: (1) designed and built an apparatus for real time study of 8-agent coordination dynamics (**Zhang et. al, 2018**): hardware engineering of touch sensors, integrated circuits; and software engineering of a microcontroller-PC signal processing pipeline. (2) developed GPU programs (written in CUDA C++, interfacing with MATLAB) to simulate multiagent social coordination in parallel, achieved ~1000 times faster computation (generating ~1 Terabyte simulated data per hour) than MATLAB built-in ODE solvers (**Zhang et al, *2019***; Chapter 3 of **Zhang, 2018**); developed GPU programs for Continuous Wavelet Transform, outperform MATLAB built-in function ~100 times.

2013-2014 **Research Project**, Complex System Summer School, Santa Fe Institute
Collaborators: Bruno Pace and Dr. Tom Carter
Project: Simulation of Evolutionary Dynamics and Fitness Landscapes.

2013 **Research Project**, Complex System Summer School, Santa Fe Institute
Collaborators: D. Massad, E. Omodei, C. Strohecker, Dr. Y. Xu, J. Garland and Dr. L. F. Seoane
Project: Unfolding History: Classification and analysis of written history as a complex system, using Wikipedia editing data of networks of historical events.

2012-2013 **Research Coordinator**, Center for functional Neuroimaging (CfN), University of Pennsylvania
Supervisor: Dr. Hengyi Rao, Dr. John Detre
Projects: *f*MRI correlates of individual differences in risk taking in healthy controls and patients with cocaine addiction; *f*MRI correlates of risk taking in smokers before and after smoking abstinence.

2012 **Masters Research**, Department of Criminology, University of Pennsylvania
Supervisor: Dr. John Roman
Project: The role of internet in shaping traditional crime with data from Federal Uniform Crime Report.

2011-2012 **Research Assistant**, Jerry Lee Center of Criminology, University of Pennsylvania
Supervisor: Dr. Adrian Raine
Project: Health, Brains and Behavior Study: the etiology and treatment of conduct disorder, aggression, and psychopathy in 11-12 year old children from the community in Philadelphia.

2010-2011 **Bachelor Thesis**, Dept. of Clinical Pharmacology, Peking University
Supervisor: Yiheng Yang, Associate Chief Pharmacist
Project: A meta-analysis of 59 clinical studies on Ginkgo Biloba leaves injection's effect on Coronary Heart Disease in Chinese population.

2010-2011 **Research Assistant**, Behavior and Neuroeconomics Lab, Peking University
Supervisor: Dr. Xiaolin Zhou
Project: The impact of social comparison on economic decision-making in different fairness contexts.

2010-2011 **Research Assistant**, Neuroscience Research Institute, Peking University
Supervisor: Dr. Cai-Lian Cui
Project: Study on the neurobiological basis of opioid addiction in animal models.

2008-2011 **Research Assistant**, Department of Psychology, Peking University
Supervisor: Dr. Liqing Zhang
Projects: Self-Esteem and Social Decision-Making; A Meta-Analysis Study of Self-Esteem and Its Psychological Correlates in Chinese Population.

Current Collaborators

Drs. Emmanuelle Tognoli and J. A. Scott Kelso
Complex Systems and Brain Sciences, Florida Atlantic University, USA

Dr. Christopher Beetle
Physics, Florida Atlantic University, USA

Dr. William D. Kalies
Mathematics, Florida Atlantic University, USA

Dr. Guillaume Dumas
Human Genetics and Cognitive Functions, Institut Pasteur, France

Dr. Fernando Rosas
Complexity Science, Mathematics, Imperial College London, UK

Publications

Zhang, M., Beetle, C., Kelso, J., Tognoli, E. (*2019*). **Connecting empirical phenomena and theoretical models of biological coordination across scales**. Journal of The Royal Society Interface 16(157), 20190360. https://dx.doi.org/10.1098/rsif.2019.0360

Mengsen Zhang (*2018*). ***The Coordination Dynamics of Multiple Agents*** (Doctoral dissertation, Florida Atlantic University). http://search.proquest.com/openview/7c645c22059c7794c84bb4c4f730524d/1?pq-origsite=gscholar&cbl=18750&diss=y

Mengsen Zhang, J. A. Scott Kelso, Emmanuelle Tognoli (*2018*). **Critical diversity: Divided or united states of social coordination.** PLOS ONE 13(4): e0193843. https://doi.org/10.1371/journal.pone.0193843

Emmanuelle Tognoli, Mengsen Zhang, and J. A. Scott Kelso (*2018*). **On the Nature of Coordination in Nature**. *Advances in Cognitive Neurodynamics VI* (Ed. JM Delgado-Garcia). https://doi.org/10.1007/978-981-10-8854-4_48

Guillaume Dumas, Aline Lefebvre, Mengsen Zhang, Emmanuelle Tognoli, and J.A. Scott Kelso (2018). **The Human Dynamic Clamp: a probe for Coordination across Neural, Behavioral, and Social Scales**. In: Müller S., Plath P., Radons G., Fuchs A. (eds). *Complexity and Synergetics* (Springer, Cham). https://doi.org/10.1007/978-3-319-64334-2_24

Mengsen Zhang, Guillaume Dumas, J. A. Scott Kelso, and Emmanuelle Tognoli. (2016). **Enhanced emotional responses during social coordination with a virtual partner**. *International Journal of Psychophysiology*, 104, 33-43. http://dx.doi.org/10.1016/j.ijpsycho.2016.04.001 **[Altmetric, 95th percentile, an index of public interest]**

Mengsen Zhang, Craig Nordham, and J. A. Scott Kelso (2015). **Deterministic versus probabilistic causality in the brain: to cut or not to cut**. *Physics of Life Review*, 15: 136-138. http://dx.doi.org/10.1016/j.plrev.2015.10.002

In Preparation

Mengsen Zhang, J. A. Scott Kelso, and Emmanuelle Tognoli (*work in progress*). **Dynamics of EEG neuromarkers during competitive coordination between humans and a Virtual Partner.**

Mengsen Zhang, J. A. Scott Kelso, and Emmanuelle Tognoli (*in prep*[a]). **Simple oscillators produce complex and ordered sequences without synchronization.**

Mengsen Zhang, William D. Kalies, J. A. Scott Kelso, and Emmanuelle Tognoli (*in prep*[b]). **Multiscale topological portraits of collective dynamics**.

Roxana A. Stefanescu, Mengsen Zhang, Armin Fuchs, Fred. L. Steinberg, Emmanuelle Tognoli, J.A. Scott Kelso (*in prep*[c]). **From self to other: transactions of agency in social coordination.**

Invited Talks

Mengsen Zhang (2019). **The Coordination Dynamics of Multiple Agents.** (*Invited talk, Stanford Complexity Group, Stanford University, CA*)

Mengsen Zhang (2017). **Identifying pattern changes in human rhythmic movement coordination with persistent homology.** (*Invited talk, Analysis and Applications Seminar, Department of Mathematics, Florida Atlantic University*)

Mengsen Zhang (2016). **Multiagent social coordination dynamics.** *(Invited talk, Department of Psychology, University of Miami, FL)*

Abstracts/Presentations

Mengsen Zhang and Manish Saggar (2019). **The topology of time: Charactering transitions in simulated neural dynamics using topological data analysis**. (*Poster, Society for Neuroscience Annual Meeting, Chicago, IL, October 2019*).

Roxana A. Stefanescu, Mengsen Zhang, Armin Fuchs, Fred. L. Steinberg, Emmanuelle Tognoli, and J. A. Scott Kelso (2018). **Transaction of agency between self and other: an fMRI study of social coordination**. *(Poster, Society for Neuroscience Annual Meeting, San Diego, November 2018)*

Mengsen Zhang, Christopher Beetle, J. A. Scott Kelso, and Emmanuelle Tognoli (2018). **Linking the many and the few: an experimental-theoretical analysis of multiagent coordination**. *(Oral presentation, the Ninth International Conference on Complex Systems, Cambridge, MA, USA, July 2018)*

Pedro A. M. Mediano, Fernando Rosas, and Mengsen Zhang (2018). **Synergistic Synchronisation in Coupled Oscillators**. *(Poster, Conference on Analysis and Modeling of Complex Oscillatory Systems, Barcelona, Spain, March 2018)*

J. A. Scott Kelso, Mengsen Zhang, and Emmanuelle Tognoli (2018). **Coordination laws for couples and collectives: What about the 'in-between'?** (*Society of Experimental Psychologists, Tucson, Arizona, March 1-4, 2018.*)

Mengsen Zhang, J.A. Scott Kelso, and Emmanuelle Tognoli (2017). **Multiagent Social Coordination Dynamics – from Experiment to Model.** *(Poster, Society for Neuroscience Annual Meeting, Washington, DC, 2017)*

Mengsen Zhang, J.A. Scott Kelso, and Emmanuelle Tognoli (2017). **Multiagent Coordination Dynamics: the Human Firefly Experiment.** *(Oral presentation, Conference on Complex Systems, Cancun, Mexico, September 2017)*

Mengsen Zhang, J.A. Scott Kelso, and Emmanuelle Tognoli (2017). **A New Paradigm for Studying Pattern Generation in Multiagent Systems.** *(Poster, Progress in Motor Control XI, Miami, Florida, July 2017)*

Emmanuelle Tognoli, Mengsen Zhang, and J.A. Scott Kelso (2017). **On the nature of Coordination in Nature.** *(Oral presentation, 6th International Conference on Cognitive Neurodynamics, Carmona, Spain, August 1-5, 2017)*

Mengsen Zhang, J.A. Scott Kelso, and Emmanuelle Tognoli (2016). **How social coordination emerges and changes among multiple heterogeneous agents: An experimental 'human firefly' study.** *(Poster, Society for Neuroscience Annual Meeting, San Diego, CA, November 2016)*

Mengsen Zhang, Guillaume Dumas, Emmanuelle Tognoli, J.A. Scott Kelso (2014). **Emotional Response during Human-Virtual Partner Interaction**. *(Poster, Society for Neuroscience 2014, Washington DC)*

Mengsen Zhang (2013). **Simplicity (Synthesizing questions - in search of a simple analogy of complexity)**. *(Oral presentation, Complex System Summer School, Santa Fe Institute, June 2013)*

Bruno Pace, Mengsen Zhang and Tom Carter (2013). **Evolutionary Dynamics**. *(Oral presentation, Complex System Summer School, Santa Fe Institute, June 2013)*

Mengsen Zhang (2012). **Agent-Based Modeling and Its Potential Use in Developing Criminology Theories with Interdisciplinary Evidence**. *(Oral presentation, the 64th Annual Meeting of the American Society of Criminology, Chicago, November 15, 2012.)*

Mengsen Zhang and Adrian Raine (2011). **Psychopathic Personality Enhances Proactive Aggression in East Asian Females But Not Males.** *(Poster, the 63rd Annual Meeting of the American Society of Criminology, Washington, D.C., November 17, 2011)*

Adrian Raine, Mengsen Zhang, Sarah Appelby, and Peter H. Venables (2011). **Early Childhood Risk Factors for Psychopathic Personality in Adulthood: Findings from the Mauritius Child Health Project.** *(Oral presentation, 4th biennial meeting of the Society for the Scientific Study of Psychopathy, Montreal, Canada, May 20, 2011)*

Awards

2016 **FAU Brain Institute Travel Award**
2016 **NSF Travel award**, Society for Social Neuroscience. (ID: 1543122; PI: Dr. Stephanie Cacioppo)
2014 **Graduate Fellowship of Academic Excellence**, Florida Atlantic University.
2014 **1-st Year Graduate Research Award**, College of Science Research Day, Florida Atlantic University.

Professional Membership

2017- Society for Industrial and Applied Mathematics (SIAM)
2014- Society for Neuroscience (SfN)
2011-2013 American Society of Criminology (ASC)

Professional Service

2018-2019 **Vice President**
Society for Industrial and Applied Mathematics, Florida Atlantic University Student Chapter
2017- 2018 **Secretary**
Society for Industrial and Applied Mathematics, Florida Atlantic University Student Chapter

Peer reviewer for journal articles: Cognitive Processing, Cognitive Systems Research, Biological Cybernetics*, International Journal of Psychophysiology*, PLoS*, Physics of Life Reviews*, Psychological Science*, Journal of Neuroscience Research*. (* assisting Dr. J. A. Scott Kelso)

Mentoring

2018 Advisor of graduate student Joshua Childs (Political Sciences, FAU) for his Directed Independent Study on oscillator models of economic inequality.
2015-2017 Advisor of undergraduate research assistant Ananda Chowdhury (Engineering, FAU) on socially-inspired learning in AI.
2015-2016 Advisor of undergraduate research assistant Daniela Herrera (Neuroscience, FAU) on experiments of multiagent social coordination.

Teaching and Other Experience

2016 **Instructor**, Matlab Boot Camp, College of Science, Florida Atlantic University
2013-2016 **Teaching Assistant**, in Psychology, Biological Bases of Behavior, Comparative Animal Behavior. College of Science, Florida Atlantic University
2010-2011 **Internship**, Phase III Clinical Trial Laboratory, Pharmacy Department, Peking University Third Hospital
2009-2010 **Teaching Assistant**, Social Psychology, Instructor: Liqing Zhang, Assistant Professor
2008-2009 **Director of University Radio Station**, Peking University Health Science Center
2007-2008 **Minister of the Student Association of Psychology**, Peking University Health Science Center

Computing Skills

- System: Windows, Mac OS, Linux
- Programming: Matlab, C/C++, CUDA C/C++ (for GPU-CPU heterogeneous computing), Mathematica, Python
- Statistics: Matlab, R, SAS, SPSS, Review Manager, SPM
- Data/Lab: AFNI, Neuroscan, Acqknowledge, Matlab/PsychToolBox, FreeSurfer
- Graphics: Adobe Photoshop and Illustrator
- Others: Arduino (microcontrollers), Eagle (circuit design)