

# Curriculum Vitae

## Mengsen Zhang

Brain Dynamics Lab  
 Department of Psychiatry and Behavioral Sciences  
 Stanford University  
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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, in review**; 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<sup>a</sup>**).

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<sup>b</sup>**); (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, in review**; 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:** fMRI correlates of individual differences in risk taking in healthy controls and patients with cocaine addiction; fMRI 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

<b>Drs. Emmanuelle Tognoli and J. A. Scott Kelso</b>	Complex Systems and Brain Sciences, Florida Atlantic University, USA
<b>Dr. Christopher Beetle</b>	Physics, Florida Atlantic University, USA
<b>Dr. William D. Kalies</b>	Mathematics, Florida Atlantic University, USA
<b>Dr. Guillaume Dumas</b>	Human Genetics and Cognitive Functions, Institut Pasteur, France
<b>Dr. Fernando Rosas</b>	Complexity Science, Mathematics, Imperial College London, UK
<b>Pedro Martinez Mediano</b>	Computational Neurodynamics, Imperial College London, UK

## Publications

Mengsen Zhang, Christopher Beetle, J. A. Scott Kelso, Emmanuelle Tognoli (*In review*). **Connecting empirical phenomena and theoretical models of biological coordination across scales.**  
[arXiv:1812.00423](https://arxiv.org/abs/1812.00423)

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](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](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, 95<sup>th</sup> 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<sup>a</sup>*). **Simple oscillators produce complex and ordered sequences without synchronization.**

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

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

## Invited Talks

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

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, 6<sup>th</sup> 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 64<sup>th</sup> 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 63<sup>rd</sup> 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.

## Selected Public Outreach, Press Coverage

Science Daily – May 17<sup>th</sup>, 2016

'Virtual partner' elicits emotional responses from a human partner in real-time.

<https://www.sciencedaily.com/releases/2016/05/160517094204.htm>

The Stack – May 20<sup>th</sup>, 2016

Virtual partner created for 'emotional' Turing test

<https://thestack.com/world/2016/05/20/virtual-partner-created-for-emotional-turing-test/>

University Press – May 23<sup>rd</sup>, 2016

“Virtual partner” is a technology that can play with your emotions

<http://www.upressonline.com/2016/05/virtual-partner-is-a-technology-that-can-play-with-your-emotions/>

Guokr (a Chinese popular science-technology network) – May 26<sup>th</sup>, 2016

Human-human coordination vs. human-machine coordination: same for emotion? (in Chinese)

<http://www.guokr.com/article/441468/>

## 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- **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, NetLogo, Javascript, Lisp
- 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), INTLAB (interval arithmetic)