Curriculum Vitae

Date Prepared: 15/05/2020
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Education

2002 – 2006	B.Sc.	Automatic Control	Beijing Institute of Technology Beijing, China
2006 – 2008	M.Sc.	Control Theory and Control Engineering	Beijing Institute of Technology Beijing, China
2008 – 2013	Ph.D.	Electrical and Computer Engineering Advisor: Tryphon T. Georgiou	University of Minnesota, Minneapolis, MN

Postdoctoral Training

2013 – 2015	Research Fellow	Medical Image Analysis Advisor: Yogesh Rathi	Harvard Medical School Boston, MA

Faculty Academic Appointments

2015 – 2019	Instructor	Department of Psychiatry	Harvard Medical School Boston, MA
2019 –	Assistant Professor	Department of Psychiatry	Harvard Medical School Boston, MA

Appointments at Hospital/Affiliated Institutions

2015 –	Research Associate	Department of Psychiatry	Brigham and Women's Hospital Boston, MA
2017 –	Assistant in Research	Department of Psychiatry	Massachusetts General Hospital Boston, MA

Professional Societies

2013 –	Institute of Electrical and Electronics Engineers (IEEE)	
	2013 –	Member
2014 –	International Society of Magnetic Resonance in Medicine (ISMRM)	
	2014 – 2017	Trainee Member
	2017 –	Member

2014 –	Medical Image Computing and Computer Assisted Intervention Society (MICCAI)	
	2014 –	Member
	2014	Organizer, SPARC Challenge
	2017-2018	Organizer, CDMRI workshop
	2017	Organizer, harmonisation challenge
	2018	Organizer, MUSHAC challenge

Editorial Activities

Ad Hoc Reviewer

IEEE Transactions on Signal Processing
IEEE Transactions on Automatic Control
IEEE Transactions on Medical Imaging
IEEE Signal Processing Letters
Journal of Biomedical and Health Informatics
Psychometrika
Automatica
Journal of Guidance, Control, and Dynamics
International Conference on Medical Imaging Computing and Computer-Assisted Intervention
IEEE Conference on Decision and Control
American Control Conference
NeuroImage
Frontiers in Neuroscience

Other Editorial Roles

2015–	Frontiers in Neurology and Neuroscience	Review editor
2016–	Frontiers in Physics - Biomedical Physics	Review editor

Honors and Prizes

2002–2006	People's Scholarship	Beijing Institute of Technology Beijing, China
2005	First Award in Beijing Region	National Electronic Design Contest Beijing, China
2011	Student Travel Fellowship	University of Minnesota
2016	ISMRM Trainee Stipend	ISMRM, Singapore
2017	Stanford University Teacher Tribute (for mentoring of a student, Pranav Upadhyayula, who was admitted by Stanford University)	Stanford University

Report of Funded and Unfunded Projects

Current Funded Projects

2018–2020 Multimodal brain-connectivity biomarkers for profiling heterogeneity in early psychosis
NIH/NIMH R21MH116352
Role: PI ($275,000- total direct cost for the funding cycle beginning in Sep. 2018)
The goal of this project is to develop novel techniques for joint analysis of diffusion MRI and resting-state functional MRI and to apply these techniques to study the heterogeneity of brain abnormalities among patients with early psychosis.

2019–2023 Joint structural-and-functional MRI analysis for predicting electroconvulsive therapy response in major depressive disorder
NIH/NIMH K01MH117346
Role: PI ($857,045- total direct cost for funding cycle beginning of Sep. 2019)
The goal of this project is to develop and apply novel multimodal MRI measures to predict treatment efficacy of ECT therapy for major depressive disorder.

Past Funded Projects

2017–2019 Personalized target selection for TMS therapy using functional vs. structural connectivity MRI
NIH/NIMH R21MH115280
Role: PI ($275,000- total direct cost for the funding cycle beginning in Dec. 2017)
The goal of this project is to improve the localization of brain target in transcranial magnetic stimulation (TMS) therapy for major depressive disorder based on subject-specific brain connectivity.

2017–2022 Next generation in-vivo diffusion imaging at submillimeter resolution
NIH/NIMH R01MH116173 (PI: Setsompop, Rathi)
Role: Co-Investigator
The goal of this project is to develop a novel approach to acquire and reconstruct ultra high-resolution diffusion MRI with voxel size smaller than 1 mm.

2017–2020 Patient-specific, effective and rational functional connectivity targeting (PERFECT) for DBS in OCD
NIH/NIMH R01MH111917 (PI: Gougherty, Makris, Rathi)
Role: Co-Investigator
The goal is to use our existing cohort of OCD subjects and to validate target engagement of DBS in OCD.

2017–2022 Novel diffusion MRI in early psychosis.
NIH/NIMH R01MH074794 (PI: Westin)
Role: Co-Investigator
The goal is to provide novel, clinically feasible, and precise diffusion MRI technologies for investigation of the in-vivo human brain's cellular microstructure in early psychosis.

Report of Local Teaching and Training

Teaching of Students in Courses

2008	Linear Control System Undergraduate students	University of Minnesota Teaching Assistant, 2 hr/wk for 15 wks
2009	Linear Control System Lab Undergraduate students	University of Minnesota Lab Instructor, 2 hr/wk for 15 wks
2009	State Space Control System Design Undergraduate students	University of Minnesota Teaching Assistant, 2 hr/wk for 15 wks

Laboratory and Other Supervisory and Training Responsibilities

All the following mentoring activities happened in Psychiatry Neuroimaging Laboratory (PNL)/BWH/HMS.

2015–2017	Mentoring of a visiting post-doctoral fellow from Harbin Engineering University, China	Weekly mentorship
2015–2016	Mentoring of a visiting master student from École Polytechnique Fédérale de Lausanne (EPFL), Switzerland	Weekly mentorship
2015–2018	Mentoring of a research assistant	Weekly mentorship
2016	Mentoring of a student from MIT RSI program (PNL/BWH is a collaborating institute of the MIT RSI program)	Daily for 1 month
2017	Mentoring a student from MIT RSI program	Daily for 1 month
2018	Mentoring a student from MIT RSI program	Daily for 1 month
2018	Mentoring a visiting student from Friedrich-Alexander-University Erlangen-Nuernberg (FAU), Germany	Weekly for two months
2018–2019	Mentoring of a research assistant	Weekly mentorship
2018–2019	Mentoring of two post-doctoral fellow	Weekly mentorship
2018–2019	Mentoring of a visiting Ph.D. student from Huazhong University of Science and Technology, China	Weekly mentorship

Formally Supervised Students/Fellows

All the following mentoring activities happened in Psychiatry Neuroimaging Laboratory (PNL)/BWH/HMS.

2015-2017	*Weining Wu, Ph.D.* Post-doctoral Fellow at PNL/BWH/HMS Mentor on diffusion MRI and ADHD, PNL/BWH/HMS Currently an Assistant Professor at Harbin Engineering University, Harbin, China
2015-2016	*Efe Carabeyli, M.S.* Master student from EPFL, Switzerland Mentor on master's thesis project, diffusion MRI tractography, PNL/BWH/HMS
2015-2018	*Sarina Karmacharya* Research Assistant at PNL/BWH/HMS Mentor on diffusion MRI in neonates with congenital heart disease, PNL/BWH/HMS Currently a Ph.D. student at Ludwig Maximilian University of Munich, Germany
2016	*Pranav Upadhyayula* Visiting student from MIT RSI Program and Illinois Mathematics and Science Academy, IL, USA Advisor - Reliability of personalized brain targeting in TMS, PNL/BWH/HMS Currently an undergraduate student at Stanford University
2017	*Utkarsh Tandon* Visiting student from MIT RSI Program and Cupertino High School, CA, USA Advisor - Machine-learning approach in schizophrenia studies, PNL/BWH/HMS Currently an undergraduate student at Stanford University

2018 *Anika Cheerla*
Visiting student from MIT RSI Program and Monta Vista High School, CA, USA
Advisor - Using deep-learning approach for brain masking, PNL/BWH/HMS
Currently a high-school student at Monta Vista High School, CA

2018 *Sebastian Endt*
Master student from FAU, Germany,
Advisor - Analysis of dMRI data using different magnetic field strengths, PNL/BWH/HMS

2018–2019 *Benjamin Eli Reid*
Research Assistant at PNL/BWH/HMS
Mentor on diffusion MRI in patients with major depressive disorder, PNL/BWH/HMS

2018-2019 *Gabriel Ramos Llorden, Ph.D.*
Post-doctoral Fellow at PNL/BWH/HMS
Mentor on super-resolution diffusion MRI, PNL/BWH/HMS

2018-2019 *Yang Ji, Ph.D.*
Post-doctoral Fellow at PNL/BWH/HMS
Mentor on diffusion MRI pulse sequence development, PNL/BWH/HMS

2018-2019 *Guoping Xu*
Ph.D. student from Huazhong University of Science and Technology, China
Mentor on deep-learning approaches in medical imaging analysis

Local Invited Presentations

2013 *Geometric methods for spectral analysis*
Laboratory of Mathematics in Imaging (LMI) -BWH

2014 *Estimating diffusion propagator using directional radial basis functions*
Laboratory of Mathematics in Imaging (LMI) -BWH

2015 *A compressed-sensing approach for super-resolution of diffusion MRI*
Laboratory of Mathematics in Imaging (LMI) -BWH

2016 *Estimating diffusion propagator using directional radial basis functions*
Laboratory of Mathematics in Imaging (LMI) -BWH

2016 *On the intra-subject variability of resting-state function MRI guided brain target for TMS*
Center for Morphometric Analysis (CMA) -MGH

2017 *Precise Inference and Characterization of Structural Organization (PICASO) of tissue from molecular diffusion*
Laboratory of Mathematics in Imaging (LMI) -BWH

2018 *Frequency-domain Granger causality analysis and its integration with structural connectivity*
Laboratory of Mathematics in Imaging (LMI) -BWH

2018 *Granger causality analysis and joint analysis of structural and functional connectivity*
Morphometric Analysis Center -MGH

2019 *Modeling and interpreting of brain network dynamics*
1st Boston Imaging Workshop, MIT

2019 *Modeling and interpreting of brain network dynamics*
Brainmap Seminar, MGH

Report of National and International Invited Presentations

No presentations below were sponsored by outside entities.

National Presentations

2010 *Separation of system dynamics and line spectra via sparse representation*
IEEE Conference on Decision and Control, Atlanta, GA
2011 *Sparse factor analysis via likelihood and ℓ_1-regularization*
IEEE Conference on Decision and Control, Orlando, FL

International Presentations

2012 *Geometric methods for structured covariance estimation*
American Control Conference, Montréal, Canada
2015 *A compressed-sensing approach for super-resolution of diffusion MRI* (selected oral abstract)
International Society of Magnetic Resonance in Medicine, Toronto, Canada
2017 *Diffusion MRI harmonization challenge*
Workshop on computational diffusion MRI, Québec City, Canada
2018 *Brain network estimation using magnetic resonance imaging*
Sichuan University, Chengdu, China
2018 *Integrated structural and functional connectivity analysis to characterize abnormalities in ADHD* (selected oral abstract)
International Society of Magnetic Resonance in Medicine, Paris, France
2018 *Multi-shell diffusion MRI harmonisation challenge*
Workshop on computational diffusion MRI, Granada, Spain
2019 *Cross-vendor and Cross-protocol harmonisation of multi-shell diffusion MRI data: updated results* (selected oral abstract)
International Society of Magnetic Resonance in Medicine, Montréal, Canada
2019 *Joint RElaxation-Diffusion Imaging Moments (REDIM) to probe tissue microstructure* (selected power-pitch abstract)
International Society of Magnetic Resonance in Medicine, Montréal, Canada
2019 *Joint RElaxation-Diffusion Imaging Moments (REDIM) to probe tissue microstructure*
Workshop on computational diffusion MRI, Shenzhen, China
2019 *Modeling and interpreting of brain network dynamics*
Workshop on Computational Medical Imaging and Artificial Intelligence, Hangzhou, China

Report of Technological and Other Scientific Innovations

Matlab package for implementing the PICASO model in diffusion MRI analysis	This package is able to compute several novel dMRI measures for estimating the microstructure of brain tissue based on our PICASO model. It provides information to understand brain abnormalities in mental disorders.
Matlab package for diffusion MRI analysis using Gaussian basis functions	This package is able to reconstruct dMRI data and provide several quantitative measures on the diffusion propagator of water molecules. It has been used by multiple labs in the US and abroad.
System and method for high resolution diffusion imaging	US Patent Application. 14/940,202, 2017 This technique developed by our research team could significantly improve the spatial resolution of diffusion MRI. My contribution in the work includes developing a computational algorithm that could simultaneously reduce the scan time and increase image resolution.

Report of Scholarship

Peer-reviewed articles published in Journals

1. Jiang X, **Ning L**, Georgiou TT, "Distance and Riemannian metrics for multivariate spectral densities," IEEE Transactions on Automatic Control, 57(7), 1723–1735, 2012.

2. **Ning L**, Jiang X, and Georgiou TT, "On the geometry of covariance matrices," IEEE Signal Processing Letters, 20(8), 787–790, 2013.

3. **Ning L**, Carli FP, Ebtehaj AM, Foufoula-Georgiou E, Georgiou TT, "Coping with model uncertainty in data assimilation using optimal mass transport," Water Resources Research, 50(7), 5717–5830, 2014.

4. **Ning L**, Georgiou TT, Tannenbaum A, "Matrix-valued Monge-Kantorovich optimal mass transport," IEEE Transactions on Automatic Control, 60(2), 373–382, 2015.

5. **Ning L**, Georgiou TT, Tannenbaum A, Boyd S, "Linear models based on noisy data and the Frisch scheme," SIAM Review, 57(2), 167–197, 2015.

6. **Ning L**, Westin C-F, Rathi Y, "Estimating diffusion propagator and its moments using directional radial basis functions," IEEE Transactions on Medical Imaging, 34(9), 1–21, 2015.

7. **Ning L**, Laun F, Gur Y, DiBella EVR , Deslauriers-Gauthier S, Megherbi T, et al., "Sparse Reconstruction Challenge for diffusion MRI: Validation on a physical phantom to determine what acquisition scheme and analysis method to use?," Medical Image Analysis, 26(1), 316–332, 2015.

8. **Ning L**, Setsompop K, Michailovich O, Makris N, Shenton ME, Westin C-F, Rathi Y, "A joint compressed-sensing and super-resolution approach for very high-resolution diffusion imaging," NeuroImage, 125, 386–400, 2016.

9. **Ning L**, Westin C-F, Rathi Y, "Estimation of bounded and unbounded trajectories in diffusion MRI," Frontiers in Neuroscience, 10:129, 2016.

10. Mirzaalian H, **Ning L**, Savadjiev P, Pasternak O, Bouix S, Michailovich O, Kubicki M, Westin C-F, Shenton ME, Rathi Y, "Inter-site and inter-scanner diffusion MRI data harmonization," NeuroImage, 135, 311–323, 2016.

11. **Ning L**, Setsompop K, Westin C-F, Rathi Y, "New insights about time-varying diffusivity and its estimation from diffusion MRI," Magnetic Resonance in Medicine, 78(2), 763–774, 2017.

12. **Ning L**, Özarslan O, Westin C-F, Rathi Y, "Precise Inference and Characterization of Structural Organization (PICASO) of tissue from molecular diffusion," NeuroImage, 146, 452–473, 2017.

13. Liao R, **Ning L**, Chen Z, Rigolo L, Gong S, Pasternak O, et al., "Performance of unscented Kalman filter tractography in edema: Analysis of the two-tensor model," NeuroImage: Clinical, 15, 819–831, 2017.

14. Chen Y, Georgiou TT, **Ning L**, Tannenbaum A, "Matricial Wasserstein-1 distance," IEEE Control Systems Letters, 1, 14–19, 2017.

15. Yamamoto K, Chen Y, **Ning L**, Georgiou TT, Tannenbaum A, "Regularization and interpolation of positive matrices," IEEE Transactions on Automatic Control, 63(4), 1208-1212, 2017.

16. **Ning L**, Rathi Y, "A dynamic regression approach for frequency-domain partial coherence and causality analysis of functional brain networks," IEEE Transactions on Medical Imaging, 37(9), 1957-1969, 2017.

17. Zhang F, Wu W, **Ning L**, McAnulty G, Waber D, Gagoski B, Sarill K, Hamoda HM, Song Y, Cai W, Rathi Y, O'Donnell LJ, "Suprathreshold fiber cluster statistics: leveraging white matter geometry to enhance tractography statistical analysis," NeuroImage, 171, 341-354, 2018.

18. **Ning L**, Nilsson M, Lasič S, Westin, C.-F., Rathi Y, "Cumulant expansions for measuring water exchange using diffusion MRI," Journal of Chemical Physics, 148(7):074109, 2018.

19. **Ning L**, "Smooth interpolation of covariance matrices and brain network estimation," IEEE Transactions on Automatic Control, 64(8), 3184-3193, 2019.

20. Mirzaalian H, **Ning L**, Savadjiev P, Pasternak O, Bouix S, Michailovich O, Karmacharya S, Grant G, Marx CE, Morey RA, Flashman LA, George MS, McAllister TW, Andaluz N, Shutter L, Coimbra R, Zafonte RD, Coleman MJ, Kubicki M, Westin CF, Stein MB, Shenton ME, Rathi Y, "Multi-site harmonization of diffusion MRI data in a registration framework," Brain Imaging Behavior, 12(1), 284-295, 2018.

21. Karayumak SC, Bouix S, **Ning L**, James A, Crow T, Shenton M, Kubicki M, Rathi Y, "Retrospective harmonization of multi-site diffusion MRI data acquired with different acquisition parameters," NeuroImage, 184, 180-200, 2018.

22. **Ning L**, Makris N, Camprodon JA, Rathi Y, "Limits and reproducibility of resting-state functional MRI definition of DLPFC targets for neuromodulation," Brain Stimulation, 12(1), 129-138, 2018.

23. **Ning L**, Nillson M, Lasič S, Westin CF, Rathi, Y, "Cumulant expansions for measuring water exchange using diffusion MRI," Journal of Chemical Physics, 148, 07419, 2018.

24. Tax CM, Grussu F, Kaden E, **Ning L**, Rudrapatna U, John Evans C, St-Jean S, Leemans A, Koppers S, Merhof D, Ghosh A, Tanno R, Alexander DC, Zappalà S, Charron C, Kusmia S, Linden DE, Jones DK, Veraart J, "Cross-scanner and cross-protocol diffusion MRI data harmonisation: A benchmark database and evaluation of algorithms," NeuroImage, 195, 285-299 , 2019.

25. Zhang F, **Ning L**, O'Donnell LJ, Pasternak O, "MK-curve - Characterizing the relation between mean kurtosis and alterations in the diffusion MRI signal," NeuroImage, 196, 68-80, 2019.

26. **Ning L**, "Smooth interpolation of covariance matrices and brain network estimation, Part II," IEEE Transactions on Automatic Control, 65(5), 1901-1910, 2020.

27. **Ning L**, Gagoski B, Szczepankiewicz F, Westin CF, Rathi Y, "Joint RElaxation-Diffusion Imaging Moments (REDIM) to probe neurite microstructure," IEEE Transactions on Medical Imaging, 30(3), 668-677, 2020.

28. Ramos-Llordén G, **Ning L**, Liao C, Mukhometzianov R, Michailovich O, Setsompop K, Rathi Y, "High-fidelity, accelerated whole-brain submillimeter in-vivo diffusion MRI using gSlider-Spherical Ridgelets (gSlider-SR)," Magnetic Resonance in Medicine, in press, 2020.

Peer-reviewed articles published in Conference Proceedings

1. **Ning L**, Georgiou TT, Tannenbaum A, "High resolution analysis via sparsity-inducing techniques: spectral lines in colored noise," *International Symposium on Mathematical Theory of Networks and Systems*, 469-473, Budapest, Hungary, July 2010.

2. **Ning L**, Georgiou TT, Tannenbaum A, "Separation of system dynamics and line spectra via sparse representation," *IEEE Conference on Decision and Control*, 473-178, Atlanta, December 2010.

3. **Ning L**, Georgiou TT, "Sparse factor analysis via likelihood and ℓ_1-regularization," *IEEE Conference on Decision and Control*, 5188-5192, Orlando, December 2011.

4. **Ning L**, Jiang X, Georgiou TT, "Geometric methods for structured covariance estimation," *American Control Conference*, 1877-1882, Montreal, Canada, June 2012.

5. **Ning L**, Jiang X, Georgiou TT, "Metrics for multivariate power spectra," *IEEE Conference on Decision and Control*, 4727-4732, Hawaii, December 2012.

6. **Ning L**, Jiang X, Georgiou TT, "Geometric tools for estimation of structured covariances," *International Symposium on Mathematical Theory of Networks and Systems (MTNS)*, Melbourne, Australia, July 2012.

7. **Ning L**, Georgiou TT, "The Wasserstein metric in factor analysis," *SIAM Conference on Control and Its Applications*, 8-12, San Diego, July 2013.

8. **Ning L**, Georgiou TT, Tannenbaum A, "Matrix-valued Monge Kantorovich optimal mass transport," *IEEE Conference on Decision and Control*, Florence, Italy, December 2013.

9. **Ning L**, Georgiou TT, "Metrics between matrix-valued measures via test functions," *IEEE Conference on Decision and Control*, 2642-2647, Los Angeles, 2014.

10. Karlsson J, **Ning L**, "On robustness of ℓ_1-regularization methods for spectral estimation," *IEEE Conference on Decision and Control*, 1767-1773, Los Angeles, 2014.

11. Rahti Y, **Ning L**, Michailovich O, Liao H, Gagoski B, Grant EP, Shenton ME, Stern R, Westin C-F, Lin A, "Maximum entropy estimation of Glutamate and Glutamine in MR spectroscopic imaging," *International Conference on Medical Image Computing and Computer Assisted Intervetion (MICCAI)*, 749-756, Boston, 2014.

12. **Ning L**, Michailovich O, Westin C-F, Rahti Y, "Diffusion propagator estimation using Gaussians scattered in q-space," *MICCAI 2014 Workshop on Computational Diffusion MRI*, 141-150, 2014.

13. **Ning L**, Setsompop K, Makris N, Michailovich O, Westin C-F, Rahti Y, "A compressed-sensing approach for super-resolution reconstruction of diffusion MRI," *Information Processing in Medical Imaging*, 57-68, Isle of Skye, Scotland, 2015.

14. Karlsson J, **Ning L**, "Super-resolution methods and metric uncertainty via optimal transport," MTNS, 71-74, Minneapolis, USA, 2016.

15. **Ning L**, Sandhu R, Georgiou TT, Tannenbaum A, "Matricial Wasserstein and Unsupervised Tracking," MTNS, 215-218, Minneapolis, USA, 2016.

16. **Ning L**, Rahti Y, "Dynamic Regression for Partial Correlation and Causality Analysis of Functional Brain Networks," MICCAI, 365-372, Qubéc City, Canada, 2017.

Abstracts

1. **Ning L**, Setsompop K, Eichner C, Makris N, Michailovich O, Westin C-F, Rahti Y, "A compressed sensing approach to super-resolution diffusion MRI from multiple low-resolution images," *ISMRM*, Toronto, Canada, 2015.

2. **Ning L**, Setsompop K, Westin C-F, Rahti Y, "New insights about time-varying diusivity and its estimation from diussion MRI," *ISMRM Workshop on Breaking the Barriers of Diffusion MRI*, Lisbon, Portugal, September 2016.

3. **Ning L**, Özarslan E, Westin C-F, Rahti Y, "Precise Inference and Characterization of Structural Organization (PICASO) of tissue from molecular diffusion," *ISMRM Workshop on Breaking the Barriers of Diffusion MRI*, Lisbon, Portugal, September 2016.

4. Nazeri A, **Ning L**, Pipitone J, Rotenberg D, Rahti Y, Voineskos A, "White Matter Microstructural Deficits in Schizophrenia Using Generalized Kurtosis," *ISMRM*, Singapore, 2016.

5. **Ning L**, Westin C-F, Rahti Y, "Precise Inference of Cellular and Axonal Structural Organization (PICASO) using diffusion MRI," *ISMRM*, Singapore, 2016.

6. Mirzaalian H, **Ning L**, Savadjiev P, Pasternak O, Bouix S, Michailovich O, Kubicki M, Westin C-F, Shenton ME, Rahti Y, "Harmonizing Diffusion MRI Data from Multiple Scanners," *ISMRM*, Singapore, 2016.

7. **Ning L**, Setsompop K, Rahti Y, "A combined compressed sensing super-resolution diffusion and gSlider-SMS acquisition/reconstruction for rapid sub-millimeter whole-brain diffusion," *ISMRM*, Singapore, 2016.

8. **Ning L**, Camprodon J, Makris N, Rahti Y, "Is resting-state fMRI guided brain target localization for TMS reliable and reproducible?," *ISMRM*, Hawaii, USA, 2017.

9. **Ning L**, Duval T, Cohen-Adad J, Rathi Y, "Histological Validation of Microstructural Measures Derived from the PICASO Model," *ISMRM*, Hawaii, USA, 2017.

10. Wu W, Hamoda H, **Ning L**, Gagoski B, Sarill K, Grant E, Shenton ME, Waber D, Makris N, McAnulty G, Rathi Y, "Structural Abnormalities in Frontal Lobe Pathways in Children with Attention-Deficit/Hyperactivity Disorder (ADHD)," *ISMRM*, Hawaii, USA, 02017.

11. **Ning L**, Nilsson M, Westin C-F, Rathi Y, "Measuring water exchange using cumulant expansions," *ISMRM*, Paris, France, 2018.

12. **Ning L**, Karmacharya S, Hamoda H, McAnulty G, Waber D, Rathi Y, "Integrated structural and functional connectivity analysis to characterize abnormalities in ADHD," *ISMRM*, Paris, France, 2018.

13. **Ning L**, Gagoski B, Szczepankiewicz F, Westin C-F, Rathi Y, "Joint RElaxation-Diffusion Imaging Moments (REDIM) to probe tissue microstructure," *ISMRM*, Montréal, Canada, 2019.

14. **Ning L**, Szczepankiewicz F, Westin C-F, Rathi Y, "Probing tissue microstructure using fltered q trajectory imaging," *ISMRM*, Montréal, Canada, 2019.

15. **Ning L**, Bonet-Carne E, Grussu F, Sepehrband F, Kaden E, Veraart J, Blumberg SB, Khoo CS, Palombo M, Coll- Font J, Scherrer B, Warfield SK, Karayumak SC, Rathi Y, Koppers S, Weninger L, Ebert J, Merhof D, Moyer D, Pietsch M, Christiaens D, Teixeira R, Tournier J-D, Zhylka A, Pluim J, Parker G, Rudrapatna U, Evans J, Charron C, Jones DK, Tax CWM, "Cross-vendor and Cross-protocol harmonisation of multi-shell diffusion MRI data: updated results," *ISMRM*, Montréal, Canada, 2019.

Editorial

Kaden E, Grussu F, **Ning L**, Tax CMW, Veraart J, Editors, "Computational Diffusion MRI, MICCAI Workshop, Québec, Canada", Springer, 2017.

Bonet-Carne E, Grussu F, **Ning L**, Sepehrband F, Tax CMW, Editors, "Computational Diffusion MRI, MICCAI Workshop, Granada, Spain", Springer, 2018.

Thesis

1. **Ning L**, *Matrix-valued optimal mass transportation and its applications*, University of Minnesota, November, 2013.

Narrative Report

I obtained my doctoral training in signal processing and control theory. In the past five years, I immersed myself in the medical area and gained field knowledge in neuroimaging and neuroscience. My research interest focuses on the application of mathematics, including stochastic process analysis, multivariate time series analysis and machine learning, to solve problems in neuroscience research. I am particularly interested in applying these techniques to improve the acquisition and analysis of magnetic resonance imaging data to improve the analysis of brain structural and functional networks. I have made several contributions in these areas based on my unique skill set and knowledge. Below I list and describe my contributions in further details.

Technical contributions: My interest in neuroimaging began during my post-doctoral fellowship when I was introduced to the field of diffusion MRI (dMRI). dMRI is the unique in-vivo neuroimaging modality that is able to provide information about structural connectivity between brain regions as well as the microscopic organization of cells and axons. It is increasingly used in clinical studies to understand brain abnormalities related to mental disorders. But current dMRI techniques have several limitations, including the low spatial resolution and the lack of specificity of tissue microstructural measures. My work on dMRI has focused on addressing these limitations using novel dMRI acquisition and analysis techniques. In particular, I have developed an approach for acquiring ultra-high-resolution dMRI data by integrating the compressive sensing and super-resolution reconstruction techniques. My approach can simultaneously increase image resolution and reduce scan time, to make it feasible to be used in clinical settings. It is able to improve the image resolution by a factor of 8 so that several important brain structures, such as gray-matter layers, can now be observed. Regarding dMRI microstructural measures, I have developed several novel biophysical models for understanding the origin of dMRI signals. These models take into account spatially and temporally varying diffusivities and can provide specific measures of axonal density, cellular size and membrane permeability. These measures are currently being used to better understand ADHD and schizophrenia.

Given my expertise in dynamic systems and control theory, I have started to focus on novel analysis of resting-state functional MRI (rsfMRI) data to characterize brain functional networks. In this direction, I have developed a mathematical theory for computing the causality measure by applying the optimal prediction theory from time-series analysis. My approach is able to correctly regress out external influences to provide the true intrinsic functional connectivity between brain regions in the frequency range that is relevant to brain activities. This technique is quite general and has been applied to analyze EEG data recently.

I am PI of two NIMH-funded R21 grants. The first grant focuses on using diffusion MRI and rsfMRI techniques to improve the localization of brain target for transcranial magnetic stimulation (TMS) therapy in MDD. I propose a novel approach to define brain stimulation target based on the structural brain connectivity of individual patients. Once validated, this subject-specific approach could significantly improve the efficacy of TMS therapy for patients with MDD. The goal of the second grant is to develop novel techniques for joint analysis of diffusion MRI and rsfMRI and to apply these techniques to better understand brain abnormalities in early psychosis. My approach provides a biologically meaningful solution to integrate the analysis of structural and functional MRI data by using suitable structural constraint on the information flow in functional brain networks. It could characterize abnormal brain networks related to different types of early psychosis.

I am also a major contributor to three funded R01 grants. My work in these grants focuses

on: 1) increasing spatial resolution of diffusion MRI and apply it to a study on attention deficit hyperactivity disorder (ADHD) subjects, 2) validating target engagement of deep brain stimulation for obsessive-compulsive disorder (OCD), 3) developing novel multi-dimensional imaging techniques for investigation of brain abnormalities in early psychosis.

In future work, I will continue developing and applying new neuroimaging analysis techniques to provide data-driven understanding of subtypes of mental disorders. I have a pending K01 award to start in August 2019, where the goal is to investigate target engagement for electroconvulsive therapy (ECT) in MDD. The image analysis techniques that I am developing are important tools to achieve these goals. Moreover, I will explore applications of these neuroimaging techniques in study of other brain disorders such as epilepsy, OCD and brain tumor categorization.

Teaching: I routinely mentor post-doctoral fellows, research assistants, and visiting students on novel techniques in MRI analysis. I was awarded the Stanford University Teacher Tribute in recognition of my teaching and mentoring work. I am also involved in organizing workshops on computational diffusion MRI in collaboration with researchers of international repute. Additionally, I have also organized two academic challenges where several research groups from around the world were invited to compare the performance of different dMRI analysis techniques and multi-site data harmonization methods. Moreover, I have been actively involved in peer-reviewing for major scientific journals, including NeuroImage and IEEE transactions on medical imaging.

Summary: My research interest lies at the interface of neuroscience and computer science. My goal is to develop and apply computational techniques and mathematical theories that are able to improve our understanding of mental disorders. Further, developing computational tools that allow for pushing the frontiers of technology, both for understanding the brain structure as well as guiding and monitoring clinical interventions, is my key focus to inform clinical decision-making.