RICHARD F. BETZEL – CURRICULUM VITAE

RESEARCH INTERESTS

My research program focuses on characterizing connectomes – network maps of the anatomical and functional connections between neural elements – and the relationship of these features to large-scale brain dynamics as well as human behavior, disease, and cognition. A major component of this research involves complex network models and analysis using a diverse set of mathematical tools that includes elements of graph theory, information theory, and dynamical systems theory.

CONTACT

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EDUCATION

2015-Pres	Postdoctoral Researcher at University of Pennsylvania, Philadelphia, PA Postdoctoral Advisor: Prof. Danielle S. Bassett
2012-2015	Dual Ph.D. in Psychological and Brain Sciences (Cognitive Neuroscience concentration) and Program in Cognitive Science at Indiana University, Bloomington, IN Dissertation: Age-related changes in human anatomical and functional brain networks. Research Advisor: Prof. Olaf Sporns
2008-2010	Master of Science in Human Biomechanics at Indiana University, Bloomington, IN Research Advisor: Prof. Jesus Dapena
2003-2007	Bachelor of Arts in Physics at Oberlin College, Oberlin, OH

HONORS AND AWARDS

2017	OHBM Merit Abstract Award
2017	NIH Early Independence Award Finalist
2016	Saltzman Award for Outstanding Recent PhD Graduate (IU PBS)
2016	Outstanding Dissertation Award (IU Prog. Cog. Sci.)
2016	OHBM Merit Abstract Award
2015	Regeneron Prize Nominee (University Pennsylvania, SEAS)
2015	J.R. Kantor Graduate Award (IU PBS)
2015	IGERT Poster Showcase voted 3rd Place (“Generative Models of Human Connectome”)
2015	IGERT Travel Award to NetSci2015, Zaragoza, Spain
2014	Departmental Commendation on Qualifying Examination (June 24, 2014).
2014	IGERT Travel Award to Annual Meeting of OHBM, Honolulu, HA
2014	IGERT Travel Award to Annual Meeting of SfN, Washington, DC
2013	IGERT Travel Award to Cambridge University, Cambridge, UK
2012-2015	National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT) in “The Dynamics of Brain-Body-Environment Systems”
2009-2010	Cooper Scholarship
2008-2009	HPER Fellowship

PROFESSIONAL MEMBERSHIP

2015- Pres	Network Science Society
2014- Pres	Organization for Human Brain Mapping
2011- Pres	The Society for Neuroscience

EDITORIAL BOARD

2017	NetSci2017 Program Committee
2017 - Pres	Member, Editorial Board, “Neuroimage”
2018	NetSci2018 Program Committee

INTERNSHIPS

7/2013-8/2013	Cambridge University, Cambridge UK. Supervised by Prof. Edward Bullmore

SOFTWARE

Brain Connectivity Toolbox – Contributor (https://sites.google.com/site/bctnet/)

AD HOC REVIEWER

For reviewing details, see: https://publons.com/author/1199140/richard-betzel#profile

Brain and Behavior, Brain Connectivity, Brain Structure and Function, Chaos, eLife, Experimental Brain Research, Frontiers in Neuroscience, GigaScience, Human Brain Mapping, The Journal of Complex Networks, The Journal of Neuroscience, IEEE Journal of Selected Topics in Signal Processing, Nature Communications, Neuroimage, Neurology, PLOS Computational Biology, PLOS ONE, Proceedings of the National Academy of Sciences USA, Psychophysiology, Scientific Reports, Biological Psychiatry, Brain Topography, Scientific Data, Cell Reports

TEACHING EXPERIENCE

2016-2016	BE-566 (University of Pennsylvania) Network Neuroscience T.A. (student evaluation of 3.27; 3-4 considered “good” to “excellent”)
2016-2016	BE-566 (University of Pennsylvania) Guest lecture (Topic: Generative models of the human connectome)
2008-2012	HPER-P391 (Indiana University) Biomechanics laboratory sections during Fall, Spring, and Summer sessions

UNDERGRADUATE SUPERVISION

2017-	Vidula Kopli (Penn) – Learning rate is predicted by structure/function coupling: A graph signal processing study.
2016-	Elena Wu-Yan (Penn) – Controllability measures across canonical graph models.
2016-2017	David White (Penn) – Modularity and optimal control.
2016-2017	Aditya Srivatsan (Penn) – Generative models of the human connectome in development.
2016-2017	Kanika Mohan (Penn) – Robust methods for dynamic community detection in neuroimaging data.
2014-2015	Jeffrey Rumschlag (IU/Graduate student at University of California, Riverside)
2014-2015	Jennifer Huang (IU)

GRANTS

Funded

1. Revealing the Impact of Gut Microbiome on Brain Network Dynamics Driving Mood (PennCHOP Microbiome Pilot and Feasibility Grant Program; PI: DS Bassett).

Submitted

2. Connectome engineering: Modeling the development and growth of human anatomical brain networks (NIH Early Independence Award, DP5; PI: **RF Betzel**)
3. Connectome engineering: generative models of large-scale human brain networks (Burroughs Wellcome Fund, Career Awards at the Scientific Interface)

PUBLICATIONS (Citation count = 1308, h-index = 16, i10-index = 22)

Accepted:

1. E Wu-Yan, **RF Betzel**, E Tang, S Gu, F Pasqualetti, DS Bassett (2018). Benchmarking network controllability measures on canonical graph models. *Journal of Nonlinear Science*.

2. YN Kenett, JD Medaglia, RE Beaty, Q Chen, **RF Betzel,** SL Thompson-Schill, J Qiu (2018). Driving the brain towards creativity and intelligence: A network control theory analysis. *Neuropsychologia.*

3. **RF Betzel**, JD Medaglia, DS Bassett (2018). Diversity of meso-scale architecture in human and non-human connectomes. *Nature Communications*.

4. U Braun, A Schaeffer, **RF Betzel**, A Meyer-Lindenberg, H Tost, DS Bassett (2018). From Maps to Mechanisms revisited: Using multi-dimensional network neuroscience to probe brain mechanisms of mental disorders. *Neuron*.

5. **RF Betzel**, DS Bassett (2017). Generative Models for Network Neuroscience: Prospects and Promise. *Journal of the Royal Society: Interface.*

6. A Sizemore, C Giusti, **RF Betzel**, M Cieslak, S Grafton, DS Bassett (2017). Closures and Cavities in the Human Connectome. *Journal of Computational Neuroscience*.

7. M Fukushima, **RF Betzel**, Y He, MA de Reus, MP van den Heuveul, XN Zuo, O Sporns (2017) Structure-function relationships during segregated and integrated network states of human brain functional connectivity. *Brain Structure and Function*.

8. JC Worrell, J Rumschlag, **RF Betzel**, O Sporns, B Mišić (2017). Signal spreading and sensory-motor integration in the *Drosophila* connectome. *Network Neuroscience*.

9. A Khambhati, AE Sizemore, **RF Betzel**, DS Bassett (2017). Modeling and interpreting network dynamics. *Neuroimage*.

10. GL Baum, R Ciric, DR Roalf, **RF Betzel**, TM Moore, RT Shinohara, AE Kahn, M Quarmley, PA Cook, MA Elliott, K Ruparel, RE Gur, RC Gur, DS Bassett TD Satterthwaite (2017). Modular Segregation of Structural Brain Networks Supports the Development of Executive Function in Youth. *Current Biology.*

11. S Gu, **RF Betzel**, M Cieslak, PR Delio, ST Grafton, F Pasqueletti, DS Bassett (2017). Optimal Trajectories of Brain State Transitions. *Neuroimage*.

12. M Fukushima, **RF Betzel**, Y He, MA de Reus, MP van den Heuveul, XN Zuo, O Sporns (2017). Fluctuations between high- and low-modularity topology in time-resolved functional connectivity. *Neuroimage*.

13. **RF Betzel**, TD Satterthwaite, JI Gold, DS Bassett (2017). A positive mood, a flexible brain. *Scientific Reports*.

14. **RF Betzel**, JD Medaglia, L Papadopoulos, G Baum, RE Gur, RC Gur, DR Roalf, TD Satterthwaite, DS Bassett (2017). The modular organization of human anatomical brain networks: Accounting for the cost of wiring. *Network Neuroscience*.

15. **RF Betzel**, DS Bassett (2016). Multi-scale brain networks. *Neuroimage*.

16. H Mohr, U Wolfensteller, **RF Betzel**, B Mišić, O Sporns, J Richiardi, H Ruge (2016). Integration and segregation of large-scale brain networks during short-term task automatization. *Nature Communications*.

17. XN Zuo, Y He, T Xu, CG Yan, **RF Betzel**, S Colcombe, O Sporns, MP Milham (2016). *Trends in Cognitive Science*.

18. MG Mattar*, **RF Betzel***, (* = co-first authors) DS Bassett (2016). The flexible brain (commentary). *Brain*.

19. **RF Betzel**, S Gu, JD Medaglia, F Pasqueletti, DS Bassett (2016). Optimally controlling the human connectome: the role of network topology. *Scientific Reports*.

20. B Mišić, **RF Betzel**, M de Reus, MP van den Heuvel, O Sporns (2016). Multivariate structure-function relationships in human brain networks. *Cerebral Cortex*.

21. **RF Betzel**, M Fukushima, Y He, XN Zuo, O Sporns (2016). Dynamic fluctuations coincide with periods of high and low modularity in resting-state functional brain networks. *Neuroimage*.

22. **RF Betzel**, A Avena-Koenigsberger, J Goñi, Y He, M de Reus, A Griffa, PE Vertes, B Mišić, P Hagmann, JP Thiran, MP van den Heuvel, XN Zuo, ET Bullmore, O Sporns (2016). Generative models of the human connectome. *Neuroimage*.

23. O Sporns, **RF Betzel** (2016). Modular Brain Networks. *Annual Review of Psychology*.

24. B Mišić*, **RF Betzel*** (* = co-first authors), A Nematzadeh, J Goñi, A Griffa, P Hagmann , A Flammini, YY Ahn, O Sporns (2015). Cooperative and competitive spreading on the human connectome. *Neuron*.

25. B Mišić, J Goñi, **RF Betzel**, O Sporns, AR McIntosh (2014). A network convergence zone in the hippocampus. *PLOS Computational Biology*.

26. A Avena-Koenigsberger, J Goñi, **RF Betzel**, MP van den Heuvel, A Griffa, P Hagmann, JP Thiran, O Sporns (2014). Using Pareto optimality to explore the topology and dynamics of the human connectome. *Philosophical Transactions of the Royal Society B: Biological Sciences*.

27. **RF Betzel**, L Byrge, Y He, J Goñi, XN Zuo, O Sporns (2014). Changes in structural and functional connectivity among resting state networks across the human lifespan. *Neuroimage.*

28. J Goñi, MP van den Heuvel, A Avena-Koenigsberger, NV de Mendizabal, **RF Betzel**, A Griffa, P Hagmann, B Corominas-Murtra, JP Thiran, O Sporns (2014). Resting-brain functional connectivity predicted by analytic measures of network communication. *Proceedings of the National Academy of Sciences, USA*.

29. **RF Betzel**, A Griffa, A Avena-Koenigsberger, J Goñi, P Hagmann, JP Thiran, O Sporns (2013). Multi-scale community organization of the human structural connectome and its relationship with resting-state functional connectivity. *Network Science*.

30. J Goñi, A Avena-Koenigsberger, NV de Mendizabal, MP van den Heuvel, **RF Betzel**, O Sporns (2013). Exploring the morphospace of communication efficiency. *PLOS ONE*.

31. **RF Betzel**, MA Erickson, M Abell, BF O'Donnell, WP Hetrick, O Sporns (2012). Synchronization dynamics and evidence for a repertoire of network states in resting EEG. *Frontiers in Computational Neuroscience*.

In revision, submitted, or in preparation:

1. **RF Betzel**, JD Medaglia, AE Kahn, J Soffer, DR Schonhaut, DS Bassett (*under review*, *Nature Biomedical Engineering*) Inter-regional ECoG correlations predicted by communication dynamics, geometry, and correlated gene expression. https://arxiv.org/abs/1706.06088.

2. **RF Betzel**, DS Bassett (*under review*). The specificity and robustness of long-distance connections in weighted, inter-areal connectomes.

3. B Mišić, **RF Betzel**, A Griffa, M de Reus, Y He, XN Zuo, MP van den Heuvel, P Hagmann, O Sporns, R Zatorre (*under review, Cerebral Cortex*). Network asymmetry of the human auditory system.

4. **RF Betzel**, B Mišić, Y He, XN Zuo, O Sporns (*in preparation*). Functional modules reconfigure at multiple scales across the human lifespan. arXiv preprint: http://arxiv.org/abs/1510.08045.

5. C Xia, Z Ma, S Gu, **RF Betzel**, ME Calkins, PA Cook, A Garcia de La Garza, TM Moore, DR Roalf, K Ruparel, DH Wolf, RC Gur, RE Gur, C Davatzikos, RT Shinohara, DS Bassett, TD Satterthwaite (*under review*). Discovering linked dimensions of psychopathology and functional connectivity in high-dimensional brain networks

6. GL Baum, R Ciric, C Xia, DR Roalf, **RF Betzel**, TM Moore, RT Shinohara, PA Cook, MA Elliott, K Ruparel, C Davatzikos, RE Gur, RC Gur, DS Bassett, TD Satterthwaite (*in preparation*). Mapping network-level coupling of structural and functional connectivity during adolescence.

PRESS

1. Baum et al. (2017), National Public Radio.
2. Sizemore et al. (2016), MIT Technology review.
3. Mišić et al. (2015), Neuroscience News, Scientific Computing.

POSTERS AND CONFERENCE PROCEEDINGS

1. RF Betzel et al (June 2017). Diversity of connectome mesoscale organization. Annual meeting of Organization of Human Brain Mapping. Vancouver, Canada.

2. RF Betzel et al (June 2017). Inter-regional ECoG correlations predicted by communication dynamics, geometry, and correlated gene expression. Annual meeting of Network Science. Indianapolis, Indiana.

3. RF Betzel et al (October 2016). Optimally controlling the human connectome. Collaborative Research in Computational Neuroscience. Paris, France.

4. RF Betzel et al (November, 2016). Space independent communities in the human connectome. Annual meeting of the Society for Neuroscience. San Diego, CA.

5. A Sizemore et al (November, 2016). Functional role of topological cycles in the human structural connectome. Annual meeting of the Society for Neuroscience. San Diego, CA.

6. S Gu et al (November, 2016). Optimal Trajectories of Brain State Transitions. Annual meeting of the Society for Neuroscience. San Diego, CA.

7. M Fukushima (November, 2016). Optimal Trajectories of Brain State Transitions. Annual meeting of the Society for Neuroscience. San Diego, CA.

8. G Baum (November, 2016). Modular evolution of structural brain networks in adolescence supports executive function. Annual meeting of the Society for Neuroscience. San Diego, CA.

9. RF Betzel et al (June, 2016). Optimally controlling the human connectome. Annual meeting of the Organization for Human Brain Mapping. Geneva, Switzerland.

10. RF Betzel et al (October, 2015). Functional modules reconfigure at multiple scales across the human lifespan. Annual meeting of the Society for Neuroscience. Chicago, IL.

11. B Mišić et al (October, 2015). Multivariate structure-function relationships in human brain networks. Annual meeting of the Society for Neuroscience. Chicago, IL.

12. H Mohr et al (June, 2015). Large-scale integration and segregation of functional brain modules during rapid learning processes. Annual meeting of the Organization for Human Brain Mapping. Honolulu, HA.

13. RF Betzel et al (June, 2015). Generative models of the human connectome. Annual meeting of the Organization for Human Brain Mapping. Honolulu, HA.

14. B Mišić et al (June, 2015). Cooperative and competitive spreading on the human connectome. Annual meeting of the Organization for Human Brain Mapping. Honolulu, HA.

15. RF Betzel et al (October, 2014). Changes in structural and functional connectivity among resting-state networks across the human lifespan. Annual meeting of the Society for Neuroscience. Washington, DC.

16. RF Betzel et al (October, 2013). Multi-scale community organization in the human connectome and its relationship with functional connectivity. Annual meeting of the Society for Neuroscience, San Diego, CA.

17. A Avena-Koenigsberg et al (October, 2013). Using Pareto optimality to explore the topology and dynamics of the human connectome. Annual meeting of the Society for Neuroscience, San Diego, CA.

18. J Goñi et al (October, 2013). Resting brain functional connectivity predicted by analytic measures of network communication. The Indiana Neuroimaging Symposium, Bloomington, IN.

19. RF Betzel et al (May, 2013). Multi-scale community organization in the human connectome and its relationship with functional connectivity. IGERT Research Showcase, Bloomington, IN.

20. A Griffa et al (April, 2013). Group representative partitions of human brain structural networks. Annual meeting of the International Society for Magnetic Resonance in Medicine, Salt Lake City, UT.

21. J Goñi (November, 2012). Predicting resting-state functional connectivity by modeling random-walk processes on structural connectivity. Annual meeting of the Society for Neuroscience, New Orleans, LA.

22. RF Betzel (November, 2011). Recurrent functional network topologies reveal a finite dynamic repertoire in resting-state EEG. Annual meeting of the Society for Neuroscience, Washington, DC.

23. MA Erickson (September, 2011). Functional network organization of schizophrenia and healthy control participants in resting state EEG. Annual meeting for the Society for Research in Psychopathology, Boston, MA.

INVITED TALKS

1. RF Betzel (March 2018). Reconfiguration of functional and structural brain networks over the human lifespan. Imaging: Innovations to Enhance Aging Research. National Institutes of Health. Bethesda, MD.

2. Organization for Human Brain Mapping 2017 – Session on Connectivity Methods (Vancouver, Canada) – Diversity of meso-scale architecture in the human and non-human connectome

3. NetSci 2017 (Indianapolis, IN) (June 21, 2017) – ECoG functional connectivity predicted by communication dynamics, geometry, and correlated gene expression

4. Social Affective Neuroscience Annual Meeting (Los Angeles, CA), (March 18, 2017) – Positive affect, surprise, and fatigue are correlates of network flexibility.

5. SIAM Conference on Computational Science and Engineering (Atlanta, GA), (March 1, 2017) – Multi-layer, Time-varying Brain Networks: Community Structure and Network Flexibility

6. Yale MRRC Colloquium Series (New Haven, CT), (February 8, 2017) – Brain network dynamics: Flexibility and Control.

7. Institut du Cerveau et de la Moelle Epinière (Paris, France), (October 27, 2016) –The modular organization of human anatomical brain networks: Accounting for the cost of wiring

8. Collaborative Research in Computational Neuroscience (CRCNS) (Paris, France), (October 24, 2016) – Optimally controlling the human connectome: the role of network topology.

9. Resting State Connectivity Conference – Satellite course on Brain Network Methods (Vienna, Austria) (Sept. 24) – Optimal control and multilayer analysis of brain network data.

10. Organization for Human Brain Mapping 2016 – Graph theory educational course (Geneva, Switzerland) (June 26, 2016) – Generative Models of Brain Networks.

11. Organization for Human Brain Mapping 2016 – Graph theory educational course (Geneva, Switzerland) (June 26, 2016) – Multi-layer and dynamic networks.

12. Organization for Human Brain Mapping 2016 – Session on Predictive and Statistical Modeling (Geneva, Switzerland) (June 28, 2016) – Optimally controlling the human connectome: the role of network topology.

13. NetSci-LASH: Network Science in Languages, Arts, Sciences & Humanities (Kansas University, Lawrence, KS) (April 1, 2016) – Networks in the Neural Sciences.

14. Annual meeting of the Society for Neuroscience (Nanosymposium – Human Brain Networks) (October 23, 2015) - Functional modules reconfigure at multiple scales across the human lifespan.

15. NetSci 2015 (Brain networks satellite symposium) (Zaragoza, Spain) (June 1, 2015) – Generative models of the human connectome.

16. Indiana University, guest lecture (Networks of the Brain undergraduate course, taught by Olaf Sporns) (March 10, 2015) – Changes in structural and functional connectivity among resting-state networks across the human brain.

17. University of Pennsylvania Complex Systems Seminar (March 6, 2015) – Generative models of the human connectome.

18. University of Cambridge Brain Mapping Unit Networks Meeting (July 16, 2013) – Relating structure and function: Diffusion and modularity in the human connectome.