

Erik P Hoel, PhD
Curriculum Vitae
Research assistant professor

Allen Discovery Center
Tufts University
Medford, MA, 02155

hoelerik@gmail.com
www.erikphoel.com
@erikphoel

University education

PhD, 2010 – 2015

University of Wisconsin-Madison, WI
Advisor: Giulio Tononi, M.D., PhD.
Thesis: “Brain organization and information integration”

B.A. 2006 – 2010

Hampshire College, MA
Advisor: Jane Couperus, PhD.
Theses: “A Graph-Theoretic Approach to the Neural Correlates of Consciousness” and “Closing the Explanatory Gap in Philosophy of Mind”

Research interests

I use information theory and causal analysis to explore the nature of emergence and consciousness. The goal of my research is to understand in a formal quantitative manner how causal structure changes across scale. The potential outcome of this research is to improve causal model choice in scientific fields, guide scientific experiments, and highlight the importance of scale in considering causation, information, and function in physical systems. Additionally, I am interested in how formal metrics can be used to measure both the level and content of consciousness in the brain.

Publications

a. Journal articles

1. **Hoel, E.**, Klein, B. Causal Structures as Networks. *In prep.*
2. Wenzel, M., Han, S., Smith, H.E., **Hoel, E.**, Greger, B., House, P.A., Yuste, R. Reduced repertoire of cortical microstates and neuronal ensembles in medically-induced loss of consciousness. *BioRxiv*. Under review.
3. Albantakis, L., Marshall, W., **Hoel, E.**, Tononi, G. What caused what? An irreducible account of actual causation. *ArXiv*. Under review.
4. **Hoel, E.** (2017) When the map is better than the territory. *Entropy*, 19(5), 188. Selected for the issue cover.
5. **Hoel E.**, Albantakis, L., Marshall, W., Tononi, G. (2016) Can the macro beat the micro? Integrated information across spatiotemporal scales. *Neuroscience of Consciousness*, no.1.

6. **Hoel, E.**, Albantakis, L., Cirelli, C., Tononi, G. (2016) Synaptic refinement during development and its effect on slow-wave activity: a computational study. *Journal of neurophysiology* 115.4: 2199-2213.
7. **Hoel, E.**, Albantakis, L., Tononi, G. (2013) Quantifying causal emergence shows that macro can beat micro. *Proceedings of the National Academy of Sciences* 110.49: 19790-19795 (2013).

b. *Peer-reviewed conference publications*

1. Aubert-Kato, N., Witkowski, O., **Hoel, E.**, Bredeche, N. (2016) Towards Detecting the Emergence of Agency in Evolved Artificial Chemistries. Carlos Gershenson, Tom Froese, Jesus M. Siqueiros, Wendy Aguilar, Eduardo J. Izquierdo and Hiroki Sayama (eds.), *Artificial Life XV: Late- Breaking Proceedings of the Fifteenth International Conference on the Synthesis and Simulation of Living Systems*, 20–21.

c. *Essays and articles*

1. “Who Invented Memes? On the Impossibility of Originality in the Digital Age” featured by the Medium editorial staff.
2. “Will the Bitcoin bubble pop? Or Will It Envelop Us All?” in *Arc Digital* (2018)
3. “A Fiction for the Future” at The Center for Fiction (2017)
4. “Intellectuals defend the value of being intellectuals” in *Scientific American* (2017).
5. “Agent Above, Atom Below.” The Foundational Questions Institute’s essay contest Wandering Toward a Goal: How can mindless mathematical laws give rise to aims and intention? (2017).
6. “Fiction in the Age of Screens.” *The New Atlantis* (2016), selected for the Best American Essays series.
7. “Why Do We Sleep?” *Big Questions Online* (2016).
8. “How to Mathematically Measure Consciousness.” *The Daily Beast* (2016).
9. “*City on Fire* by Garth Risk Hallberg proves how Culturally Dominant Television Has Become.” *The Atlantic* (2015).
10. “Why Free-Range Kids Are Healthier.” *The Daily Beast* (2014).
11. “Science as a Subject of Art.” *SciArt in America* (2013).
12. “A Review of Incomplete Nature: How Mind Emerged from Matter.” The Neuroethics Blog of Emory University (2012).
13. “Framing and Responsibility in Consciousness Studies.” The Neuroethics Blog of Emory University (2012).

d. *Short stories*

1. “Higher Education.” *Arts & Letters* (2017).
2. “Ars Memoritiva.” Winner of the *Writer’s Digest* Literary Fiction Award; anthologized in the 77th Annual *Writer’s Digest* Writing Contest Collection (2012)
3. “The Substance I am Made of.” Anthologized in *American Fiction: Vol 12* (2012).
4. “Big Cats.” A winner in the Emerging Writer Awards; published in *Our Stories* (2010).
5. “All the Anne Franks.” Honorable mention in the Writers of the Future Award; published in *Strange Horizons* (2009).

Invited talks

1. “Causation as Information” at the Physics of Living Systems Lab, MIT, Boston, MA, USA.

2. “Quantifying emergence and reduction in complex systems” at *Complexity: From Cells to Consciousness*, Thessaloniki, Greece. (2018)
3. “A Way Forward for Consciousness Research” at *Causation and Complexity in the Conscious Brain*, Aegina, Greece. (2018)
4. “Causal Structure Across Scales” at Araya, Inc, Tokyo, Japan. (2018)
5. “Information and Causation” at the Info-metrics and Causal Inference workshop at Carnegie Mellon University, Pittsburgh, PA, USA.
6. “Quantifying Emergence and Reduction” at the Network Science Institute at Northeastern University, Boston, MA. (2018)
7. “Biological Organization Across Scales” at Tufts University, Medford, MA, USA.
8. “Emergence and Reduction” at Arizona State University, AZ, MA, USA. (2017)
9. “Macro vs Micro” at Hampshire College, Amherst, MA, USA. (2017)
10. “Free Will and Causation” at the London School of Economics, London, UK. (2017)
11. “Emergence, Free Will, and Causal Responsibility” at Yhouse, Inc, New York, NY, USA. (2017)
12. “Literature and the Hard Problem of Consciousness” at the Institute for Advanced Study, Princeton, NJ, USA. (2016)
13. “Brain Organization and Integrated Information” at the Neuroscience Training Program, University of Wisconsin-Madison, Madison, WI, USA. (2016)
14. “Causal Emergence and Neural Ensembles” at the NeuroTechnology Center at Columbia University, New York, NY, USA. (2015)
15. “Measuring Causal Emergence” at the Center for Theoretical Neuroscience at New York, NY, USA. (2015)
16. “How the Macro Beats the Micro” at the workshop on The Integrated Information Theory of Consciousness: Foundational Issues. (2015)
17. “Brain organization and the spatiotemporal scale of brain activity” for the Neuroscience Training Program seminar series, University of Wisconsin-Madison, Madison, WI, USA. (2015)
18. “The Limits of Reductionism” at Hampshire College, Amherst, MA. (2013)
19. “Graph Theory and the Neural Correlates of Consciousness” at Hampshire College, Amherst, MA. (2010)
20. “Electrophysiological Evidence of Pattern Completion and Separation in the CA1 Region of the Macaque Hippocampus” at New York University, New York, NY, USA. (2008)

Poster presentations

1. Aubert-Kato, N., Witkowski, O., **Hoel, E.**, Bredeche, N. (2016) *Decision Making in Messy Chemistries: Case Study with an Invasion-based Reaction Diffusion Scenario*. Proceedings of the International Conference on Unconventional Computation and Natural Computation.
2. **Hoel, E.**, Albantakis, L., Tononi, G. (2015) *The spatial and temporal scale of conscious experience*, presented at the Association for the Scientific Study of Consciousness.
3. **Hoel, E.**, Albantakis, L., Tononi, G. (2014) *Synaptic refinement and brain organization*. Presented at the Neuroscience Research Symposium of the Neuroscience Training Program.
4. Albantakis, L., **Hoel, E.**, Oizumi, M., Koch, C., Tononi, G. (2014) *Intrinsic causation and consciousness*. Presented at The Association for the Scientific Study of Consciousness.
5. **Hoel, E.**, Albantakis, L., Tononi, G. (2012) *The ‘neural code’ from the intrinsic perspective: Quantifying causal power at different spatiotemporal scales*. Present at Frontiers in Computational Neuroscience Conference.
6. **Hoel, E.**, Hogan, M., Couperus, J. W. (2010) *The network properties of conscious experience: relative blindsight, ‘small worlds,’ and functional connectivity*. Presented at The Association for the Scientific Study of Consciousness.

7. Couperus, J. W., **Hoel, E.**, Alperin, B. (2009) *Perceptual load modifies processing of distractor stimuli both in the presence and absence of target stimuli*. Presented at the Annual Meeting of the Cognitive Neuroscience Society.

Research positions

2018 – ongoing	TUFTS UNIVERSITY, Medford, MA Research assistant professor, Allen Discovery Center
2016 – 2018	COLUMBIA UNIVERSITY, New York, NY Advisor: Rafael Yuste, Professor of Biological Sciences Postdoctoral researcher
2016 – 2018	YHouse Inc, Hoboken, NJ Co-founder; Co-chair of coordinating committee
2016 – 2017	INSTITUTE FOR ADVANCED STUDY, Princeton, NJ Advisor: Piet Hut, Head of The Program of Interdisciplinary Studies Visiting scholar
2010 – 2016	UNIVERSITY OF WISCONSIN-MADISON, Madison, WI. Advisor: Giulio Tononi PhD student
2008 – 2010	HAMPSHIRE COLLEGE, Amherst, MA Advisor: Jane Couperus, Dean of the School of Cognitive Science EEG lab manager
2008	NEW YORK UNIVERSITY, New York, NY Advisor: Wendy Suzuki, Professor of Neural Science NSF research internship

Scientific awards

2018	Forbes 30 Under 30 in Science
2010 – 2012	Neuroscience Training Program Merit Scholarship
2006 – 2010	Hampshire College Faculty Choice Scholarship
2009	Culture, Brain, and Development Research Assistantship
2008	SURP at the Center for Neural Science at NYU, NSF-REU

Grants

2018 – 2020	Templeton World Charity Foundation – Grant ID: TWCF 0273
2013 – 2015	Templeton World Charity Foundation – Grant ID: TWCF 0067/AB41
2010	Culture, Brain, and Development Grant: brain structure in ADHD
2010	School of Cognitive Science Grant
2009	School of Natural Science Grant
2008	Culture, Brain, and Development grant: neuronal development

2008 Coppinger Grant to study human evolution

Teaching

2014 – 2015	PEOPLE Program, Madison, WI <i>Taught neuroscience to low-income minority high school students over the summer</i>
2009	Hampshire College, Amherst, MA <i>TA: "Minds, Brains, Machines."</i>
2009	Hampshire College, Amherst, MA <i>TA: "Gene Cloning."</i>
2008	Hampshire College, Amherst, MA <i>TA: "Brain Mechanisms."</i>

Outreach and engagement

a. Organizations

I co-founded YHouse, Inc, a registered nonprofit organization based in New York City devoted to scientific outreach, innovative and transdisciplinary research, intellectual partnership, and public discourse tackling questions on awareness, consciousness, and the future of intelligence. We host ongoing programs of public lecture series, events, weekly meetups, and conversations about scientific and philosophical approaches to consciousness, often in partnership with other organizations.

b. Talks for the public

1. "Literature and the Problem of Other Minds" at YHouse, Inc, New York, NY, USA (2018)
2. "How We Experience" at The Center for Fiction, New York, NY (2018)
3. "How We Grieve" at The Center for Fiction, New York, NY (2017)
4. The Story Collider, The Caveat Center, Brooklyn, NY, USA (2017)
5. "The Threat of Artificial Intelligence," The Caveat Center, Brooklyn, New York, NY, USA.
6. "Emergence, Free Will, and Causal Responsibility," at YHouse, Inc, New York, NY, USA (2017).
7. "The Mind-Body Problem: The More Theories the Better?" at YHouse Inc, New York, NY, USA (2016)
8. "The Origins of Awareness," at *Chasing Consciousness: from cells to societies, neuroscience to machine awareness*. Rubin Museum of Art, New York, NY, USA (2016).
9. "The Hard Problem of Consciousness or the Hard Problem of Matter?" at *Chasing Consciousness: from cells to societies, neuroscience to machine awareness*. Rubin Museum of Art, New York, NY, USA (2016).

c. Press profiles

1. "New Math Untangles the Mysterious Math of Causality" in *WIRED* (2017)
 2. "A Theory of Consciousness Can Help Build a Theory of Causality" in *Nautilus* (2017)
-

References

Rafael Yuste, M.D., PhD
PI of the NeuroTechnology Center
Department of Biological Sciences
Columbia University
906 NWC Building
550 West 120th St
New York, NY 10027
rmy5@columbia.edu
(212) 854-2354

Piet Hut, PhD
Head of the Program in Interdisciplinary Studies
Professor, Program of Interdisciplinary Studies
Institute for Advanced Study
1 Einstein Drive
Princeton, NJ 08540
piet@ias.edu
(609) 734-8075

Giulio Tononi, M.D., PhD
Distinguished Chair in Consciousness Research
Center for Sleep and Consciousness
University of Wisconsin
6001 Research Park Blvd
Madison, WI 53719
gtononi@wisc.edu
(608) 263-6063