

**Erik P Hoel, PhD**  
Curriculum Vitae  
*Postdoctoral researcher*

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*University education*

- PhD, 2010 (Sept.) – 2016 (Jan.)      University of Wisconsin-Madison, WI  
Advisor: Giulio Tononi, M.D., PhD.  
Thesis: “Brain organization and information integration”
- B.A. 2006 (Sept.) – 2010 (May)      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”

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*Research interests*

I use information theory and causal analysis to explore the biological basis of consciousness and understand the nature of emergence. In the former aspect of my research, my current focus is on how complexity and information theory can be used to track or measure the neural difference between consciousness and unconsciousness, using data from cutting-edge neuroscientific methodologies. The goal of this research is develop a formal measure of consciousness that can be empirically verified and is medically useful. The latter aspect of my research is to understand how causal structure changes across scale, and how information theory metrics can capture and quantify the emergence of macroscale causal structure. The goal of this research is to improve causal model choice in scientific fields, as well as solve long-standing problems in neuroscience, such as identifying the fundamental functional unit of the mammalian brain. This can be done by causally analyzing the cortex from the microscale of individual neurons to the mesoscale of neural ensembles to the macroscale of brain regions.

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*Publications*

*a. Peer-reviewed journal articles*

1. **Hoel, E. P.**, Wenzel, M., & Yuste, R. The complexity of neural activity at different levels of consciousness. *In prep.*
2. **Hoel, E. P.** (2016) When the map is better than the territory. *arXiv:1612.09592*.
3. **Hoel E. P.**, Albantakis, L., Marshall, W., & Tononi, G. (2016) Can the macro beat the micro? Integrated information across spatiotemporal scales. *Neuroscience of Consciousness*, no.1.

4. **Hoel, E. P.**, 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.
5. **Hoel, E. P.**, 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. P.**, 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. “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).
2. “Fiction in the Age of Screens.” *The New Atlantis* (2016).
3. “Why Do We Sleep?” *Big Questions Online* (2016).
4. “How to Mathematically Measure Consciousness.” *The Daily Beast* (2016).
5. “*City on Fire* by Garth Risk Hallberg proves how Culturally Dominant Television Has Become.” *The Atlantic* (2015).
6. “Why Free-Range Kids Are Healthier.” *The Daily Beast* (2014).
7. “Science as a Subject of Art.” *SciArt in America* (2013).
8. “A Review of Incomplete Nature: How Mind Emerged from Matter.” The Neuroethics Blog of Emory University (2012).
9. “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 77<sup>th</sup> 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).

*Research talks*

1. **Hoel, E. P.** (2016, **Invited**) “Literature and the Hard Problem of Consciousness” presented at the Institute for Advanced Study, Princeton, NJ, USA.
2. **Hoel, E. P.** (2016) “Brain Organization and Integrated Information” for the public defense portion of the PhD for the Neuroscience Training Program, University of Wisconsin-Madison, Madison, WI, USA.
3. **Hoel, E. P.** (2015, **Invited**) “Causal Emergence and Neural Ensembles” at the NeuroTechnology Center at Columbia University, New York, NY, USA.

4. **Hoel, E. P.** (2015, **Invited**) “Measuring Causal Emergence” at the Center for Theoretical Neuroscience at New York, NY, USA.
5. **Hoel, E. P.** & Marshall, W. (2015, **Invited**) “How the Macro Beats the Micro” presented at the workshop on The Integrated Information Theory of Consciousness: Foundational Issues.
6. **Hoel, E. P.** (2015) “Brain organization and the spatiotemporal scale of brain activity” for the the Neuroscience Training Program seminar series, University of Wisconsin-Madison, Madison, WI, USA.
7. **Hoel, E. P.** (2013, **Invited**) “The Limits of Reductionism” at Hampshire College’s 40<sup>th</sup> anniversary celebration, Amherst, MA.
8. **Hoel, E. P.** (2010) “Graph Theory and the Neural Correlates of Consciousness” in the Division III Presentation Series, Hampshire College, Amherst, MA.
9. **Hoel, E. P.** (2008) “Electrophysiological Evidence of Pattern Completion and Separation in the CA1 Region of the Macaque Hippocampus” at the Summer Undergraduate Research Program at New York University, New York, NY, USA.

#### *Poster presentations*

1. Aubert-Kato, N., Witkowski, O., **Hoel, E. P.**, & 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. P.**, 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. P.**, 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. P.**, Oizumi, M., Koch, C., & Tononi, G. (2014) *Intrinsic causation and consciousness*. Presented at The Association for the Scientific Study of Consciousness.
5. **Hoel, E. P.**, 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. P.**, 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. P.**, 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*

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| 2016 (Apr.) – ongoing  | COLUMBIA UNIVERSITY, New York, NY<br>Advisor: Rafael Yuste, Professor of Biological Sciences<br><b>Postdoctoral researcher:</b> <i>Causal structure of the cortex</i>                                    |
| 2016 (May) – ongoing   | INSTITUTE FOR ADVANCED STUDY, Princeton, NJ<br>Advisor: Piet Hut, Head of The Program of Interdisciplinary Studies<br><b>Visiting scholar:</b> <i>Measures of the level and content of consciousness</i> |
| 2016 (Sept.) – ongoing | YHouse Inc, Hoboken, NJ<br><b>Co-chair of coordinating committee:</b> <i>Development and outreach</i>  |

2010 (Sept.) – 2016 (Jan.)	UNIVERSITY OF WISCONSIN-MADISON, Madison, WI. Advisor: Giulio Tononi <b>Graduate student:</b> <i>Developing Integrated Information Theory (IIT)</i>
2008 (Sept.) – 2010 (May)	HAMPSHIRE COLLEGE, Amherst, MA Advisor: Jane Couperus, Dean of the School of Cognitive Science <b>EEG lab manager:</b> <i>Neuroimaging research of attention</i>
2008 (summer)	NEW YORK UNIVERSITY, New York, NY Advisor: Wendy Suzuki, Professor of Neural Science <b>NSF research internship:</b> <i>Electrophysiology in primates</i>

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### *Scientific awards and grants*

2013 – 2015	Templeton World Charity Foundation – Grant ID: TWCF 0067/AB41
2010 – 2012	Neuroscience Training Program Merit Scholarship
2006 – 2010	Hampshire College Faculty Choice Scholarship
2010	Culture, Brain, and Development Grant: brain structure in ADHD
2010	School of Cognitive Science Grant
2009	Culture, Brain, and Development Research Assistantship Grant
2009	School of Natural Science Grant
2008	SURP at the Center for Neural Science at NYU, NSF-REU
2008	Culture, Brain, and Development grant: neuronal development
2008	Coppinger Grant to study human evolution

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### *Teaching*

2014 – 2015 (summers)	PEOPLE Program, Madison, WI <i>Taught neuroscience to low-income minority high school students</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>

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### *Public outreach*

#### *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. Public talks*

1. Panel member on “The Origins of Awareness” as part of the Chasing Consciousness: from cells to societies, neuroscience to machine awareness series of public events that I co-organized, hosted at the Rubin Museum of Art in partnership with YHouse, Inc.
2. “The Hard Problem of Consciousness or the Hard Problem of Matter?” as part of the Chasing Consciousness: from cells to societies, neuroscience to machine awareness series at the Rubin Museum of Art, in partnership with YHouse, Inc.
3. “The Mind-Body Problem: The More Theories the Better?” with John Horgan, on the current state of the field of consciousness research, at the Consciousness Club.

*References*

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