Brennen A. Hill

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scholar.google.com/citations?user=E7N2fXkAAAAJ

Education

University of Wisconsin-Madison; Madison, WI *Expected Graduation May 2026*
Bachelor of Science in Computer Science

- **GPA:** 3.81/4.0.
- **Honors:** Letters & Science Dean's List, Honors in Computer Science Program, Letters & Science Honors Program.
- **Graduate AI Coursework:** Foundation Models, Learning-Based Image Synthesis, Advanced Robotics, Advanced Reinforcement Learning, Advanced Seminar (audit), Theory of Multi-agent ML, Mathematical Foundations of ML (upcoming).
- **AI Coursework:** Directed Study on LLMs with Dr. Sala, Game AI, Artificial Neural Networks, Artificial Intelligence, Game Theory & Learning.
- **Neuro Coursework:** Molecular & Cellular Mechanisms of Memory, Neurobiology, Computational Neuroscience (upcoming), Nanotechnology in Neuroscience (upcoming)

National University of Singapore; Singapore *Jan 2025 - May 2025*
Exchange Scholar

- Awarded a merit-based placement through a highly competitive, university-wide application process.
- **GPA:** 3.75/4.0 (calculated by UW-Madison).
- **Graduate AI Coursework:** Neural Networks & Deep Learning II (audit).
- **Graduate Neuro Coursework:** Frontiers in Neurotechnology (audit), Behavioral & Cognitive Neuroscience (audit).
- **AI Coursework:** AI Planning & Decision Making, Mind & Machine (both).
- **Neuro/Bio Engineering Coursework:** Mind & Machine, Organoid Engineering (audit), Bioinformatics.

Research Experience

Wisconsin Neuromorphic Computing and NeuroAI Lab; Madison, WI *Jun 2024 - Present*
Founding Director & Research Lead neuromorphic.cs.wisc.edu/people

- Founded and direct to explore the intersection of neuroscience and artificial intelligence.
- Secured formal funding, dedicated space, support from Dr. Akhilesh Jaiswal as advisor, partnership with NeuroAI startup FinalSpark, and administrative support from UW-Madison.
- Lectured on neuroAI (e.g. STDP) to audiences of over 100 (including graduate students and professionals) and organized biweekly workshops.
- Mentoring 15 researchers from initial project proposals to research papers and advised 100.
- *Publications from this research:* [2], [5], [3].

Dr. Frederic Sala's Sprocket Lab; Madison, WI *Sep 2024 - Present*
Foundation Models Researcher

- Researching and implementing novel methods for editing representations within large language models including coarse-to-fine pipelines.
- Worked with big data, GPU clusters, and high throughput systems.

- *Publications from this research:* [7], [8].

Dr. Josiah Hanna's Badger RL Lab; Madison, WI *May 2024 - Present*
Reinforcement Learning Researcher

- Designing and implementing reinforcement learning policies to train physical robots for autonomous soccer, focusing on multi-agent coordination.
- Key Accomplishments: Top ranking in RoboCup International Robotics Competition (3rd place in the Standard Platform League 2025; 1st place in the Challenge Shield League 2024).
- *Publications from this research:* [1] (in collaboration with Dr. Berland's Lab), [6].

Dr. Matthew Berland's Complex Play Lab; Madison, WI *Apr 2024 - Present*
Reinforcement Learning Researcher

- Architecting communication strategies between agents in multi-agent reinforcement learning (MARL) environments incorporating world models.
- Researched and developed a novel adversarial co-evolution framework to automatically generate curriculum for MARL.
- *Publications from this research:* [1] (in collaboration with Dr. Hanna's Lab), [4].

Dr. Rajendra Kumar-Singh (Tufts University, Neuro); Boston, MA (Remote) *Oct 2025 - Present*
NeuroAI Research Collaborator & AI Lead

- Personally recruited by Dr. Kumar-Singh to serve as the AI lead for two proposed biomedical ventures.
- Authored comprehensive technical roadmaps analyzing competitive landscape, resource requirements, and strategic path for (1) a genAI platform for de novo AAV gene-therapy vector design & (2) a clinically-tailored AI vision aid for patients with AMD & Glaucoma.

Dr. Michael Levin (Tufts University, Biology); Allen Discovery Center, (Remote) *Oct 2025 - Present*
NeuroAI Research Mentee

- Invited to mentorship from Dr. Levin to extend "Structural Plasticity as Active Inference" research [3].
- Designing embodied agents where the computational cells are the device and investigating model robustness to damage & topological changes.

Industry Research Engineer Experience

Stealth Mode Startup; Boston, MA *May 2025 - Present*
Software Engineer (Research Engineer) BrennenHill.com/stealth-startup

- Spearheaded the complete research and development lifecycle for a novel artificial intelligence system, taking the project from an ambiguous high-level goal to a fully deployed, production-ready system.
- Devised, prototyped, and implemented a custom, hardware-aware algorithm that significantly outperformed SOTA approaches by over 100x in accuracy on the system's hardware.

HRL Hughes Research Laboratories; Malibu, CA *Summer 2024 & Summer 2023*
Quantum Software Intern (Research Engineer)

- **Quantum Compiler Optimization via Template Matching** BrennenHill.com/quantum-circuit
  - Engineered a production-ready implementation of an exact pattern matching algorithm within the Quilc quantum compiler, translating a novel theoretical method into a high-impact optimization tool.
  - Reduced quantum circuit depth by up to 37%, shortening execution time on quantum hardware, directly enhancing algorithmic fidelity by mitigating qubit decoherence.
- **Low-Level Quantum Control Compiler** BrennenHill.com/quantum-compiler

- Architected a multi-pass compiler in Common Lisp to generate optimized binary directly for a custom quantum control processor (the QICK tProcessor ISA), creating a low-level pathway for direct FPGA execution to maximize performance and control flexibility.
- Designed and implemented a custom assembly language to bridge high-level experimental logic with the hardware instruction set, enabling advanced compiler optimizations, automatic resource allocation, and precise picosecond-level timing calculations.

- Awarded a return offer after each period with HRL in recognition of significant technical contributions and research impact.

PUBLICATIONS: FIRST-AUTHOR, PEER-REVIEWED, & FULL-LENGTH

Representative:

1 **Brennen A. Hill**, Mant Koh En Wei, Thangavel Jishnuanandh. "Communicating Plans, Not Percepts: Scalable Multi-Agent Coordination with Embodied World Models ." *In proceedings of **NeurIPS 2025** Workshop on Scaling Environments for Agents; in NeurIPS 2025 Workshop on Embodied World Models for Decision Making; and in NeurIPS 2025 Workshop on Optimization for Machine Learning*. arxiv.org/abs/2508.02912

Developed a novel intention communication framework in MARL that achieved >96% success in a complex coordination task using a learned world model for latent trajectory planning and a self-attention mechanism to encode and share agent intentions, significantly outperforming emergent protocols.

2 **Brennen A. Hill**, Zhang Xinyu, Timothy Putra Prasetio. "The Geometry of Cortical Computation: Manifold Disentanglement and Predictive Dynamics in VCNet ." *In proceedings of **NeurIPS 2025** Workshop on Symmetry and Geometry in Neural Representations and in NeurIPS 2025 Workshop on Interpreting Cognition in Deep Learning Models*. arxiv.org/abs/2508.02995

Designed VCNet, a novel architecture emulating the primate visual cortex, achieving state-of-the-art accuracy on two vision benchmarks with over 10x greater parameter efficiency than standard models.

3 **Brennen A. Hill**. "Structural Plasticity as Active Inference: A Biologically-Inspired Architecture for Homeostatic Control." *In National Science Foundation (NSF) Workshop on Brain-Inspired Dynamics for Engineering Energy-Efficient Circuits and Artificial Intelligence*. arxiv.org/abs/2511.02241

One of two undergraduates selected to present alongside Principal Investigators. Developed a novel architecture that integrates synaptic and structural plasticity, demonstrating that computational agents can solve tasks by physically migrating processing units to minimize local prediction error, driven solely by an intrinsic, active inference-based objective.

4 **Brennen A. Hill**. "Co-Evolving Complexity: An Adversarial Framework for Automatic MARL Curricula ." *In proceedings of **NeurIPS 2025** Workshop on Scaling Environments for Agents*. arxiv.org/abs/2509.03771

Developed a novel adversarial co-evolution framework to automatically generate a curriculum for multi-agent reinforcement learning that induces complex emergent strategies, increasing agent task performance by over 300% compared to baseline.

Additional:

5 **Brennen A. Hill**. "The Physical Basis of Prediction: World Model Formation in Neural Organoids via an LLM-Generated Curriculum ." *In proceedings of **NeurIPS 2025** Workshop on Scaling Environments for Agents and in NeurIPS 2025 Workshop on Embodied World Models for Decision Making*. arxiv.org/abs/2509.04633

6 **Brennen A. Hill**. "Generative World Models of Tasks: LLM-Driven Hierarchical Scaffolding for Embodied Agents." *In **NeurIPS 2025** Workshop on Embodied World Models for Decision Making*. arxiv.org/abs/2509.04731

Publications: In Review, First-Author, & Full-Length

7 **Brennen A. Hill**. "HEFT: A Coarse-to-Fine Hierarchy for Enhancing the Efficiency and Accuracy of Language Model Reasoning." *In review*. arxiv.org/abs/2509.09801

8 **Brennen A. Hill**, Surendra Parla, Venkata Abhijeeth Balabhadruni, Atharv Prajod Padmalayam, Sujay Chandra Shekara Sharma. "Breaking to Build: A Threat Model of Prompt-Based Attacks for Securing LLMs." *In review*. arxiv.org/abs/2509.04615

Selected Research Projects

Representation Fine-Tuning for Vision-Language Models *Sep 2024 - Dec 2024*
Lead Researcher BrennenHill.com/vision-representations

- Investigated Representation Fine-Tuning, a parameter-efficient fine-tuning method, on a vision-language model (nanoLLaVA) for a spatial reasoning task.
- Co-authored a research paper demonstrating that ReFT achieved accuracy comparable to LoRA (65.7% vs. 66.0%) while using nearly 10x fewer trainable parameters (0.019% of the model).

Reinforcement Learning for Quadruped Roller Skating *Sep 2024 - Dec 2024*
Researcher BrennenHill.com/rl-skating

- Co-authored a research paper on training a Unitree Go1 quadruped robot with passive wheels to skate using reinforcement learning in the Isaac Gym simulator.
- Developed an RL policy that resulted in emergent complex behaviors, including automatic gait switching from a stable diagonal gait at low speeds to a dynamic galloping gait at high speeds (3 m/s).

Honors and Awards

RoboCup International Robotics Competition *May 2024 - Present*
3rd Place (Standard Platform League 2025), 1st Place (Shield 2024)

- Achieved top placements in a competition that serves as an international scientific benchmark for multi-agent AI in adversarial environments, using fully autonomous, identical NAO robots.
- Guided the team's technical strategy by conducting a comprehensive literature review on multi-robot soccer, leading to a publication on language-driven world models [6].
- Designed and implemented the multi-agent coordination protocols for collaborative passing that formed a component of our team's winning strategy, applying concepts from my research [1].

National University of Singapore School of Computing Showcase *Jan 2025 - Present, presented May 2025*
Presenter BrennenHill.com/ai-game

- Selected to present a self-developed 3D videogame to an audience of over 100 students and faculty.
- The game featured AI-driven monster agents that used complex pathfinding algorithms to navigate dynamic 3D environments and make strategic targeting decisions; complex player abilities including harvesting resources, crafting equipment, and placing structures; and representing a unique mix of PvE, survival, resource management, and tower defense.

University of Wisconsin-Madison *Sept 2022 - Present*
Dean's List, Honors in Computer Science Program, Letters & Science Honors Program

NASA International Space Apps Challenge 2024 *Oct 2024*
Honorable Mention BrennenHill.com/exosky

- Received a global Honorable Mention, only awarded to 19 of 93,520 (0.02%) global participants.
- Processed large-scale NASA/ESA astronomical data and implemented the 3D visualization, rendering, and user interface.
- Won the Chicago hackathon and advanced to global finals; additionally awarded Best Presentation.

Hack Midwest 2024 *Oct 2024*
Winner (awarded $2,500) BrennenHill.com/badger-vision

- Won (of over 300 developers), awarded $2,500, and noted for Best Enterprise-Scale Business Solution.
- Designed and built "Badger Vision," an AI-powered assistive tool to help individuals with prosopagnosia (face blindness) by providing real-time audio cues for face identification and emotion recognition.
- Implemented a computer vision pipeline using deep learning (convolutional neural networks) to identify individuals and classify their emotional expressions from a live low-level video stream.

Agoura High School *Aug 2018 - May 2022*
Valedictorian of 600, 4.6/4.0 GPA, International Baccalaureate Diploma, State Golden State Seal Merit Award, State Seal of Biliteracy, 4-year Scholar Athlete

Professional Research Service

Conference on Neural Information Processing Systems (NeurIPS) *Sep 2025*
Served as a peer reviewer upon nomination by the respective program committees:

- Neurips 2025 Workshop on Scaling Environments for Agents (SEA)
- Neurips 2025 Workshop on Aligning Reinforcement Learning Experimentalists and Theorists (ARLET)
- Neurips 2025 Workshop on Interpreting Cognition in Deep Learning Models (CogInterp)
- Neurips 2025 Workshop on Efficient Reasoning (ER)
- Neurips 2025 Workshop on Data on the Brain and Mind Findings (DBM)
- Neurips 2025 Workshop on Symmetry and Geometry in Neural Representations (NeurReps)

AAAI Conference on Artificial Intelligence *Nov 2025*
Served as a peer reviewer upon nomination by the respective program committees:

- AAAI 2026 Workshop on Neuro for AI & AI for Neuro: Towards Multi-Modal Natural Intelligence (NeuroAI)

Cortical Labs Journal Club *Oct 2024*
Host and speaker BrennenHill.com/scale-free-cognition

- Presented a critical analysis on the origins of intelligence, synthesizing concepts of scale-free cognition and developmental bioelectricity, and referencing work by Dr. Levin to discuss how higher-level agency evolves from the homeostatic, problem-solving capabilities of cellular collectives.
- Facilitated a post-talk discussion with researchers on the future of synthetic biological intelligence and the applications of the mechanisms presented.
- Invited to give future talks in recognition of the presentation's quality and the engaging discussion.

Leadership & Professional Experience

Madison Machine Learning *Sep 2025 - Present*
Co-Founder

- Co-organizing and growing new community hub connecting machine learning researchers.
- Co-leading weekly technical deep-dives and critical discussions on SOTA papers in machine learning.

Badger Solar Racing *Aug 2025 - Present*
Head of AI

Badger Ballroom Dance Team *Dec 2023 - Present*
Vice President and Vice-Captain

AI Club *Mar 2024 - Mar 2025*
Executive Boardmember and Webmaster

Ballroom Association UW-Madison *Dec 2022 - Dec 2023*
Executive Boardmember and Webmaster

Slow Food UW *Nov 2022*
Volunteer Leadership
• Mobilized and coordinated a team of 30 to prepare and distribute pay-what-you-can meals.

Agoura High School Math Honors Society *Aug 2020 - May 2022*
Math Tutor

Agoura High School Science Honors Society *Aug 2020 - May 2022*
Science Tutor

Thunder Warrior Gaming *Mar 2018 - Apr 2022*
Lead Developer and Founder BrennenHill.com/thunder-warrior
• Designed, built, self-published, and marketed the video game Thunder Warrior: Genesis.
• Achieved net profit.
• Engineered a custom game engine, multiplayer server, database, 3D models, and animations.

Grants & Funding: Under Review / Pending

Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service Program

Vitalik Buterin PhD Fellowship in AI Existential Safety

Department of Energy Computational Science Graduate Fellowship (DOE CSGF)

Link Foundation Modeling, Simulation, and Training Fellowship

Languages

English
Native

Spanish
Fluent Written, Advanced Oral