

Ryan S. Phillips

Curriculum Vitae

Seattle Children's Research Institute
Center for Integrative Brain Research
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Google Scholar Profile
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Research Interests

Neuroscientist investigating the neural circuit mechanisms linking pain modulation and respiratory control, with a focus on opioid-induced respiratory depression. Integrates computational modeling, electrophysiology, and intersectional genetic circuit dissection to identify mechanisms that could dissociate analgesia from life-threatening respiratory suppression. Develops data-driven biophysical models of respiratory rhythm generation and builds open-source, AI-integrated tools for multimodal physiological data analysis, including ML-based classification pipelines and NLP methods for automated data curation and analysis.

Education

- 2017 **Ph.D., Physics**, *National Institutes of Health & University of New Hampshire – Joint Program*.
Thesis: Biophysical Mechanisms of Rhythm Generation in the Pre-Bötzinger Complex
- 2017 **Cognate in College Teaching**, *University of New Hampshire*.
- 2009 **B.S., Physics**, *Portland State University*.

Funding & Awards

- 2025 **NIH R01 Research Project Grant (PI: Phillips)**, *NIBIB 1R01EB040469-01*, Pending review.
Title: *Machine Learning and NLP Methods for Multimodal Physiological Data Curation and Analysis*
- 2023–2028 **NIH K01 Research Scientist Development Award**, *NIDA K01DA058543*, **4th percentile**.
Title: *Dissociating respiratory depression and analgesia via a data-driven model of interacting respiratory and pain networks*
- 2015–2017 **Dissertation Scholarship**, *Jayne Koskinas Ted Giovanis Foundation for Health and Policy*.
- 2014–2017 **Intramural Research Training Award (IRTA)**, *National Institutes of Health*.

Research Experience

- 2025–Present **Research Scientist**, *Seattle Children's Research Institute*, Center for Integrative Brain Research.
Investigating opioid effects on respiratory and pain networks through NIH K01 award (awarded 2023, 4th percentile). Employing intersectional genetic strategies, Neuropixels recordings, fiber photometry, and computational modeling to identify therapeutic targets that could preserve analgesia while preventing respiratory depression. Developing open-source Python software platforms (PhysioMetrics, CageMetrics) integrating ML-based analysis of respiratory physiology and behavioral data, with planned publication in *Journal of Open Source Software*. Submitted first R01 application as PI (NIBIB), with two additional R01s in development (NIDA, NINDS).
- 2021–2025 **Postdoctoral Fellow**, *Seattle Children's Research Institute*, Center for Integrative Brain Research.
- 2017–2021 **Postdoctoral Associate**, *University of Pittsburgh*, Department of Mathematics.
Developed novel mathematical models of respiratory rhythm generation and basal ganglia dynamics. Published high-impact papers on biophysical mechanisms underlying neural oscillations.
- 2014–2017 **Pre-Doctoral IRTA Fellow**, *National Institutes of Health*, National Institute of Neurological Disorders and Stroke.
Created and validated biophysical models of respiratory rhythm generation in the pre-Bötzinger complex. Collaborated with experimental neuroscientists to test model predictions.

- 2011–2017 **Graduate Student**, *University of New Hampshire*, Department of Physics.
Completed doctoral research through NIH-UNH joint program.
- 2009–2011 **Postbaccalaureate Researcher**, *Oregon Health and Science University*, Department of Neurological Surgery.
Investigated descending pain modulation circuits using electrophysiology and pharmacology.

Publications

15 peer-reviewed publications | 7 first-author | 3 corresponding author
h-index: 10 | 273 citations (Google Scholar, March 2026)

✉ Corresponding author

Manuscripts in Preparation

Phillips, Ryan S✉, Arthurs, Joseph W, Huff, Aidan D, Reily, Elora, Sedano, Jonathan, and Baertsch, Nathan A. Respiratory depression and sex-dependent pain suppression via inhibitory RVM neurons. *In preparation*.

Phillips, Ryan S✉, John, Sushmita R, and Rubin, Jonathan E. Regulation of cellular and network bursting properties via activity-dependent modulation of spike shape. *Near submission*.

Phillips, Ryan S✉, et al. Comprehensive cell-type specific dissection of RVM subpopulations in the control of pain, breathing, and motor output. *In preparation*.

Journal Articles

- 2025 Nathan A Baertsch, Elora Reily, Jonathan Sedano, **Phillips, Ryan S**, and Joseph W Arthurs. Multimodal breathing control: Pontomedullary mechanisms and current perspectives. *BioEssays*, page e70072. Wiley Online Library, 2025.
- 2024 **Phillips, Ryan S**✉ and Nathan A Baertsch. Interdependence of cellular and network properties in respiratory rhythm generation. *Proceedings of the National Academy of Sciences*, volume 121, page e2318757121. National Acad Sciences, 2024.
- 2024 Sushmita R John, **Phillips, Ryan S**, and Jonathan E Rubin. A novel mechanism for ramping bursts based on slow negative feedback in model respiratory neurons. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, volume 34. AIP Publishing, 2024.
- 2024 Grant M Chou, Nicholas E Bush, **Phillips, Ryan S**, Nathan A Baertsch, and Kameron Decker Harris. Modeling effects of variable prebötzing complex network topology and cellular properties on opioid-induced respiratory depression and recovery. *eNeuro*, volume 11. Society for Neuroscience, 2024.
- 2024 Nathan A Baertsch and **Phillips, Ryan S**. How neural networks walk and chew gum. *The Journal of Physiology*, volume 602, pages 767–768. Wiley Online Library, 2024.
- 2022 **Phillips, Ryan S**✉ and Jonathan E Rubin. Putting the theory into ‘burstlet theory’ with a biophysical model of burstlets and bursts in the respiratory prebötzing complex. *eLife*, volume 11, page e75713. eLife Sciences Publications Limited, 2022.
- 2022 **Phillips, Ryan S**, Hidehiko Koizumi, Yaroslav I Molkov, Jonathan E Rubin, and Jeffrey C Smith. Predictions and experimental tests of a new biophysical model of the mammalian respiratory oscillator. *eLife*, volume 11, page e74762. eLife Sciences Publications Limited, 2022.
- 2022 Nicholas J Burgraff, **Phillips, Ryan S**, Liza J Severs, Nicholas E Bush, Nathan A Baertsch, and Jan-Marino Ramirez. Inspiratory rhythm generation is stabilized by ih. *Journal of neurophysiology*, volume 128, pages 181–196. American Physiological Society Rockville, MD, 2022.
- 2022 Muhammad U Abdulla, **Phillips, Ryan S**, and Jonathan E Rubin. Dynamics of ramping bursts in a respiratory neuron model. *Journal of computational neuroscience*, pages 1–20. Springer, 2022.
- 2020 **Phillips, Ryan S**, Ian Rosner, Aryn H Gittis, and Jonathan E Rubin. The effects of chloride dynamics on substantia nigra pars reticulata responses to pallidal and striatal inputs. *eLife*, volume 9, page e55592. eLife Sciences Publications, Ltd, 2020.

- 2019 **Phillips, Ryan S** and Jonathan E Rubin. Effects of persistent sodium current blockade in respiratory circuits depend on the pharmacological mechanism of action and network dynamics. *PLoS computational biology*, volume 15, page e1006938. Public Library of Science San Francisco, CA USA, 2019.
- 2019 **Phillips, Ryan S**, Tibin T John, Hidehiko Koizumi, Yaroslav I Molkov, and Jeffrey C Smith. Biophysical mechanisms in the mammalian respiratory oscillator re-examined with a new data-driven computational model. *eLife*, volume 8, page e41555. eLife Sciences Publications, Ltd, 2019. * **Featured in eLife Insight article.**
- 2018 Hidehiko Koizumi, Tibin T John, Justine X Chia, Mohammad F Tariq, **Phillips, Ryan S**, Bryan Mosher, Yonghua Chen, Ryan Thompson, Ruli Zhang, Naohiro Koshiya, et al. Transient receptor potential channels *trpm4* and *trpc3* critically contribute to respiratory motor pattern formation but not rhythmogenesis in rodent brainstem circuits. *eNeuro*, volume 5. Society for Neuroscience, 2018.
- 2012 **Phillips, Ryan S**, Daniel R Cleary, Julia W Nalwalk, Seksiri Arttamangkul, Lindsay B Hough, and Mary M Heinricher. Pain-facilitating medullary neurons contribute to opioid-induced respiratory depression. *Journal of neurophysiology*, volume 108, pages 2393–2404. American Physiological Society Bethesda, MD, 2012.
- 2012 Daniel R Cleary, **Phillips, Ryan S**, Michael Wallisch, and Mary M Heinricher. A novel, non-invasive method of respiratory monitoring for use with stereotactic procedures. *Journal of neuroscience methods*, volume 209, pages 337–343. Elsevier, 2012.
- Selected Invited Talks**
- March 2025 **Ryan S. Phillips**, *Disentangling pain modulation and respiratory depression at the level of the rostral ventromedial medulla*, SPEAR Conference 2025, Friday Harbor Labs, University of Washington.
- October 2024 **Ryan S. Phillips**, *Disentangling pain modulation and respiratory depression at the level of the rostral ventromedial medulla*, Breathing for Life: 16th Oxford Conference on Breathing, Emotion, and Beyond, Williamsburg, Virginia.
- July 2024 **Ryan S. Phillips**, *Disentangling descending pain modulation and respiratory control at the level of the rostral ventromedial medulla based on μ -opioid receptor expression*, International Narcotics Research Conference, University of Michigan.
- October 2023 **Ryan S. Phillips**, *Cellular and network properties in respiratory rhythm generation: an interdependent perspective*, Society for Neuroscience meeting, Washington, DC.
- October 2022 **Ryan S. Phillips**, *Interdependence of cellular and network properties in respiratory rhythmogenesis*, The 15th Oxford Conference on Modeling and Control of Breathing, Odawara, Japan.
- December 2022 **Ryan S. Phillips**, *Predictions and experimental tests of a new biophysical model of the mammalian respiratory oscillator*, Smithfest, National Institutes of Health.
- July 2022 **Ryan S. Phillips**, *Action potential shape regulates intrinsic bursting and reveals unifying model of respiratory rhythm generation*, Society for Industrial and Applied Mathematics Conference on the Life Sciences, Pittsburgh, PA.
- October 2021 **Ryan S. Phillips**, *Putting the theory into 'burstlet theory': A biophysical model of bursts and burstlets in the respiratory preBötzinger complex*, Department of Mathematics, University of Iowa.
- June 2021 **Ryan S. Phillips**, *The effects of chloride dynamics on substantia nigra pars reticulata responses to pallidal and striatal inputs*, International Conference on Mathematical Neuroscience - Digital Edition, virtual event.
- October 2020 **Ryan S. Phillips**, *Mechanisms of inspiratory rhythm and pattern generation in the preBötzinger complex*, 13th Annual Society for Neuroscience Satellite Symposium on Motor Systems, Washington, DC.
- July 2019 **Ryan S. Phillips**, *Effects of short-term ionic plasticity of GABAergic synapses in the basal ganglia and brainstem respiratory circuits*, 26th annual Computational Neuroscience meeting, Barcelona, Spain.

March 2018 **Ryan S. Phillips**, *The role of CAN currents in the respiratory Pre-Bötzinger Complex*, Complex Systems in Neuroscience: Bridging Theory and Experiment, Pittsburgh, PA.

Open-Source Software

- PhysioMetrics** Desktop application for respiratory signal analysis featuring automated breath detection, a cascading ML classification pipeline (Random Forest, XGBoost, MLP; 95–99% accuracy), and integrated fiber photometry analysis. Computes 75+ breath metrics across multiple file formats. DOI: 10.5281/zenodo.17575911
- CageMetrics** Desktop application for analysis of home cage behavioral and respiratory data from Sable Systems Promethion and Allentown Discovery IVC (EnVision) systems, with automated group consolidation, statistical comparisons (t-tests, ANOVA with post-hoc corrections), circadian time averaging, and publication-ready figure generation. In use at the Seattle Children’s Behavioral Phenotyping Core. DOI: 10.5281/zenodo.17968545
- NeuronForge** Desktop application for building, running, and analyzing conductance-based neuronal network simulations with automatic C++ code generation, Allen Brain Atlas integration, and parameter sweep capabilities.

Technical Skills

- Programming** Python, MATLAB, C/C++, Bonsai, bash scripting, Arduino
- Data Science & ML** Scikit-learn, pandas, numpy, scipy, PyQt6, Jupyter notebooks, clustering (GMM), classification (Random Forest), AI-assisted development (Claude, LLM integration)
- Modeling** Computational neuroscience, biophysical modeling, dynamical systems analysis, bifurcation analysis
- Software** XPP-AUTO, gnuplot, Git/GitHub, LaTeX, Qt Designer, EthoVision, Spike2, Clampex, Clampfit, SpikeGLX, GraphPad Prism, Adobe Illustrator, Linux/Unix, HPC clusters (SLURM job scheduling at NIH, University of Pittsburgh)
- Experimental** Whole-body plethysmography, intersectional genetics (optogenetics, chemogenetics), Neuropixels recordings, fiber photometry, in vivo electrophysiology, calcium imaging, Hargreaves test, open field behavioral assays

Service & Professional Activities

- Editorial** **Review Editor:** *Frontiers in Computational Neuroscience*
- Peer Review** **Ad hoc Reviewer:** *eLife, PLOS Computational Biology, Journal of Neuroscience, Journal of Physiology, Scientific Reports, Frontiers in Neuroscience, Chaos: An Interdisciplinary Journal of Nonlinear Science*
- 2018 **Conference Co-organizer:** *Complex Systems in Neuroscience: Bridging Theory and Experiment*, University of Pittsburgh

Teaching Experience

University of Pittsburgh

- 2018–2021 **Instructor of Record**, 4 semesters total.
MATH0220: Analytic Geometry and Calculus 1 (3 semesters), MATH0230: Analytic Geometry and Calculus 2 (1 semester)

University of New Hampshire

- 2011–2013 **Graduate Teaching Assistant**, 4 semesters total.
Lab Instructor for PHYS 407: General Physics 1 and PHYS 408: General Physics 2

■ Mentoring & Leadership

- 2023–Present **Research Mentor**, *Seattle Children's Research Institute*.
Supervised 2 summer undergraduate researchers in computational neuroscience projects
- 2020–2021 **Virtual Research Mentor**, *NIH Summer Internship Program*.
Mentored 1 high school student in computational modeling of neural circuits
- 2018–2021 **Research Mentor**, *University of Pittsburgh – Carnegie Mellon Summer Program*.
Supervised 3 undergraduate researchers in mathematical neuroscience projects, resulting in 2 conference presentations

■ Professional Memberships

- Society for Neuroscience (SfN)
Society for Industrial and Applied Mathematics (SIAM)
Organization for Computational Neurosciences (OCNS)