

CONTACT INFORMATION

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RESEARCH INTERESTS

neural oscillations and waves, predictive coding, auditory perception and cognition, applied probability, machine learning, neural data analysis, signal processing, biosignals, electrophysiology, high-dimensional time series

EDUCATION

University of California San Diego (UCSD) Sep '16 - Mar '24
Doctor of Philosophy, Department of Psychology
- Thesis: Predictive Coding in the Auditory System
Master of Science, Department of Bioengineering
- Thesis: Predictive Coding in the Auditory Cortex
- Thesis Advisor: Prof. Timothy Q. Gentner; Auditory Neuroscience Laboratory
Indian Institute of Technology Madras (IITM) Jul '11 - Jun '16
Master of Technology, Department of Biotechnology
- Thesis: Role of microRNA-7-5p in tumor progression in breast cancer
- Thesis Advisor: Prof. Devarajan Karunagaran; Cancer Biology Laboratory
Bachelor of Technology (Hons.), Department of Biotechnology
- Completed a minor degree in social entrepreneurship at Department of Management Studies, IIT Madras
- Activities: Events Coordinator, Shastra (IITM Tech Festival); Placement Coordinator; Coordinator, Biotechnology Department Festival

RESEARCH EXPERIENCE

Visiting Scholar, Neural Interaction Laboratory
Department of Bioengineering
Stanford University Sep '24 - present

Postdoctoral Scholar, Auditory Neuroscience Laboratory
Department of Psychology
University of California San Diego Apr '24 - Aug '24

Graduate Researcher, Auditory Neuroscience Laboratory
Department of Psychology
University of California San Diego Apr '17 - Mar '24

Graduate Researcher, Mathematical Neuroscience Laboratory
Department of Bioengineering
University of California San Diego Jan '17 - Mar '17

Undergraduate Research Assistant, Cancer Biology Laboratory
Department of Biotechnology
IIT Madras, India Jun '15 - Jun '16

Undergraduate Research Assistant, Microbiology Laboratory
Department of Biotechnology
IIT Madras, India Dec '14 - Jun '16

Research Intern
Logsdon Laboratory
MD Anderson Cancer Center, Houston Jun '14 - Aug '14

Research Intern
Biological E. Limited
Hyderabad, India Jun '13 - Aug '13

PAPERS

Rudraraju, S., Turvey, M. E., Theilman, B. H., Gentner, T. Q., 2024. Predictive and error coding for vocal communication signals in the songbird auditory forebrain. (under review).

Rudraraju, S., McPherson, T. S., Gentner, T.Q., 2024. Predictive coding and behavioral modulation in the perception of vocal sequences. (in prep).

Sainburg, T., McPherson, T., Arneodo, E., **Rudraraju, S.**, Turvey, M., Tostado, P., Thielk, M., Gentner, T. (2025). Expectation-driven sensory adaptations support enhanced acuity during categorical perception. *Nature Neuroscience*. (to appear).

Theilman, B.H., McPherson, T. S., Turvey, M.E., **Rudraraju, S.**, Gentner, T.Q. 2023. Intrinsic geometry of a combinatorial sensory neural code for birdsong. (under review).

Rudraraju, S., Turvey, M.E., Theilman, B.H., Gentner, T.Q. (2023). Hierarchical predictive coding across the auditory forebrain. *Conference on Cognitive Computational Neuroscience*, 1047-1049.

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. (2022). Predictive coding in auditory cortical neurons of songbirds. *Conference on Cognitive Computational Neuroscience*, 1-3.

Vahidi, N. W., **Rudraraju, S.**, Castagnola, E., Cea, C., Nimbalkar, S., Hanna, R., Arvizu, R., Dayeh, S. A., Gentner, T. Q., Kassegne, S. (2020). Épi-Intra neural probes with glassy carbon microelectrodes help elucidate neural coding and stimulus encoding in 3D volume of tissue. *Journal of Neural Engineering*, 17(4), 046005.

Castagnola, E., Vahidi, N. W., Nimbalkar, S., **Rudraraju, S.**, Thielk, M., Zucchini, E., Cea, C., Carli, S., Gentner, T. Q., Ricci, D., Fadiga, L., & Kassegne, S. (2018). In Vivo Dopamine Detection and Single Unit Recordings Using Intracortical Glassy Carbon Microelectrode Arrays. *MRS Advances*, 3(29), 1629–1634.

TALKS AND POSTERS

Rudraraju S. and Gentner T., 2022. Predictive coding in the auditory cortex. *International Conference of Artificial Intelligence IEEE (ICAI)*, Perú. (**Invited Talk**)

Rudraraju S. and Gentner T., 2021. Tools to investigate predictive coding in the auditory cortex. *IEEE Women in Engineering*, Perú. (**Invited Talk**)

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in songbird secondary auditory cortical neurons. *Advances and Perspectives in Auditory Neuroscience (APAN 2022)*. (**Oral Presentation**)

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in auditory cortical neurons of songbirds. *Conference on Cognitive Computational Neuroscience, (CCN 2022)*. (**Oral Presentation**)

Rudraraju, S and Gentner T., 2021. Predictive coding in the songbird auditory cortex. *Cognitive Neural Systems Brown Bag UCSD*. (**Long Talk**)

POSTERS

Rudraraju, S., Turvey, M.E., Theilman, B.H., McPherson, T.S., Gentner, T.Q. 2023. Hierarchical predictive coding across the auditory forebrain. *Conference on Cognitive Computational Neuroscience (CCN 2023)*.

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in auditory cortical neurons in songbirds. *Society for Neuroscience (SfN 2022)*.

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in auditory cortical neurons of songbirds. *Conference on Cognitive Computational Neuroscience (CCN 2022)*.

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in auditory cortical neurons of songbirds. *CNSL Meet IIT Madras 2022*.

Rudraraju, S., Theilman, B.H., Turvey, M.E., Gentner, T.Q. 2022. Predictive coding in songbird secondary auditory cortical neurons. *Society for Neuroscience (SfN 2021)*.

Rudraraju, S. and Gentner, T.Q. 2020. Predictive coding in the auditory cortex. *CNSL Meet IIT Madras 2020*.

Turvey, M.E., **Rudraraju, S.**, Theilman, B.H., Gentner, T.Q. 2022. Neural responses to violation of expectation in a higher auditory area in the European starling. *Advances and Perspectives in Auditory Neuroscience (APAN 2022)*.

Theilman, B.H., McPherson, T. S., Turvey, M.E., **Rudraraju, S.**, Gentner, T.Q. 2021. Reconstruction of natural auditory stimuli from neuronal population activity. *Society for Neuroscience (SfN 2021)*.

FELLOWSHIPS AND AWARDS

Norman Anderson Research and Travel Grant
Finalist, Narotam Sekhsaria Foundation PG Scholarship

Fall '23
Spring '16

Predictive Coding in the Auditory System

Fall '19 – Winter '24

*Thesis advisor: Prof. Timothy Q. Gentner**Decoding complex behaviors such as vocal recognition with predictive coding*

- Studied predictive coding mechanisms underlying learning temporal pattern recognition in songbirds.
- Analyzed sequential dynamics of song by modeling transitions between vocal elements using UMAP and generated syllable transition network graphs.
- Designed operant behavior paradigms for birdsong recognition from whole starling libraries.
- Built computational frameworks to show that predictive coding hypothesis can be used to explain complex behaviors such as birdsong recognition.
- Temporal dynamics of birdsong recognition: working on variational Bayesian GMMs (Gaussian Mixture Models), neural population dynamics, developing models to explain sequential dynamics during birdsong recognition
- Working on population decoding of neural data to draw insights about acoustic representations and behavior.

Predictive coding for natural vocal signals in the songbird auditory forebrain

- Showed evidence for the predictive coding hypothesis, a powerful theoretical framework employed to explain perceptual and cognitive phenomena, in single cortical neurons to natural auditory signals.
- Developed and implemented machine learning techniques and statistical methods to develop generative models of incoming sensory signals.
- Performed multi-electrode electrophysiology to record and signal processing extracellular neural activity from auditory neurons in songbirds.

Computational framework for implementation of predictive coding hypothesis Spring '16 - Summer '19*Thesis advisor: Prof. Timothy Q. Gentner*

- Computed prediction spectrograms by training the data as a Gaussian distribution on a loss function given by the negative log likelihood, and then estimating the means and variances of the signal.
- Explored stimulus-response relationships using Maximum Noise Entropy (MNE) model.

Teaching Assistant, UCSD*Responsible for heading discussions on related queries, framing and grading reports, and conducting final exams*

Climate Crisis	Prof. Adam Aron	Winter '24
Clinical Assessment and Treatment	Prof. Eddie Chapman	Spring '23
Sensory Neuroscience	Prof. Timothy Gentner	Winter '23
Eating Disorders	Prof. Walter Kaye	Spring '22
Research Methods in Psychology	Prof. Emma Geller	Winter '22
Introduction to Statistics	Prof. Timothy Rickard	Spring '21
Introduction to Statistics	Prof. Angela Lowe	Fall '20
Cognitive Psychology	Prof. Angela Lowe	Fall '19
Thermodynamics	Prof. Todd Coleman	Winter '19
Introduction to Psychology	Prof. Esther Hanes	Spring '18
Introduction to Statistics	Prof. Eric Steiner	Winter '18
Physiological Systems Engineering	Prof. David Gough	Spring '17
Biology and Medicine of Exercise	Prof. Randolph Hampton	Winter '17

Teaching Assistant, IIT Madras*Responsible for heading discussions on related queries, framing and grading reports, and conducting final exams*

BT2111: Biochemistry and Microbiology Laboratory	Prof. Suresh Rayala	Spring '16
BT2112: Microbiology Laboratory	Prof. Verma R.S.	Fall '15

MENTORSHIP & OUTREACH

Mentorship in Gentner Lab, University of California San Diego
Yuan Gao, Computer Science Undergraduate UCSD
Ron Hasson, Cognitive Science Undergraduate at UCSD
Karen Chiem, Cognitive Science Undergraduate at UCSD

Spring '21 – Spring '22
Spring '21 – Fall '21
Fall '19

Science Club Instructor

Clubes de Ciencia, Peru

Summer '20

The Predictive Mind

Clubes de Ciencia, Mexico

Summer '18

From behavior to brain function

Responsibilities: Designing lectures and tutorials with daily coding assignments for a class of 30 students consisting of undergraduates and a few high school students, assisting in end-of-club projects and poster

GradAMP Mentor

, University of California San Diego

2020 – 2021

Mentee: Mariela Lopez Valencia, Neuroscience PhD Program, University of Pennsylvania

Responsibilities: Mentor undergraduate students applying to graduate school, advising on choices of programs, and labs to apply, helping write and proofread statements of purpose and CVs, assisting in fellowship applications.

TECHNICAL SKILLS

Programming Languages: Python, Matlab, R

Packages: TensorFlow, PyTorch, SciPy, scikit-learn, Pandas, Keras, statsmodels, matplotlib, ggplot2

Tools: Linux/Unix systems, git

Software: Illustrator, Photoshop, 3D printing, SketchUp

CERTIFICATIONS & WORKSHOPS

Micro MBA, Rady School of Management, UCSD

Summer '18

Biotechnology Entrepreneurship Student Teams

Association for Biotechnology Led Enterprises, Bangalore, India

Nov '15

- Selected into one of the top 20 teams from all over India.
- Attended the three day Entrepreneurship Development Workshop on Business Plan Essentials, Raising Finance, Intellectual property Rights and Patenting Strategies, HR Practices and Communication Skills.
- Pitched my business plan to a panel of 8 jury member

SERVICE

Reviewer, Conference on Cognitive and Computational Neuroscience

2022, 2023

REFERENCES

Prof. Todd Coleman (*Principal Investigator*)

Department of Bioengineering, Electrical Engineering, Stanford

toddcol@stanford.edu

Prof. Timothy Gentner (*Principal Investigator*)

Department of Psychology, Neuroscience, UC San Diego

tgentner@ucsd.edu

Dr. Ezequiel Arneodo (*Postdoctoral Mentor*)

HID Machine Learning Engineer, Apple

zeke.arneodo@gmail.com

Prof. John Serences (*Dissertation Committee*)

Department of Psychology, Neuroscience, UC San Diego

jserences@ucsd.edu

Dynamic probabilistic description of phase amplitude coupling and traveling waves *Sep '24 - present*
Guide: Prof. Todd Coleman *Neural Interaction Laboratory, Stanford*

- Working on a novel approach for PAC analysis in dynamic settings by leveraging a state-space point process model with a latent Gaussian Markov Process to infer coupling dynamics, capturing both time-varying changes in the underlying distribution and state transitions.
- Developing a statistical model to characterize the joint probability distribution of spatially-recorded oscillations by incorporating Gaussian state-space models into interaction screening framework on oscillatory phases.

Dynamics of neural networks in C.elegans *Oct '16 - Mar '17*
Guide: Prof. Gabriel Silva *Mathematical Neuroscience Laboratory, UCSD*

- Study how the firing dynamics of its neurons interact in context with the known connectivity of the connectome

Role of microRNA-7-5p in tumor progression in breast cancer *Jun '15 - Jun '16*
Guide: Prof. Karunakaran Devarajan *Cancer Biology Laboratory, IIT Madras*

- Established VDAC1 (an important marker in cancer) as a target for microRNA7 using luciferase assay, confirming TargetScan predictions.
- Observed gradient deregulation of VDAC1 in transfections by determining its expression levels.
- Developed stable clones using lentiviral vector and neomycin resistant vector to further determine miRNA function using MTT, flow cytometry, colony forming assay, wound healing assay.

Eco-friendly water desalinator based on microbial desalination technique *Dec '14 – Jun '16*
Guide: Prof. T.S. Chandra *Microbiology Laboratory, IIT Madras*

- Co-founder, AquaBSafe; inducted under Nirmaan, Centre for Innovation IIT Madras to incubate this project with a seed funding of 200,000 INR.
- Developed a prototype with zero discharge and zero external power.
- Measured desalination parameters such as conductivity among others with different salinities of input water.
- Optimizing the setup for enhanced ion removal rates.

S100P derived RAGE antagonist peptide reduces tumor growth in pancreatic cancer *Jun '14 – Aug '14*
Guide: Prof. Thiruvengadam Arumugam t *MD Anderson Cancer Center, Houston*

- Determined the binding of sRAGE with amphoterin by ELISA immunoassays.
- Observed the effect of RAP on tumor growth in vivo by analyzing NF-kB luciferase activity.
- Basic exposure to mammalian cell culture, performing transient transfections and animal handling (mice).

Industrial production and purification of tetanus toxoid vaccine *Jun '13 – Jul '13*
Biological E. Limited, Hyderabad, India

- Monitored industrial processing of tetanus toxoid vaccine.
- Measured parameters such as toxoid and PRP content in PRP TT conjugate to test quality of vaccine batches.

GPS for All Terrestrial Drone *May '12 – Jul '12*
Centre for Innovation, IIT Madras

- Installed a GPS module on All Terrestrial Drone which can navigate through natural and man-made obstacles on any terrain.
- Developed code on Arduino to automatically generate waypoints given the coordinates of initial and final points.