

# PAVAN RAMKUMAR

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## EXPERIENCE

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**NORTHWESTERN UNIVERSITY, CHICAGO, IL**

**Research Associate**

**Oct 2012 — present**

**Advisor:** Konrad Kording

**Collaborators:** Mark Segraves, Lee Miller, Rob Turner, Scott Grafton, Matthew Smith

### **Systems Neuroscience Interests**

Natural Scene Search (Saliency Models, Generalized Linear Models, Frontal Eye Fields),  
Sensorimotor Uncertainty, Reaching (Bayesian Decision Theory, Premotor & Motor Cortex),  
Movement Sequence Learning (Optimal Control Models, Motor Cortex and Basal Ganglia),  
Color Vision, Natural Scenes (Deep Learning, Visual Area V4)

**Experimental Techniques** Primate Psychophysics, Electrophysiology

**Computational Techniques** Generalized Linear Models, Multivariate Decoding, Bayesian  
Behavior, Optimal Control, High-performance GPU/ CPU Computing, Deep Learning

**Training Responsibilities** High-Performance Computing (Cluster/ GPU Server) education and  
infrastructure management

**Software** Python, Spark, Matlab, Github

**AALTO UNIVERSITY, ESPOO, FINLAND**

**Doctoral Candidate**

**Aug 2006 – Aug 2012**

**Advisors:** Riitta Hari, Aapo Hyvärinen

**Collaborators:** Lauri Parkkonen, Sebastian Pannasch, Bruce Hansen, Lester Loschky

### **Systems Neuroscience Interests**

Resting-state Functional Connectivity, Modeling Oscillatory Dynamics, Primary Visual Cortex,  
Rapid Scene Categorization

**Experimental techniques** Magnetoencephalography (MEG), Functional MRI,

**Computational techniques** Dimensionality Reduction, Independent Component Analysis, Multivariate Decoding, Volterra Kernels, Fourier Analysis

**TECHNISCHE UNIVERSITÄT GRAZ, AUSTRIA**

**Summer Intern**

**May – July 2005**

Dynamic Stereo-Visual Servoing of a MITSUBISHI 6-DOF Robot

**INDIAN INSTITUTE OF SCIENCE BANGALORE, INDIA**

**Summer Intern**

**May – July 2004**

Stereo Camera Calibration and Hand Eye Co-ordination of a RHINO XR-3 Robot

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## **EDUCATION**

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**AALTO UNIVERSITY, FINLAND**

PhD in Information and Computer Science

**2012**

**Thesis:** Advances in modeling and characterization of human neuromagnetic oscillations.

**Advisors:** Riitta Hari and Aapo Hyvärinen

**HELSINKI UNIVERSITY OF TECHNOLOGY, FINLAND**

M.Sc. Tech. in Bioinformatics

**2009**

**Thesis:** Modeling the dynamics of human neuromagnetic brain rhythms

**Advisors:** Riitta Hari and Lauri Parkkonen

**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI, INDIA**

B. Tech. Electronics and Communication Engineering

**2006**

**Thesis:** EEG Signal Acquisition, De-Noising and Classification for Biometric Applications

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## **PUBLICATIONS AND SCIENTIFIC SOFTWARE**

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### **JOURNAL PUBLICATIONS**

#### **IN PREPARATION**

[A17] **Ramkumar P**, Turner RS, Körding KP. Control of habitual movements by basal ganglia output structures.

[A16] **Ramkumar P**, Fernandes HL, Smith MA, Körding KP. Hue tuning during active vision in natural scenes.

#### **IN REVIEW**

[A15] Glaser J, Perich M, **Ramkumar P**, Miller LE, Körding KP. Dorsal premotor cortex encodes ubiquitous probability distributions.

## PUBLISHED

- [A14] **Ramkumar P**, Cooler S, Dekleva BM, Miller EL, Körding KP. 2016. Premotor and motor cortices encode reward. **PLoS One**, 11 (8), e0160851.
- [A13] **Ramkumar P\***, Lawlor PN\*, Glaser JI, Wood DW, Segraves MA, Körding KP. 2016. Feature-based attention and spatial selection in frontal eye fields during natural scene search. **Journal of Neurophysiology**, Epub Ahead of Print.
- [A12] Glaser JI\*, Wood DW\*, Lawlor PN, **Ramkumar P**, Körding KP, Segraves MA. 2016. Frontal eye field represents expected reward of saccades during natural scene search. **Journal of Neurophysiology**, Epub Ahead of Print.
- [A11] Dekleva BM, **Ramkumar P**, Wanda PA, Körding KP, Miller LE. 2016. Uncertainty leads to persistent representations of alternative movements in PMd. **eLife**, 5, e14316.
- [A10] **Ramkumar P**, Acuna DE, Berniker M, Grafton S, Turner RS, Körding KP. 2016. Chunking as the result of an efficiency–computation tradeoff. **Nature Communications**, 7, 12176.
- [A9] **Ramkumar P**, Hansen BC, Pannasch S, Loschky LC. 2016. Visual information representation and natural scene categorization are simultaneous across cortex: An MEG study. **Neuroimage**, 134:295–304.
- [A8] **Ramkumar P**, Fernandes HL, Körding KP, Segraves MA. 2015. Modeling peripheral visual acuity enables discovery of gaze strategies at multiple time scales during natural scene search. **Journal of Vision** 15: 9.
- [A7] **Ramkumar P**, Parkkonen L, Hyvärinen A. 2014. Group-level spatial independent component analysis of Fourier envelopes of resting-state MEG data. **Neuroimage** 86: 480–491.
- [A6] **Ramkumar P**, Jas M, Pannasch S, Parkkonen L, Hari R. 2013. Feature-specific information processing precedes concerted activation in human visual cortex. **J Neurosci** 33: 7691–7699.
- [A5] Hyvärinen A, **Ramkumar P**. 2013. Testing independent component patterns by inter-subject or inter-session consistency. **Front Hum Neurosci**, 7 (94).
- [A4] **Ramkumar P**, Parkkonen L, Hari R, Hyvärinen A. 2012. Characterization of neuromagnetic brain rhythms over time scales of minutes using spatial independent component analysis. **Hum Brain Mapp**, 33: 1648–1662.

[A3] Hyvärinen A, **Ramkumar P**, Parkkonen L, Hari R. 2010. Independent component analysis of short-time Fourier transforms for spontaneous EEG/MEG analysis. **Neuroimage**, 49: 257–271.

[A2] **Ramkumar P**, Parkkonen L, Hari R. 2010. Oscillatory Response Function: Towards a parametric model of rhythmic brain activity. **Hum Brain Mapp**, 31: 820–834.

[A1] Malinen S, Vartiainen N, Hlushchuk Y, Koskinen M, **Ramkumar P**, Forss N, Kalso E, Hari R. 2010. Aberrant spatiotemporal resting-state brain activation in patients with chronic pain. **Proc Natl Acad Sci USA**, 107: 6493–6497.

#### SCIENTIFIC SOFTWARE

[S1] **Pyglmnet**: A Python Package for elastic-net regularized generalized linear models. <http://github.com/glm-tools/pyglmnet>; <http://glm-tools.github.io/pyglmnet>

[S2] **Spykes**: A Python Package for visualization, tuning curve estimation and population decoding from spiking neural data. <http://github.com/KordingLab/spykes>

#### CONFERENCE PUBLICATIONS

[P5] **Ramkumar P**, Hansen BC, Lee A, Lanphier S, Pannasch S, Loschky LC. 2014. A high-resolution neural portrait of natural scene processing. Computer Vision and Pattern Recognition (**CVPR**) — Scene Understanding Workshop.

[P4] **Ramkumar P**, Pannasch S, Hansen BC, Larson AM, Loschky LC. 2011. How does the brain represent visual scenes? A neuromagnetic scene categorization study. Neural Information Processing Systems (**NIPS**) — Workshop on Machine Learning and Interpretation in Neuroimaging.

[P3] Klami A, **Ramkumar P**, Virtanen S, Parkkonen L, Hari R, Kaski S. ICANN/PASCAL2 challenge: MEG mind reading—overview and results. 2011. Proceedings of the International Conference on Artificial Neural Networks (**ICANN**), June 2011, Helsinki.

[P2] **Ramkumar P**, Hyvärinen A, Parkkonen L, Hari R. Characterization of spontaneous neuromagnetic brain rhythms using independent component analysis of short-time Fourier transforms. 2010. Proceedings of the 17th International Conference on Biomagnetism (**BIOMAG**), April 2010, Dubrovnik.

[P1] Singhal GK\*, **Ramkumar P\***. Person identification using evoked potentials and peak matching. 2007. IEEE Biometrics Symposium (**BSYM**), Sept 2007, Baltimore.

## CONFERENCE ABSTRACTS

- [C31] **Ramkumar P**, Fernandes H, Smith MA, Kording KP. 2016. Understanding biological computation through synthetic neurophysiology. Deep Learning Summer School, August 2016, Montreal, Canada.
- [C30] Glaser J, Wood D, Perich M, Lawlor P, **Ramkumar P**, Miller L, Segraves M, Kording KP. 2016. Option coding in the movement system. Computational Systems Neuroscience, February 2016, Salt Lake City, Utah, USA.
- [C29] **Ramkumar P**, Acuna DE, Berniker M, Grafton S, Turner RS, Kording KP. 2016. Optimization costs underlying movement sequence chunking in basal ganglia. Computational Systems Neuroscience, February 2016, Salt Lake City, Utah, USA.
- [C28] Wood DK, Berthiaume E, Glaser JI, Lawlor PN, **Ramkumar P**, Kording KP, Segraves MA. 2015. Frontal Eye Fields read out, but do not assign, priority. Society for Neuroscience, October 2015, Chicago, USA.
- [C27] Glaser JI, Wood DK, Lawlor PN, **Ramkumar P**, Kording KP, Segraves MA. 2015. Early Frontal Eye Field Activity Reflects Saccade Expectation Prior to Saccade Selection. Society for Neuroscience, October 2015, Chicago, USA.
- [C26] **Ramkumar P**, Cooler S, Dekleva BM, Miller EL, Kording KP. 2015. A reinforcement signal in motor and premotor cortices. Society for Neuroscience, October 2015, Chicago, USA.
- [C25] **Ramkumar P**, Hansen BC, Pannasch S, Losckhy LC. A rapid whole-brain neural portrait of scene category inference. Vision Science Society, May 2015, St. Pete's beach, Florida, USA.
- [C24] Glaser JI, Lawlor PN, Wood DK, **Ramkumar P**, Caddigan S, Drapekin J, Frick B, Qin B, Kording KP, Segraves MA. The frontal eye field reflects task demands in natural scenes. Society for Neuroscience, November 2014, Washington DC, USA.
- [C23] Wood DK, **Ramkumar P**, Glaser JI, Lawlor PN, Kording KP, Segraves MA. How do frontal eye field neurons ignore distractors while selecting target-relevant features in natural scenes? Society for Neuroscience, November 2014, Washington DC, USA.
- [C22] **Ramkumar P**, Fernandes HL, Smith MA, Kording KP. Shift and gain of color-tuning in V4 neurons is modulated by hue distribution in natural scenes. Society for Neuroscience, November 2014, Washington DC, USA.
- [C21] **Ramkumar P**, Acuna DE, Berniker M, Grafton S, Turner RS, Kording KP. Movement chunking as locally optimal control. Translational and Computational Motor Control, November 2014, Washington DC, USA.

- [C20] **Ramkumar P**, Dekleva B, Wanda P, Fernandes HL, Miller L, Körding KP. Uncertainty modulates timing of neural interaction in PMd during reach planning. Computational Systems Neuroscience, February 2014, Salt Lake City, Utah, USA.
- [C19] **Ramkumar P**, Fernandes HL, Segraves MA, Körding KP. Target relevance modulated primate gaze behavior during natural scene search. Vision Science Society, May 2013, Naples, Florida, USA.
- [C18] **Ramkumar P**, Parkkonen L, Hyvärinen A. Independent component analysis of Fourier energies: characterizing long-range cortico-cortical interactions in magnetoencephalography (MEG) data. Society for Neuroscience, November 2011, Washington DC, USA.
- [C17] Hyvärinen A, **Ramkumar P**, Hari R. Advances in analysis of spontaneous EEG/MEG activity by independent component analysis. 29th International Congress on Clinical Neurophysiology, October 2010, Kobe, Japan.
- [C16] **Ramkumar P**, Hyvärinen A, Parkkonen L, Hari R. Characterization of spontaneous neuromagnetic brain rhythms using spatial independent component analysis of short-time Fourier transforms. International Congress on Default Mode Network, June 2010, Barcelona, Spain.
- [C15] Yokosawa K, Pamilo S, Hirvenkari L, **Ramkumar P**, Pihko E, Hari R. Activation of auditory cortex by anticipating and hearing emotional sounds: an MEG study. 16th Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.
- [C14] Nangini C, **Ramkumar P**, Hari R. SII neurons can phase-lock to trains of bilateral 4-Hz tactile stimuli. 16th Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.
- [C13] Mudigonda M, **Ramkumar P**, Zhu D, Stockman G, Jin R. Multivoxel pattern analysis identifies brain regions that discriminate indoor and outdoor scenes. 16th Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.
- [C12] **Ramkumar P**, Malinen S, Vartiainen N, Hlushchuk Y, Forss N, Kalso E, Hari R. Hub maps reveal reduced resting-state connectivity of insular cortex in patients with chronic pain. 16th Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.
- [C11] Hyvärinen A, **Ramkumar P**, Hari R. Selecting independent components by testing inter-subject reproducibility. 16th Annual Meeting of the Organization for Human Brain Mapping, June 2010, Barcelona, Spain.

- [C10] Hyvärinen A, Zhang K, **Ramkumar P**, Hari R. Analyzing statistical dependencies of MEG source envelopes. 17th International Conference on Biomagnetism, April 2010, Dubrovnik, Croatia.
- [C9] **Ramkumar P**, Hyvärinen A, Parkkonen L, Hari R. Separating independent components of neuromagnetic brain rhythms by combining spatial and spectral sparseness. 17th International Conference on Biomagnetism, April 2010, Dubrovnik, Croatia.
- [C8] **Ramkumar P**, Parkkonen L. Characterization of the temporal structure of neuromagnetic rhythms using clustering and self-organizing maps. 2nd INCF Congress on Neuroinformatics, September 2009, Pilzen, Czech Republic.
- [C7] Parkkonen L, **Ramkumar P**, Hari R. A descriptive model of the dynamics of rhythmic brain activity. 1st INCF Congress on Neuroinformatics, September 2008, Stockholm, Sweden.
- [C6] Hyvärinen A, Parkkonen L, **Ramkumar P**, Hari R. A new method for unsupervised analysis of spontaneous MEG/EEG data: Combination of projection pursuit and parallel factor analysis. 1st INCF Congress on Neuroinformatics, September 2008, Stockholm, Sweden.
- [C5] Hyvärinen A, Parkkonen L, **Ramkumar P**, Hari R. Finding 'interesting' frequency bands in MEG using an unsupervised learning approach. 16th International Conference on Biomagnetism, August 2008, Sapporo, Japan.
- [C4] **Ramkumar P**, Parkkonen L, Hari R. Oscillatory Response Functions: Towards a parametric model of rhythmic activity. PENS Spring School: Models in Neuroscience, April 2008, St. Petersburg, Russia.
- [C3] **Ramkumar P**, Parkkonen L, He B, Raichle M, Hämäläinen M, Hari R. Identification of stimulus related and intrinsic networks by spatial independent component analysis of MEG signals. Society for Neuroscience, November 2007, San Diego, USA.
- [C2] **Ramkumar P**, Parkkonen L, Hari R. Independent component analysis of neuromagnetic data reveals extrinsic and intrinsic cortical networks during natural stimulation. Nordic Neuroinformatics meeting, October 2007, Helsinki, Finland.
- [C1] **Ramkumar P**, Singhal GK, Dandapat S. EEG Correlates of highly cognitive mental tasks for closed-set biometric authentication. International Biometric Conference, July 2006, Montreal, Canada.

## BOOK CHAPTERS

[B2] Creating a Flourishing Innovation Climate. In Bitbang: Energising Innovation, Innovating Energy. 2011. Eds. Yrjö Neuvo and Sami Ylonen.

[B1] Smart Grids: Power to the people, power from the people. In Bitbang: Energising Innovation, Innovating Energy. 2011. Eds. Yrjö Neuvo and Sami Ylonen.

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## INVITED TALKS

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[T17] **Invited Talk**. February 2017. Independent component analysis for MEG/ EEG: a tutorial. Chicago Python User Group, Chicago.

[T16] **Invited Neuroscience Seminar**. November 2016. Using deep learning to reverse engineer preferred stimuli of visual cortical neurons. Loyola University, Chicago.

[T15] **Invited Talk**. September 2016. On the computational complexity of movement sequence learning. Brain & Mind Institute, University of Western Ontario, London, Ontario.

[T14] **Contributed Conference Talk**. August 2016. Pyglmnet: A Python package for elastic-net regularized generalized linear models. PyData Chicago, Chicago.

[T13] **Invited Workshop Speaker**. February 2016. On the computational complexity of movement sequence learning. In: "Towards the real world: naturalistic experiments and analysis". Cosyne, Salt Lake City.

[T12] **Invited Workshop Speaker**. February 2016. The representation of uncertainty in the motor system. In: "Am I attending the right workshop? Certainty and confidence in decision making". Cosyne, Salt Lake City.

[T11] **Invited Colloquium Speaker**. February 2015. Department of Psychological Sciences, Kansas State University, Manhattan, KS. Host: Dr. Lester Loschky.

[T10] **Contributed Conference Talk**. November 2014. Translational and Computational Motor Control, Washington DC.

[T9] **Invited Department Visit**. August 2013. Department of Neuroscience, Indian Institute of Science, Bangalore, India. Host: Dr. Supratim Ray.

[T8] **Invited Group Visit**. June 2013. Neurospin, Paris. Host: Dr. Alex Gramfort.

[T7] **Invited Group Visit**. June 2013. Group for Neural Theory, Paris. Host: Dr. Sophie Deneve.

[T6] **Postdoctoral Candidate**. November 2011. Center for Neural Basis of Cognition, Pittsburgh, PA. Host: Dr. Avniel Ghuman.



[T5] **Postdoctoral Candidate**. November 2011. Sensorimotor Performance Program, Rehabilitation Institute of Chicago. Host: Dr. Konrad Kording.

[T4] **Conference Poster Spotlight**. October 2010. International Neuroinformatics Coordination Facility, Stockholm.

[T3] **Invited Department Visit**. December 2009. Indira Gandhi Center for Atomic Research, Chennai. Host: Dr. M.P.Janwadkar

[T2] **Invited Seminar**. February 2009. BIOMAG Lab, University of Helsinki.

[T1] **Invited Motivational Speaker for high school science class**. December 2008. Symbiosis High School, Pune.

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## AWARDS AND HONORS

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- Finnish Graduate School of Neuroscience **Academic Fellowship**: competitive funding for graduate studies: €55,000
- Aalto University **Doctoral Scholarship** 2011 and 2012 (awarded for thesis proposal within two years and a successful defense within 4 years and under the age of 30): €3,000
- Represented Finland at the annual **Lindau Meeting of Nobel Laureates** in Physiology and Medicine 2011, held in Lindau, Germany. **Acceptance rate under 5%. Appointment by nomination only.**
- **Travel and best abstract awards** from Human Brain Mapping (**HBM**), Biomagnetism International Conference (**BIOMAG**) and International Neuroinformatics Coordination Facility (**INCF**)
- **Visiting Research Fellowship**, Centre of International Mobility, Finland: proposal-based grant funding for visiting researchers: €12,000
- **Indian Academy of Sciences (IAS) Student Summer Fellowship** Programme 2004
- **Institute Merit Scholarship** (awarded for securing highest departmental GPA 2002–2003), IIT Guwahati
- **Gold Medalist** in the **Indian National Chemistry Olympiad**, 2002 (among 28 in India after 4 stages of rigorous theoretical and practical examinations)

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## REFEREE EXPERIENCE

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- **Editorial board member** of Frontiers in Brain Imaging Methods (2012 onwards).
- **Reviewer for journals** including Neuroimage (2011–present), Nature Scientific Reports (2012–present), Frontiers in Brain Imaging Methods (2013–present), Decision (2013–present), PLoS One (2013–present), European Journal of Neuroscience (2013–present), Biological Cybernetics (2014–present), Philosophical Transactions of the Royal Society B (2015–present).

- **Reviewer of abstracts** for the Organization of Human Brain Mapping Annual Meeting 2010.
- Co-organized and reviewed contest submissions for an **MEG data analysis contest**: <http://www.cis.hut.fi/icann11/mindreading.php>

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## LEADERSHIP EXPERIENCE

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### ACADEMIC

- 2016. Mentor of an undergraduate junior, Mayank Agarwal, from Swarthmore College who serves as a part-time developer of Spykes, a scientific Python package for spike train data analysis and visualization.
- 2016. Mentor of four summer research students from Loyola University Chicago who serve as part-time developers of Pyglmnet, a scientific Python package for generalized linear modeling.
- 2015. Mentor of a masters thesis student, Karim Farrag, working on experimental design and modeling of gaze behavior in natural scene search.
- 2015. Instructor of a visiting undergraduate student, Abhishek Ravichandran, working various neural data analyses from population recordings in the motor cortex.
- 2015. Instructed and provided tools for a rotation student, Sam Cooler, working on investigating reward coding the motor cortex. I am first author on a paper resulting from this work, which is currently in press at PLoS One.
- 2014. Instructor of a first year PhD student, Heidi Jiang, for one term, working on testing computational models of decision making.
- 2013. Instructor of a first year PhD student, James Ellis, for one term working on data analysis of neurons in visual area V4.
- 2010–2012. Instructor for a machine-learning and data mining masters thesis student, Kranthi Kumar Nallamothu, on eye-gaze-based classification of visual stimuli.
- 2011. Served as a mentor and instructor to an international summer student, Mainak Jas. I proposed the summer project and was responsible for hiring and supervising his work, which resulted in a publication in the Journal of Neuroscience.
- 2010–2011. Mentored and edited interdisciplinary teams of PhD students working on book chapters related to entrepreneurship, services, energy, and innovation: <http://mide.aalto.fi/en/BitBang10-11>. Co-organized an industrial visit from Helsinki to Bangalore.

### EXTRACURRICULAR

- Vice-president of the founding board of a university-wide organization called **Aalto Social Impact**, which strives to support social entrepreneurship and promote social consciousness. I participated in building the vision, setting strategic directions, putting together a team of international board members, as well as organizing various events: <http://www.aaltosi.org>
- Founded and ran a monthly event series where I screened talks from leading multidisciplinary conferences such as **TED** and moderated free discussion to a public audience with the intention of increasing curiosity towards great ideas. Organized **TEDx** meetings are part of the series.