Vikram Pal Singh

Centre for Neuroscience, Indian Institute of Science, Bangalore-560012 |+91-8861668233| vikram@iisc.ac.in | vikrampalsingh17@gmail.com |web profile: www.vikrampsingh.com

Objective

Understanding the neural correlates of complex behaviours in animals. I want to understand how neuronal engrams can arrive at very complicated behaviours with the help of memory networks and mental schema. I want to understand how these abstractions (mental schema) of external environment and experiences dictates the ability of an animal to successfully solve a problem and how these complexities break down in scenario of a neurodegenerative disease. The neural underpinnings of such behaviours is rather poorly understood and I believe that given the current advancements in imaging (microscopy), electrophysiology, real time photometry, endoscopy (miniscope) and signal processing, we may be able to address such interesting questions.

Education

Research Associate| 2019-present | INDIAN INSTITUTE OF SCIENCE

- Department: Centre for Neuroscience
- Project: Role of systems consolidation in formation of mental schema.

PhD| 2014-2019 | INDIAN INSTITUTE OF SCIENCE

- Lab: The Neurodynamics Lab
- Department: Centre for Neuroscience
- Project: Mental Schema and its role in problem solving

Integrated PhD | 2012-2014 | INDIAN INSTITUTE OF SCIENCE

- Division: Biological Sciences
- I was selected as one of the 12 students across the country for the year 2012 in the highest ranked institute of the country. My selection was based on rigorous evaluation which included written examination followed by interview process.
- Coursework: General Biochemistry, General Biology, Introduction to Biophysical Chemistry, Essentials in Microbiology, Genetics, Proteomics, Mathematics and Statistics for Biologists, Evolutionary Biology, Macromolecular Crystallography, Gene Expression and Development, Cellular Neurophysiology, Molecular and Cellular Biology, Introduction to Neuroscience, Optical Spectroscopy and Microscopy, Topics in Molecular and Cellular Neuroscience, Computer Aided Designs.
- Result: ***CGPA: 6.2/8***

Bachelor of Science | 2009-2012 | ABASAHEB GARWARE COLLEGE, UNIVERSITY OF PUNE

- Department: Microbiology
- Coursework: Chemistry, Zoology, Microbiology, Botany, English, Environmental Awareness ·

Result: ***First Class with Distinction***

Awards

- Invited speaker at ***Zeiss Microscopy Conclave 2019***, Bangalore – Multiphoton microscopy: Bench to brain.
- ***Most Deserving student*** of the year 2010, AGC, Pune
- Chemiad-2010 Pune district ***2nd Rank***
- Pune inter College consortium- Nurturing Nourishing Talent ***PICC-NNT fellowship*** 2011
- Pune city ***inter-college Archery competition*** 2011, 4th Rank
- Represented Pune city at ***Zonal Archery competition*** 2011
- ***Student of the year*** for all round performance, 2012, AGC, Pune
- Firodiya Karandak, on stage live art and drama exhibition, 2012: Awarded for painting
- Elected as the ***General Secretary*** for sports and culture, Indian Institute of Science, 2015-2017

Publications and conference abstracts

- Singh A, Kumar S, **Singh VP**, Das A and Balaji J; *"Flavor Dependent Retention of Remote Food Preference Memory"*. Frontiers in Behavioral Neuroscience 11:7(2017)
- Singh A, Kumar S, **Singh VP**, Balaji J; *"Optical microscopy methods for understanding learning and memory"*. Current Science 105, 1537–1548 (2013)
- **V Singh**, S Shridhar, S Kundu, R Bhatt, S Sam, A Singh, S Kumar, J Balaji; *"Differential influence of neocortical networks (mental schema) in relational and abrupt learning."* Chicago: Society for Neuroscience, 2015
- **V Singh**, R Bhatt, S Kundu, S Shridhar, A Singh, S Sam, B Jayaprakash; *"Acquisition dependent influence of mental schema on problem solving in mice."* San Diego: Society for Neuroscience, 2016
- **V Singh**, R Bhatt, S Kundu, S Shridhar, A Singh, S Sam, B Jayaprakash; *"Bayesian nature of remote memory assisted learning (Mental Schema) and its role in problem solving in mice."* Washington, DC: Society for Neuroscience, 2017
- **V Singh**, R Bhatt, S Kundu, S Shridhar, A Singh, S Sam, B Jayaprakash; "*Prior Schema Assists in Acquiring Complex Multitude of Information and Acts as a Substrate for Emergence of Novel Solution Through Schema Completion*" [*Manuscript under preparation*]

  "*Memories of related events and facts are stored in form of neocortical associative networks (mental Schema) and they help in rapid consolidation of new memories. In our current study we investigated if such networks can facilitate in acquiring multitude of such complex information sets. We demonstrate that such multitude of schematically related associations can be acquired only when presented in relation to pre-existing schema in a graded manner. Once acquired we investigated the role of such memory networks in solving problems that are derived from prior knowledge. Specifically, we wanted to ask if prior acquisition of multiple schema can help in acquiring new schema even when presented partially. Such kind of "completion" mechanism can serve as a vital substrate for the emergence of novel solutions that were not taught before. We show that mice having acquired two different schematic network of flavor place associations in a continuous fashion, can find the correct place in their first exposure without any training, for a new configuration that is mix of previous 2 configurations."*

- A Singh, S Kundu, **V Singh**, S Saumitra, J Balaji; "*Hippocampus-dependent acquisition and rapid systems consolidation of new learning through elemental second-order conditioning during remote retrieval of contextual memories*" [*Manuscript under preparation*].

Research experience

- I had the opportunity to work at National Centre for Cell Science after being shortlisted as one of the PICC-NNT fellow during my graduation and worked with DNA sequencing of gut microbiota. My project was titled: ***"To find out the microbial gut flora of wild and captive animals and study its significance. (16S rRNA gene seq.)"***. This was my first exposure to experimental labs, and I knew that I will continue in research.
- I got selected for Integrated PhD program at Indian Institute of Science in 2012 and as per the design of the program, did 3 compulsory lab rotations in Neuroscience, Cell and Microbiology; and Molecular Reproduction and Developmental Genetics.
- For my first lab rotation I worked with Dr. Balaji Jayaprakash and characterized the ***pulse profile*** of ultrafast laser pulses used for in-vivo imaging. I also set up a ***prism pair pulse compression unit*** to control the temporal profile of the pulse.
- In my second lab rotation, I worked with Prof. Saumitra Das to determine the ***p47/p53 ratio in various cancerous cell lines.*** During this rotation, I learnt working in a tissue culture lab, extracting proteins from cells and quantifying using western blots.
- In my third lab rotation, I worked with Zebra fish actin protein under the supervision of Prof. Upinder Nongthomba. My objective was to ***differentiate the two kinds of actin proteins found in zebra fish***, i.e. cardiac muscle and skeletal muscles. I used confocal microscopy; and performed protein extraction and quantification from intact tissue.
- I joined The Neurodynamics lab in 2014 and started working on ***the role of remote memories in new acquisition and problem-solving*** using mice as the animal model. I developed, fabricated and calibrated an animal behavioral paradigm to ask such a question since no such paradigm existed in mice at that time. I have been conducting animal behavior studies since then and have presented my work at multiple national and international platforms. I have developed imaging methods using multimodal fiber bundles to image in wake-behaving animals. I performed craniotomy in animals and in-vivo imaging in transgenic animals using multi-photon microscopy. I have performed transcardial perfusion and stained the extracted experimental animal brains for Immediate early genes for studying the activation patterns relevant to the behavior (fluorescent ImmunoHistoChemistry). I also developed an artificial neural network based on contrastive Hebbian learning to simulate the behavioral results achieved from experiments with mice.

Projects and training

Behaviour:

- Designed, developed and established an event arena-based flavor place association task in mice.
- Designed small animal behavior experiments in mice to study mental schema.
- Developed a novel task to test problem solving in mice using the custom-built setup.

Optics:

- Pulse width measurement of ultrafast laser (of the order of 100s of femtoseconds) using Michelson interferometer.
- Pulse width compression setup using prism pair dispersion compensation unit.
- Developing a multimodal fiber imaging system to image real time neuronal activity in behaving animal.
- In effort to study sub cellular structural changes and IEGs activation simultaneously, I developed a reflective Golgi imaging method that gives us the ability to image both Golgi staining and fluorescent staining using the same scanning fluorescent microscope.

Molecular Biology:

- Immunohistochemistry for immediate early gene staining (*c-fos, Arc*).
- Transcardial perfusion in mice for extracting brains post behaviour.
- Tissue culture for viral preparation to infect neurons and express excitatory/inhibitory channel Rhodopsins.
- Clarity and RTF– rendering the brains transparent for imaging thick sections under standard confocal microscope.

Softwares developed:

- Real-time mice tracking algorithm using Simulink Matlab workflow.
- Image acquisition apps using Matlab
- Random data sheet generator for complex experiments.
- Real-time interactive 3D environment for mice using C++ and OpenGL to be used for Virtual Reality in mice.
- ImageJ plugins for generating heatmaps for custom analysis.
- Analysis in Netbeans 8.0 using Java programming language.
- Automating behavioral apparatus using Arduino UNO and Raspberry-pi.
- 3D modelling using FreeCAD.
- 3D printing custom-designed parts.

Extracurricular activities

- I have been practicing Archery at a professional level since 2010 and have established my own archery club *(The Falcons)* at IISc.
- I have been coach for archery since 2013 and have participated at inter college and zonal level archery competitions.
- I have been playing Ultimate frisbee and have been to many national tournaments since 2016.
- I have been the spirit captain for my ultimate frisbee team for many tournaments.
- I also like to play badminton and like to trek or go to long rides on my bike whenever I get a chance.
- I like to make small circuits and robots using Arduino and like to animate and do 3D modelling.
- I am a freelance digital artist with knowledge of software like Adobe Photoshop, Adobe Illustrator, Adobe Flash, Autodesk Maya, Adobe After Effects, FreeCAD, VideoScribe and ZBrush.
- I like to do human figure oil painting and cartoons using watercolors. I believe that sometimes science is more art than science and art and science go hand in hand.
- I like to play Piano and classical instrument Tabla.

References

- **Dr. Balaji Jayaprakash**, Assistant Professor, Centre for Neuroscience, Indian Institute of Science, Bangalore; Contact: ***jbalaji@iisc.ac.in***, Office: (+91)-80-2293-3049
- **Dr. Naren Ramanan**, Associate Professor, Centre for Neuroscience, Indian Institute of Science, Bangalore; Contact: ***naren@iisc.ac.in***, Office: (+91)-80-2293-3532
- **Prof. Aditya Murthy**, Professor, Centre for Neuroscience, Indian Institute of Science, Bangalore; Contact: ***adi@iisc.ac.in***, Office: (+91)- 80 2293 3290