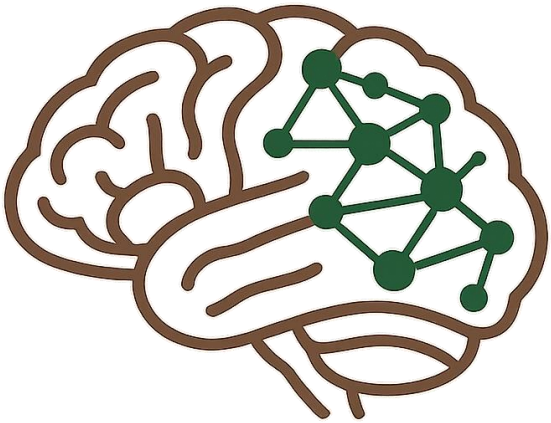
भारतीय विज्ञान संस्थान

CENTRE FOR NEUROSCIENCE



CNS SYMPOSIUM

CENTRE FOR NEUROSCIENCE

2025

CNS Annual Symposium 2025

13th September, Saturday

Teams link for the Symposium:

Join the meeting now

Meeting ID: 474 923 159 659 2

Passcode: kW6GW95Y

Schedule for CNS Symposium

(13th September 2025)

Time	Event	Speaker	Lab/Organization	Title
08:45 am	Tea/Coffee			
08:55 am	Welcome address	Prof. SP Arun	CNS	
09:00 – 09:15 am	Talk 1	Somesh Shingane	Adi lab	Dynamics of different sensorimotor perturbations on motor learning
09:15 – 09:30 am	Talk 2	Shrivallabh Deshpande	Deepak lab	Investigating the Role of Amyloid Precursor Protein in the Development of Alzheimer's Disease
09:30 – 09:45 am	Talk 3	Raj V Jain	Sridharan lab	The neural basis of serial dependence in visuospatial attention
10:00 – 11:00 am	**Keynote Address**	**Prof. Sheeba Vasu**	**JNCASR**	**From behaviour to molecules - a fly model to investigate human movement disorders**
11:15 – 11:30 am	Talk 4	Rajesh Mandal	Balaji lab	fNIRS-Driven Cortical Hemodynamic-Metabolic Mapping Reveals Increased mPFC activity During Spatial Memory Retrieval
11:30 – 11:45 am	Talk 5	Lipika Taneja	Srikanth lab	Modulation of reward prediction errors by negative emotion
11:45 – 12:00 pm	Talk 6	Rishika Sharma	Ashesh lab	Exploration of complex environments is guided by generalization and uncertainty
12:00 – 12:15 pm	Talk 7	Sveekruth Pai	Supratim lab	Is a Picture worth a thousand Dimensions?
12:15 – 12:30 pm	Talk 8	Jhilik Das	Arun lab	Seeing through the blur: how familiarity shapes blurry object representations in monkey visual cortex
12:30 – 01:00 pm	Poster session 1			
01:00 – 02:00 pm	Lunch			
02:15 – 03:00 pm	Poster session 2			
03:00 – 03:15 pm	Photo session			
03:30 – 03:45 pm	Talk 9	Vanika Dhingra	Deepak lab	How Plasticity shapes condensation at the excitatory postsynapse
03:45 – 04:00 pm	Talk 10	Vishesh Choudhary	Sridharan lab	Training attention using neurofeedback
04:00 – 04:15 pm	Talk 11	Surbhi Munda	Arun lab	Is neural activity in inferotemporal cortex during real-world vision fundamentally different or more variable than during screen-based tasks?
04:15 – 04:30 pm	Tea/Coffee			
04:30 – 05:30 pm	**Panel Discussion**	**Moderator: Prof. Aditya Murthy**	**CNS**	**Careers in Neuroscience: From Research to Society** **Panel members:** • **Mr. Ananthapathmanabhan A. P. – Science Communicator** • **Prof K.V.S. Hari - Director, Centre for Brain Research** • **Prof. K. VijayRaghavan - NCBS**
05:30 pm	Closing remarks	Prof. SP Arun	CNS	
High tea				

Oral Presentations

Dynamics of different sensorimotor perturbations on motor learning

Name: Somesh Shingane

Supervisor: Dr. Aditya Murthy

Abstract:

Motor adaptation enables accurate movement by compensating for environmental changes. Such adaptive learning can involve dynamics that involve either feedforward, feedback control or even a combination of both. To distinguish between these alternatives, we assessed the dynamics of learning induced by two different perturbations: a target jump, and a cursor rotation. In target jump perturbation the reaching target location is switched during the reaching movement and in gradual rotation perturbation the reaching movement feedback is gradually mismatched over the course of a session. Our analysis revealed movement generated to counter target jumps occurred primarily via feedback control, while countering gradual rotation was accomplished through feedforward control. Further analysis of these perturbations revealed a striking similarity between the properties of explicit and implicit process of adaptive learning similar to that suggested by previous studies. Adaptation to gradual rotation resulted in lower learning rates, reaction time, saving extent, generalizations, and high retention mimicking the implicit process; and high learning rates, reaction time, saving extent, generalizations, and low retention for the target jump perturbation mimicking the explicit process of learning suggested in previous work. Taken together, these results allow the isolation of implicit and explicit processes in a single task and enable the testing of how implicit and explicit motor learning interacts during motor learning. Further, these findings motivate us to examine the dynamics of learning sudden rotation perturbation, which involves the simultaneous interplay of explicit and implicit learning processes by using a novel forward approach – which is rather conventionally inferred in an inverse manner. These findings open a new window to understand the dynamics of different perturbations in isolation and in conjunction to study their interactions.

Investigating the Role of Amyloid Precursor Protein in the Development of Alzheimer's Disease

Name: Shrivallabh Deshpande

Supervisor: Dr. Deepak Nair

Abstract:

Alzheimer's disease (AD) is the leading cause of neurodegeneration worldwide. Predominantly, resources are directed to efforts targeting the amyloid-beta peptide in the hope of treating AD (Cummings et al., 2023). The lack of a cure and the high failure rate of anti-Alzheimer drugs in various stages of clinical trials points to the voids in our understanding of the onset of AD and the prevalent management strategies. We are primarily interested in understanding the role of the Amyloid-beta precursor protein (APP) in causing AD. Making use of super-resolution microscopy, we have shown that the APP is distributed heterogeneously in the functional zones of the synapse as nanodomains. These nanodomains, which are on the order of a few tens of nanometres, are dynamically modulated over time (Kedia et al., 2020). Our observation has also highlighted the discrete association of the APP nanodomains with that of secretases (Kedia et al., 2021). The heterogenous distribution of the amyloidogenic proteolytic machinery and the stochasticity in product formation provide new evidence of factors possibly regulating the pathogenesis of AD. This is now an interesting prospect for generating targeted molecules for controlling the APP nanodomain formation transiently, which opens a novel therapeutic window for addressing the pathogenesis of AD. Currently, there is a lack of detailed biochemical and biophysical studies that characterize this nano-organization. Emerging evidence points towards phase separation having an important role in formation of the nanodomains and I'll be presenting our initial body of work on the in-silico phase separation studies of the APP.

The neural basis of serial dependence in visuospatial attention

Name: Raj V Jain

Supervisor: Dr. Sridharan Devarajan

Abstract:

Events in the recent past – even those that are no longer relevant – may be tracked implicitly by the brain and influence our decisions. While such "serial dependence" has been observed ubiquitously in various cognitive phenomena, its neural basis remains unclear.

Here, we investigate serial dependencies in behaviour with a probabilistically cued visuospatial attention paradigm (n=26 participants; Sengupta et al., 2024). In this experiment, participants performed a change detection/localization task across a series of pseudo-randomly sampled trials. Training a long short-term memory network (LSTM) to predict participants' trial-wise behaviour from task variable history, we identify robust serial dependency effects in response times, that is, task variables in past trials, despite being irrelevant to current trial performance, influence participant response times in the current trial.

The posterior parietal cortex (PPC), a region crucial for visuospatial attention, has been shown to causally mediate serial dependence in rodents; similar evidence in humans is correlative at best. Here, we investigate whether the PPC causally mediates serial dependence in humans. By functionally inhibiting the PPC with 40-Hz transcranial alternating current stimulation (tACS), we observe significant reduction in magnitude of serial dependence effects in participant response times.

Expected gradients-based feature attribution of the trained LSTM models reveals a graded influence of past trials on current behaviour and traced tACS effects to a reduced impact of past stimuli and perceived validities. Finally, race modelling (Bogacz et al., 2006) of participant choices and response times suggests that tACS affects serial dependence by altering the starting point for evidence accumulation for uncued responses.

Our findings suggest a causal role of the human PPC in serial dependence. In particular, the PPC may mediate history-driven selection by which attentional choices from recent past influence current behaviour.

fNIRS-Driven Cortical Hemodynamic-Metabolic Mapping Reveals Increased mPFC activity During Spatial Memory Retrieval

Name: Rajesh Mandal

Supervisor: Dr. Balaji Jayaprakash

Abstract:

Visualizing brain activity has inspired a spectrum of modalities with distinct mechanisms, including EEG, MEG, fMRI, and PET. Functional near-infrared spectroscopy (fNIRS) is a powerful optical modality that non-invasively monitors the molecular basis of neural activity that exploits near-infrared light to traverse scalp and skull, enabling cortical measurements linked to cellular energy (ATP) metabolism. By probing molecular states in oxidative pathways- specifically oxygen and cytochrome-c oxidase, fNIRS provides temporally resolved, region-specific signatures of neural function.

In this talk, I will present our lab-developed custom fNIRS devices and how these devices quantify oxygen demand via changes in oxygenated and deoxygenated hemoglobin (Δ[HbO], Δ[Hb]) and capture oxygen utilization through shifts in the redox state of cytochrome-c oxidase (oxCCO). Using these signals, we generate hemodynamic and metabolic maps of the human forebrain during cognitive tasks along with putative hot spots of metabolic inefficiency, showing spatial activation patterns and temporal dynamics that characterize cortical engagement during probe trials.

Modulation of reward prediction errors by negative emotion

Name: Lipika Taneja

Supervisor: Dr. Srikanth Padmala

Abstract:

Reward prediction errors (RPEs)—the difference between expected and actual outcomes—are central to reinforcement learning and adaptive decision-making. They are typically encoded by midbrain dopaminergic neurons and reflected in activity across target sites in the striatum and prefrontal cortex. While the role of RPEs in guiding behaviour through reward learning is well established, less is known about how emotional context—particularly task-relevant negative emotional information—influences this process. Studying how negative emotion shapes RPE processing is important for uncovering mechanisms underlying multiple affective disorders. In this fMRI study (N=32; 14 F; Age: 23.2±2.8 years), we investigated the modulation of RPE-related brain activity by negative emotion. We hypothesized that this modulation could be driven either by the valence or the salience of negative stimuli relative to neutral. Participants performed a guessing task in which they could win monetary reward, where each trial had either a high (80%) or a low probability (20%) of winning reward. In the absence of emotional information, we observed RPE signals in the ventral striatum and substantia nigra/ventral tegmental area, replicating previous findings. However, in the main phase, the outcome was indicated by an emotional image—either negative or neutral—mapped explicitly to indicate reward or no-reward outcome. In this phase, we found a significant interaction between RPE type (positive vs. negative) and outcome emotion (negative vs. neutral) in a right dorsolateral prefrontal cortex (dlPFC) cluster, driven by a significant reduction in the positive RPE related activity when the outcome was signalled by a negative (relative to a neutral) image. These findings suggest that the dlPFC is engaged in the modulation of RPE signals by negative stimuli that is primarily driven by the competing valence between reward and emotional information. Overall, our study contributes to the emerging role of dlPFC in reward learning during affective contexts.

Exploration of complex environments is guided by generalization and uncertainty

Name: Rishika Sharma

Supervisor: Dr. Ashesh Dhawale

Abstract:

Resources in natural habitats vary over both space and time. Foraging in the wild requires animals to solve a complex search problem and learn which of many sites yields the most resources. In contrast, laboratory studies of foraging typically employ simple two-choice tasks, where learning models assume the brain maintains and updates a look-up table of preferences for every available option. Such models do not scale well to the numerous options available during real-world foraging, as they are memory-intensive and cannot easily generalize outcomes to other options. Furthermore, little is known about the neural circuits underlying exploration of complex spaces.

To investigate this question, we developed a four-choice task for rats with time-varying probability of reward at each option. We automated this task to collect large datasets spanning hundreds of thousands of trials from individual animals. We found that rats robustly identified the best option by employing a local search strategy that was more likely to sample nearby choices than those farther away. Such a strategy benefits animals by assisting in generalizing previous experience to unknown choices. We also found that rats' exploratory behaviour was modulated both by reward outcomes as well as uncertainty – rats were more likely to explore after unrewarded outcomes as well as the beginning of training sessions when there was less information on choice outcomes.

To identify the neural correlates of exploration, we recorded changes in dopaminergic activity in the midbrain, which is known to encode reward prediction error. Importantly, we found that dopaminergic input to the striatum generalized the outcome of one choice to other alternatives, pointing towards a neural mechanism for executing exploratory strategies. Our findings show that the brain explores complex environments guided by uncertainty, generalizes the results of exploration, and that this exploratory strategy relies on the midbrain.

Is a Picture worth a thousand Dimensions?

Name: Sveekruth S Pai

Supervisor: Dr. Supratim Ray

Abstract:

Images are an interesting class of stimuli in visual neuroscience. They are vast when compared to the more traditional gratings or shapes, yet they possess a structure not found in randomly generated (white noise) pixels. Moreover, they are ecologically relevant.

Understanding how the brain represents this diverse class is an ongoing challenge. From a computational standpoint, a simple fullscreen image contains over a million pixels, and the neural responses we measure, local field potential (LFP) from a microelectrode grid, are in thousands of timepoints. Is the encoding problem similarly high-dimensional in nature?

My latest results suggest that this might not be the case. Just like how images can be compressed, we can ask the same of the neural responses they generate. In this talk, I apply the popular dimensionality reduction methods, Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), on LFP data obtained from the Macaque Primary Visual Cortex (V1) during a passive fixation task on grayscale images. Both being linear approaches, they yield a few interpretable components/dimensions of LFP signals that account for most of the variance in the data. These features form a low-dimensional subspace that can be exploited for efficient encoding - one of the tenets of the predictive coding hypothesis, whereby neuronal populations may be feeding forward only differences from predicted pixel structure.

This effort is aligned with one of the sub-themes of the Brain, Computation, and Data Science (BCD) Moonshot Project - to eventually decode images from brain signals.

Seeing through the blur: how familiarity shapes blurry object representations in monkey visual cortex

Name: Jhilik Das

Supervisor: Dr. SP Arun

Abstract:

We explored whether prior familiarity changes blurred object representation in non-human primates. Two monkeys were familiarized with different sets (two sets of four unique shapes each), where each set was familiar to one monkey only. To test how blurriness affects object representation, we applied 2D Gaussian smoothing kernel with different standard deviations to each shape, generating nine blur levels (80 images total, including eight sharp images). Monkeys were familiarized only with sharp images. In a passive fixation task, we presented all 80 shapes randomly, while recording neural activity from the inferotemporal cortex, a region involved in higher-order visual processing.

Consistent with earlier studies, firing rates to unfamiliar sharp images were higher than to familiar sharp ones. However, as blur increased, this pattern reversed: responses became higher for blurred familiar shapes, driven by more units preferring intermediate blur levels in the familiar set.

Next, we classified units by familiarity preference at sharp: (1) sharp-familiar-preferring, and (2) sharp-unfamiliar-preferring. Group 1 units generalized better from sharp to blurry familiar images in a four-way shape decoder trained on familiar and unfamiliar sharp images separately, suggesting familiar blurry shapes are easier to identify. Also, neural responses to blurry shapes were explained better by multiplying shape and blur tuning than by adding them, with difference between these two models larger for familiar shapes in group 1 units. Interestingly, group 2 units shifted preference toward familiar shapes under blur, while group 1 maintained their familiar preference, showing that these two groups adapt differently to blurry visual inputs.

Taken together, our study shows that blur and shape information combine multiplicatively at the neuronal level, and prior familiarity improves identification of blurred objects. We also identified two neural populations: one maintaining, the other shifting familiarity preference from sharp to blur images. These findings highlight diverse adaptation strategies to degraded visual input.

How Plasticity shapes condensation at the excitatory postsynapse

Name: Vanika Dhingra

Supervisor: Dr. Deepak Nair

Abstract:

Synaptic plasticity depends on precise molecular reorganization within the postsynaptic density (PSD), but the physical principles driving this remodelling remain unclear. Emerging evidence highlights liquid–liquid phase separation (LLPS) as a fundamental mechanism organizing postsynaptic proteins. This study explores how PSD95, a key PSD scaffold protein, undergoes phase separation modulated by synaptic plasticity.

We show that purified PSD95 forms condensates via LLPS in vitro, and their assembly properties can be influenced by neuronal activity through signalling pathways that regulate scaffold dynamics. Extending these findings to neurons, we examined PSD95 and the GluA2 subunit of AMPAR during experimentally induced plasticity paradigms, including Hebbian and homeostatic plasticity. Utilizing 3D-DNA PAINT microscopy with density-based segmentation, we quantified nanoscale protein organization and phase separation parameters of the two proteins.

Our results reveal Hebbian plasticity bidirectionally modulates PSD95 condensates. LTP enhances the condensation propensity of PSD95 that clusters receptors and strengthens synaptic efficacy. Conversely, LTD reduces condensate stability and broadens PSD95 distribution, reflecting condensate relaxation that facilitates receptor dispersal and synaptic weakening. Homeostatic plasticity similarly promotes broader redistribution, supporting synaptic scaling mechanisms. Changes in GluA2 organization closely parallel PSD95 scaffold remodelling, underscoring coordinated regulation through phase separation.

These findings establish LLPS as a dynamic, regulatable mechanism linking biochemical signalling to structural synaptic remodelling. Integrating phase separation physics with plasticity paradigms provides a biophysical framework for understanding synaptic weight encoding and adjustment in neurons.

Training attention using neurofeedback

Name: Vishesh Choudhary

Supervisor: Dr. Sridharan Devarajan

Abstract:

Attention lapses occur frequently and can have a significant impact on daily functioning. Despite an extensive literature on attention, the neural processes that enable mitigating and recovering from attention lapses remain poorly understood. Consequently, improving attention in healthy individuals or treating attention deficits in clinical populations often involves administering systemic medications, with potentially adverse side effects.

In this project, we explore a non-invasive alternative -- closed-loop neurofeedback -- to train sustained attention abilities in healthy individuals. Previous neurofeedback studies utilizing electroencephalography (EEG) or magnetoencephalography (MEG) in humans have provided limited evidence for sustained attentional benefits that outlast training or generalization across task domains. In the first aim, I will describe a neurofeedback training paradigm using real-time EEG recordings to enhance sustained spatial attention in healthy human participants.

Specifically, we designed a novel task to help participants continuously monitor lapses in their attention by tracking steady-state visually evoked potential (SSVEP) power. Our task involves three elements of novelty over conventional neurofeedback designs: First, incorporating an urgency signal and a dynamic baseline enabled greater task engagement and successful control of neurofeedback. Second, we demonstrate attentional improvement in a distinct attention task – a continuous performance search task (CPST); this improvement occurs even following a single session of neurofeedback training but is not present in control participants. Third, I will show that the observed enhancement in attention generalizes across both trained and untrained spatial locations, but again only in neurofeedback participants. Finally, we identify the neural correlates of these behavioural improvements: classification of neural data with linear discriminant analysis (LDA) revealed increased separability of attention-related neural states after neurofeedback training, in neurofeedback, but not in control participants.

Is neural activity in inferotemporal cortex during real-world vision fundamentally different or more variable than during screen-based tasks?

Name: Surbhi Munda

Supervisor: Dr. SP Arun

Abstract:

It is widely believed that neural activity during real-world vision is either fundamentally different or more variable compared to controlled screen-based tasks. This is because each trial in a real-world task might involve variations in when and how an object is viewed and could involve additional influences due to movements. However, since neural activity has rarely been recorded in both controlled and natural settings, this remains an untested proposition.

To address this fundamental gap in our knowledge, we developed a naturalistic environment and a touchscreen workstation to study real-world vision and a screen-based vision respectively. We performed wireless brain recordings from inferior temporal (IT) and premotor/prefrontal (PMv/PFC) cortex of two monkeys while they performed two tasks. In the fixation task, monkeys viewed images of natural objects and in the naturalistic task, they moved freely through an arena to take different food rewards offered by different experimenters across many trials. To investigate visual information present in each task, we trained linear decoders on the recorded neural population to infer the food & experimenter identity on each trial of the natural task.

Our main findings are as follows: (1) Food & experimenter identity during the naturalistic task could be reliably decoded using decoders trained on the fixation task at specific event times; (2) Food was decodable from IT during the fixation task but from IT & PMv during the natural task, presumably because different foods involved different grasps; experimenter identity could be reliably decoded from IT in both tasks; (3) neural activity during the naturalistic task was systematically different around the times of key events during the trial in both IT & PMv/PFC; (4) When decoders are trained on all available trials, food & experimenter decoding was more accurate during the fixation task compared to the naturalistic task, which supports the hypothesis that natural vision is more variable. However, this advantage reversed on considering matched numbers of trials in the fixation and naturalistic task, i.e. the decoding was more accurate in the naturalistic task. When decoders were trained on matched trials from a limited number of views per object in the fixation task, we obtained similar accuracy in the fixation and naturalistic task.

Taken together, our results show that neural activity during real-world vision is less variable than previously thought and can be systematically related to neural activity during controlled fixation tasks.

Poster Presentations

S.No.	Name of Presenter	Title of Poster
1	Mainak Biswas	Semi-supervised Deep Transfer for Regression without Domain Alignment
2	Yatika	D1R-specific modulation of ACC mitigates chronic neuropathic pain
3	Mousmi Rani	A Parabrachial-thalamic Circuitry governing Nociplasticity
4	Pradeep Gade & Ishatpreet Singh	Modulating PV Interneurons to investigate Memory Interference during Systems Consolidation in Mice
5	Atharva Modi	Role of corticostriatal circuits in trial-and-error learning of movement kinematics
6	Vaishnavi Adella	Neural inference of object hollowness from dynamic physical cues
7	Kalpajyoti Hazarika	Small amplitude motor units are modulated by self-initiated reach movements
8	Meera Krishnan E R	Investigating the Synaptic Heterogeneity in Amyloid Precursor Protein Processing and Its Role in Spatio-Temporal Onset of Alzheimer's Disease
9	Prankur Saxena	Affective-cognitive crosstalk in dual-tasking and the domain specific limits of motivational control
10	Deepak Raya	Flexible reconfiguration of visual working memory across gaze shifts
11	Anusha Rastogi	Characterizing the role of CLC-3, a claudin-like molecule in olfaction in Caenorhabditis elegans
12	Shashank Gouroju	Quantifying Contextual Effects of Chromatic and Achromatic Stimuli in Macaque Primary Visual Cortex
13	Dr. Kavita Babu	Elucidating the role of neuropeptides in the regulation of amplitude of body bends of Caenorhabditis elegans
14	Debdyuti Bhadra	Encoding of self and partner joints in high level visual and motor regions in socially interacting monkeys
15	Sanjna Kumari	Dorsoventral gradients in intrinsic neuronal excitability of rat hippocampal granule cells and mossy cells
16	Sarang Saini	Dopamine-induced reduction of subthreshold excitability in rat dentate gyrus granule cells contributes to pattern separation
17	Rituparna Chaudhuri	Establishment of Human Induced Pluripotent Stem Cell (iPSC) lines for the Study of Dementia Using Well-Characterized Longitudinal Cohorts
18	Shreshth Jaiswal	Co-dependent changes in multiple ion channels implement characteristic dopaminergic neuromodulation of heterogeneous hippocampal pyramidal neurons
19	Anjana S	Task-dependence of network-to-network variability in learning, performance, and dynamics of heterogeneous recurrent networks