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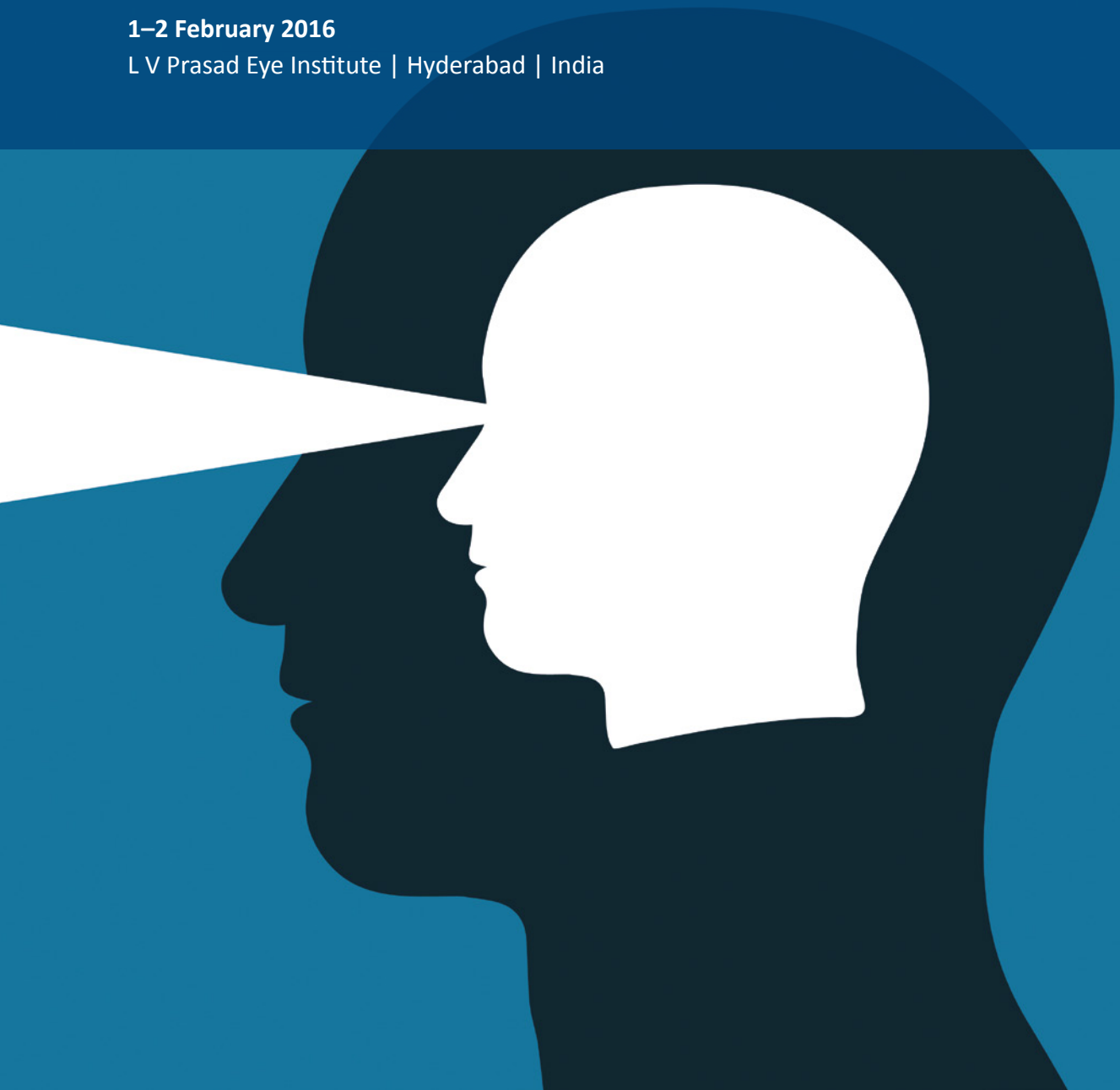
INSA-Leopoldina Symposium “Brain and Eye”

Joint Academies’ Symposium by the Indian National Science Academy (INSA) and the German National Academy of Sciences Leopoldina

1–2 February 2016
L V Prasad Eye Institute | Hyderabad | India



Impressum

Cover Image
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Content & Editing
German National Academy of Sciences Leopoldina
International Relations Department

Design
unicom Werbeagentur GmbH | Berlin | Germany

Printed in India

Content

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The joint symposium on the topic "Brain and Eye" of the Indian National Science Academy (INSA) and the German National Academy of Sciences Leopoldina discusses key issues of interdisciplinary research on vision.

The aim of this symposium is to bring together experimental, neuroscientific, theoretical and clinical research on vision. Recent advances in colour vision, eye movement control, object perception and imagery, action control and perceptual learning in development and adulthood will be discussed. The symposium includes research utilising approaches from genetics, neuroanatomy, neurophysiology, brain imaging, behaviour, and modelling both in animals and humans. Clinical perspectives, such as for understanding visual dysfunctions as well as for restoring vision, will be discussed.

In 2007, the Indian National Science Academy (INSA) and the German National Academy of Sciences Leopoldina signed a Memorandum of Understanding, which was renewed in 2012, to highlight their strategic partnership. Within the framework of this cooperation agreement, high-profile joint symposia on topics of global relevance are organised on a regular basis. The symposium in 2016 is organised under the joint leadership of INSA and Leopoldina member Professor Dorairajan Balasubramanian, L V Prasad Eye Institute, and Leopoldina member Professor Brigitte Roeder, Institute for Psychology of the University of Hamburg.

Programme

Monday, 1 February 2016

09.00 – 09.30

Welcome Addresses
Dorairajan Balasubramanian, *Director of Research, LVPEI, host of the workshop*
Raghavendra Gadagkar, *President of INSA*
Joerg Hacker, *President of Leopoldina*
Brigitte Roeder, *University of Hamburg, co-organiser of the workshop*

Session I: Visual Perception and Action 1 (Chair: Joerg Hacker)

09.30 – 10.00

Vision and Eye Movements
Karl R. Gegenfurtner

10.00 – 10.30

If We Can Make Computers Play Chess, Why Can't We Make Them See?
Sripati Panditaradhyula Arun

10.30 – 11.00 | Coffee Break

11.00 – 11.30

Understanding Visual Perception of Complex Images: The Power of Fast Periodic Visual Stimulation
Bruno Rossion

11.30 – 12.00

Cracking Mesoscopic Coding Principles in the Human Visual Cortex with Ultra-High Magnetic Field Functional MRI
Rainer Goebel

12.00 – 12.30

Charles Bonnett Syndrome: Prevalence at a Tertiary Eye Care Centre
Premnandhini Satgunam

12.30 – 13.00 | Discussion

13.00 – 14.00 | Lunch Break

Session II: Visual Perception and Action 2 (Chair: Vijayalakshmi Ravindranath)

14.00 – 14.30

Generating and Shaping Novel Action Repertoires
Rui M. Costa

14.30 – 15.00

Lighting up Brain Connections and Plasticity
Upinder Bhalla

15.00 – 15.30

What the Eye Tells the Brain and What the Brain Tells the Eye during Reading
Frank Roesler

15.30 – 16.00 | Discussion

16.00 – 16.30 | Tea Break

Session III: Visual Restoration (Chair: Raghavendra Gadagkar)

16.30 – 17.00

Axonal Degeneration and Regeneration; Therapies for the Optic Nerve
Peng Khaw

17.00 – 17.30

Neural and Behavioural Markers of Functional Recovery in Cataract-Reversal Individuals
Brigitte Roeder

17.30 – 18.00

Effect of Visual Perception on Decision Making
Koel Das

18.00 – 18.30 | Discussion

19.00 | Dinner

Tuesday, 2 February 2016

Session IV: Brain Development and Plasticity (Chair: Subrata Sinha)

09.00 – 09.30

Early Patterning Interactions of the Cortical Primordium
Shubha Tole

09.30 – 10.00

Growth Cone Mechanobiology and the Development of Neural Circuits
Aurnab Ghose

10.00 – 10.30

Connecting the Retina to the Brain: The Search for Novel Retinotectal Guidance Molecules
Jonaki Sen

10.30 – 11.00

Structural and Functional Traces of Past Sensory Experiences in the Visual Cortex
Mark Huebener

11.00 – 11.30 | Coffee Break

11.30 – 12.00

Beyond Hubel & Wiesel: Implications of a Probabilistic Approach to Visual Perception, Learning and Development
Jozsef Fiser

12.00 – 12.30

Resonating Oscillators Encode Spatial Location in the Entorhinal Cortex
Collins Assisi

12.30 – 13.00

Mechanisms and Ontogeny of Multisensory Processing in Rodents
Ileana L. Hanganu-Opatz

13.00 – 13.30 | Discussion

13.30 – 14.30 | Lunch Break

Session V: Brain Development and Clinical Aspects
(Chair: Dorairajan Balasubramanian)

14.30 – 15.00

Spinal Cord Injuries and Brain Plasticity
Neeraj Jain

15.00 – 15.30

Neurodegenerative Changes in the Retina Could be Predictive for Abnormal Vascular Changes in Diabetic Retinopathy
Inderjeet Kaur

15.30 – 16.00

Prenatal Diagnosis of Syndromes Associated with Ocular and Brain Anomalies
Meenakshi Bhat

16.00 – 16.30

Early Life and the Programming of Psychiatric Vulnerability
Vidita Vaidya

16.30 – 17.00 | Discussion over Tea

17.00 | Sightseeing

20.00 | Dinner

List of Participants

Sripati Panditaradhyula Arun	Indian Institute of Science, Bangalore, India
Collins Assisi	Indian Institute of Science Education and Research (IISER) Pune, India
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Upinder S. Bhalla	National Centre for Biological Sciences, Bangalore, India
Meenakshi Bhat	Centre for Human Genetics, Bangalore, India
Rui M. Costa	Champalimaud Center for the Unknown, Lisbon, Portugal
Koel Das	Indian Institute of Science Education and Research (IISER) Kolkata, India
Jozsef Fiser	Central European University, Budapest, Hungary
Raghavendra Gadagkar	Indian National Science Academy, New Delhi, India
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Aurnab Ghose	Indian Institute of Science Education and Research (IISER) Pune, India
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Mark Huebener	Max Planck Institute of Neurobiology, Martinsried, Germany
Neeraj Jain	National Brain Research Centre, Manesar, India
Inderjeet Kaur	L V Prasad Eye Institute (LVPEI), Hyderabad, India
Peng Khaw	Moorsfield Eye Hospital, London, United Kingdom
Marina Koch-Krumrei	German National Academy of Sciences Leopoldina, Halle (S.), Germany
Ruth Narmann	German National Academy of Sciences Leopoldina, Halle (S.), Germany
Vijayalakshmi Ravindranath	Indian Institute of Science, Bangalore, India
Brigitte Roeder	University of Hamburg, Hamburg, Germany
Frank Roesler	University of Hamburg, Hamburg, Germany
Bruno Rossion	University of Louvain (UCL), Louvain-la-Neuve, Belgium
Premnandhini Satgunam	L V Prasad Eye Institute (LVPEI), Hyderabad, India
Jonaki Sen	Indian Institute of Technology, Kanpur, India
Subrata Sinha	National Brain Research Centre, Manesar, India
Shubha Tole	Tata Institute of Fundamental Research, Mumbai, India
Vidita Vaidya	Tata Institute of Fundamental Research, Mumbai, India

Abstracts

(in order of programme)

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Vision and Eye Movements

The existence of a central fovea, the small retinal region with high analytical performance, is arguably the most prominent design feature of the primate visual system. This centralisation comes along with the corresponding capability to move the eyes to reposition the fovea continuously. Past research on perception was mainly concerned with foveal vision while the eyes were stationary. Research on the role of eye movements in visual perception emphasised their negative aspects, for example the active suppression of vision before and during the execution of saccades. But is the only benefit of our precise eye movement system to provide high acuity of small regions at the cost of retinal blur during their execution? In my talk I will compare human visual perception with and without eye movements to emphasise different aspects and functions of eye movements. I will show that the interaction between eye movements and visual perception is optimised for the active sampling of information across the visual field, and for the calibration of different parts of the visual field.

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If We Can Make Computers Play Chess, Why Can't We Make Them See?

If we can make computers play chess and even Jeopardy, then why can't we make them see like us? This is a particularly perplexing question when we consider how easy we find the act of seeing which we perform countless times each day with virtually no errors. What makes vision such a hard problem? How does the brain accomplish vision? To answer these questions, we perform behavioural tests of vision in humans and record from neurons in the monkey visual cortex. I will describe some of our recent findings elucidating object recognition at the behavioural and neuronal level showing that (1) A variety of object features combine in visual search according to a simple linear rule and (2) Neurons in the monkey inferotemporal cortex perform sophisticated computations such as view invariance and relational coding that mirror perception rather than pixels.

Arun SP (2012) Turning visual search time on its head. Vision Research, 74: 86-92.

Pramod RT & **Arun SP** (2014) Features in visual search combine linearly. Journal of Vision 14(4): 1-20.

Murty NAR & **Arun SP** (2015) Dynamics of 3d view invariance in monkey inferotemporal cortex. Journal of Neurophysiology, 113: 2180-94.

Vighneshvel T & **Arun SP** (2015) Coding of relative size in monkey inferotemporal cortex. Journal of Neurophysiology, 113: 2173-79.

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Understanding Visual Perception of Complex Images: The Power of Fast Periodic Visual Stimulation

It has long been known that visual stimulation at a rapid periodic rate, for instance a flickering light, leads to a periodic activity in the human electroencephalogram (EEG) exactly at this frequency rate (Adrian & Matthews, 1934). Since the 1960s, this approach has been used under the term "steady-state visual evoked potentials" (SSVEPs, Regan, 1966) to characterise low-level visual processes (acuity, contrast sensitivity, motion, etc.) in ophthalmology or vision research (Norcia et al., 2015 for review). Here I will summarise a recently launched research program that extends this fast periodic visual stimulation (FPVS) to understand the most complex aspects of vision, namely the perception of visual scenes and of individual human faces. This research program takes advantage of the strengths of this approach: the objective (i.e., exactly at the experimentally-defined frequency rate) definition of responses related to visual perception, the very high signal-to-noise ratio, the independence from explicit behavioural responses, and the identification of perceptual integration markers. Thanks to these advantages, FPVS is an extremely powerful approach to study perception of complex natural images, individual faces and feature integration, in particular for human populations presenting a lower sensitivity of their brain responses and the need for rapid and objective assessment without behavioural requirements (e.g., infants and children, clinical populations).

Rossion, B., Jacques, C., Torfs, K., Liu-Shuang, J. (2015). Fast periodic presentation of natural images reveals a robust face-selective electrophysiological response in the human brain. J. Vision, 15, 1-18.

Rossion, B. (2014). Understanding individual face discrimination by means of fast periodic visual stimulation. Experimental Brain Research, 232, 1599-1621.

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Cracking Mesoscopic Coding Principles in the Human Visual Cortex with Ultra-High Magnetic Field Functional MRI

Ultra-high magnetic field (UHF) scanners (7 Tesla and higher) provide the possibility to study the functional organisation of the human brain at the level of cortical columns and cortical layers. First progress in this direction has been achieved by revealing individual topographic columnar-level orientation maps in human primary visual cortex, frequency maps in primary auditory cortex and axis-of-motion maps in area hMT/V5. In an extension to multi-sensory (audio-visual) stimuli, we revealed that increased spatial resolution at 7 Tesla leads to a better segregation of unimodal and heteromodal voxels in the superior temporal gyrus and planum temporale. More recently, also cognitive tasks have been investigated at the mesoscopic level. We are, for example, able to relate the content of perception during perceptual switches of ambiguous motion stimuli (Plaids, motion quartet) to dynamic activation changes in direction-selective columnar-like activation clusters in area hMT/V5. Furthermore, we reveal that top-down effects in visual tasks operate on supragranular cortical layers in area V1, which is compatible with predictive coding theories. The presented studies demonstrate that the achievable mesoscopic level of investigation (columns and layers) offered by UHF fMRI allows to map columnar-level features within specialized brain areas as well as revealing layer-specific functional bottom-up and top-down connectivity. Furthermore, mesoscopic fMRI establishes an important bridge to invasive animal research, especially to optical imaging and electrical neuronal population recordings.

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Charles Bonnet Syndrome: Prevalence at a Tertiary Eye Care Centre

Charles Bonnet Syndrome (CBS) is a condition in which vision impaired individuals with no cognitive deficits, experience visual hallucinations typically with no other sensory hallucinations. Prevalence of CBS in India is unknown. The primary aim of this study was to estimate CBS prevalence in patients with vision impairment visiting our tertiary eye care centre in India. A cross-sectional study was conducted. 113 vision impaired patients aged above 40 years with presenting visual acuity worse than 20/63 in the better eye were enrolled. Rowland universal dementia assessment scale (RUDAS) was used to screen for cognition impairment. A CBS survey was administered only to those who passed RUDAS. 109 eligible patients (males=68) completed a CBS survey. The mean ±standard deviation age of the patients was 61±9·5 years. Two patients were found to have visual hallucinations. In addition, two other patients had visual hallucinations with associated auditory input to the visual imagery. All patients had complete insight about their hallucination. Depending on the inclusion criteria, CBS prevalence could vary from 1·8% to 3·7%. Earlier case reports have also documented an auditory component in CBS patients. A distinction needs to be made between auditory hallucination and auditory input associated with the visual hallucination. None of the four patients in this study reported about the hallucinations to their eye care professionals. Awareness amidst eye care practitioners and patients in India should improve to proactively care for this condition.

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Generating and Shaping Novel Action Repertoires

Some actions are innate or prewired (such as swallowing or breathing). Others are learned anew throughout life, likely through a process of trial and feedback. We used electrophysiology, imaging and optogenetics in behaving animals to understand how novel self-paced actions are generated, and how specific actions that lead to particular outcomes are then selected. We uncovered that dopamine is critical for the initiation of novel actions, and that plasticity in cortico-basal ganglia circuits is necessary for action selection. Furthermore, as actions are shaped they become organised into chunks, and neural substrates of parsing and concatenation of motor chunks emerge in basal ganglia circuits.

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Lighting up Brain Connections and Plasticity

Memory is a high-level behavioural phenomenon that is inherently multiscale. It emerges from a complex cascade of events, including molecular and genetic events, changes in cellular physiology, network processes, and emergent systems behaviour. To obtain a glimpse of some of the phenomena and mechanisms of memory, we have utilised some of the possibilities afforded by the emerging techniques of optogenetics and optical recording.

The hippocampal brain slice is a common preparation for studying how connections between cells change following different kinds of activity. A standard approach is to vigorously stimulate axons of CA3 pyramidal neurons that connect onto CA1 pyramidal neurons, and then monitor how these connections become strengthened or weakened. While such synaptic plasticity has been extensively studied in brain slices, the slice is almost completely lacking in background activity, in contrast to the waking and learning brain. To better understand the role of background activity we approximated background activity in the CA3 neurons using optogenetic stimulation of CA3 cells, as we delivered plasticity-inducing stimuli. We delivered randomised light patterns to the CA3 cells using a DLP projector focussed through a microscope onto the slice. We confirmed that this elicited brisk activity in the CA3, and corresponding in-vivo-like subthreshold and occasionally spiking activity the target pyramidal neurons of the CA1. We observed that background activity has profound effects on plasticity.

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What the Eye Tells the Brain and What the Brain Tells the Eye during Reading

When we think about reading, we first of all notice the aspect of information input. The eye picks up the words, they are received by the brain and the brain extracts the meaning of a message from individual words, phrases and full sentences. Event-related potentials (ERP) and event-related spectral changes (ESC) in the electroencephalogram (EEG) – allow to monitor to some extent which type of information is picked up and how this information is handled. Typical examples are the N400- and the P600-effect. The former appears when semantic inconsistencies are detected; the latter is elicited whenever a strong conflict occurs between currently held expectations on semantic meaning and/or syntactic structure and what is actually perceived. These phenomena have been typically observed in experiments in which individual words were presented one after another, each for a predefined presentation time (i.e. rapid serial visual presentation: RSVP). In that situation information uptake is fully under control of the experimenter and the participant can only passively watch the stream of individually presented words. However, natural reading is not at all as passive as in RSVP, natural reading is an active process. The eye jumps from one word to the next, rests on individual words for different times (depending e.g. on how expected a word is), and, if necessary, it also jumps back, to recollect previously missed information. In our recent work, together with Shravan Vasishth, Titus von der Malsburg and Paul Metzner at the University of Potsdam (Germany), we combined both methods and analysed fixation triggered ERPs during natural reading. I.e. participants read freely from left to right while eye movements and the EEG were recorded. ERPs and ESCs were extracted contingent to fixations, i.e. whenever the eye stopped after a saccade. Moreover, ERPs were also selectively analysed contingent to what the eye did or what it would do next, e.g. whether reading was continued with a regression, a leftward movement to a previous word, or with a rightward movement to the next word of the sentence. Among others we observed that ERPs which precede a regression are completely different from those when the eye continues with rightward movements. The effects are further modulated by where in a sentence the eye has landed, whether on a word in the middle of a clause or on the last word at the very end of a sentence. The specificities of these potentials and their dependency on features of the eye movements provide clues about how meaning is extracted and how the reading process is jointly controlled by expectations, eye movements, and actually picked up information.

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Neural and Behavioural Markers of Functional Recovery in Cataract-Reversal Individuals

Sensitive periods in development are epochs during which the effects of experience on the brain are particular strong and partially irreversible. A lack of adequate experience during these phases in development results in no or incomplete recovery of related functions if typical experience is being restored. Sensitive periods have often been assessed in animal research by systematically manipulating sensory, e.g., visual experience. Since it is not possible to experimentally vary sensory experience in humans, natural cases with deviating sensory input must be investigated. To demonstrate the existence of sensitive periods in human development, it must be shown that after restoring sight following a congenital blindness, certain functions do not or do only partially recover. Since behavioural recovery might be mediated by different neural mechanisms, neural correlates of functional recovery must be assessed.

We used behavioural, electrophysiological and brain imaging techniques to investigate both visual and multisensory recovery in these individuals. Electrophysiological data demonstrate neural systems with a differential dependence on early visual experience: While neural systems related to face processing do not functionally differentiate if visual input is absent after birth, the neural systems for biological motion do not seem to depend on early visual input. Moreover, brain oscillatory activity of cataract reversal individuals partially resembles typical patterns observed for congenitally blind individuals. Finally, functional imaging data suggest that cross-modal changes are not fully reversible which might have partially consequences for functional recovery. These data suggest, despite an overall remarkable recovery of sensory functions after restoring sight, a pivotal role of early experience for the functional tuning of many though not all neural systems; traces of early experience seem to be often irreversible.

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Effect of Visual Perception on Decision Making

Perceptual decision making typically involves evaluation of evidence based on sensory information and is influenced by several factors including prior and contextual information. Since visual information is one of the primary sources of sensory evidence in humans and primates, visual perception plays an important role in decision making. Technological advances in the last two decades had made it possible to study perceptual decision making in the visual and somatosensory domain and explore neural correlates of perceptual decision. Previous research has demonstrated that prior expectation modulates perceptual decision making. We also know from real world examples that individual decision making is influenced by interactions or consultations with others. But it is not clear how the neural dynamics of our decision is affected by decisions of others. We can use psychophysical experiments and systematically manipulate cues to explore how inputs from observers have an effect on perceptual decisions. In this talk, I will explore whether perceptual decisions can be reliably manipulated using non-informative cues. Our findings suggest that perceptual decisions can be reliably manipulated using non-informative cues. The identified neural mechanisms predicting the object when positive cues are presented seem to be distinct from those with negative cues. The temporally localised nature of the neural activity suggests that input from others influence an observer's decision significantly in the visually evoked epoch and later post-stimulus intervals.

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Early Patterning of the Cortical Primordium

The cerebral cortex arises from a simple sheet of neuroepithelial tissue in the embryo. How this sheet is patterned to produce multiple cortical structures in a reliable and reproducible manner is a question of both evolution and development. We explored interactions between three regulators of early patterning, transcription factors Foxg1, Lhx2, and Pax6. Using combinations of double mutants, we identified mechanisms that regulate the formation and position of the cortical hem, a signalling centre that is responsible for inducing hippocampal fate in adjacent cortical tissue. These genetic interactions provide insight into the early steps of patterning of the cortical primordium. Further, we found that hem is itself part of a forebrain hem system that may have arisen as part of an evolutionary mechanism to regulate cortical development.

Mangale et al., 2008: Lhx2 selector activity specifies cortical identity and suppresses hippocampal organizer fate. Science 319: 304-309, 2008.
Roy et al., 2013: Lhx2 regulates the development of the forebrain hem system. Cerebral Cortex 10.1093/cercor/bhs421.

Work in Dr. Tole's lab has been supported by a Wellcome Trust Senior Fellowship (056684/Z/99/Z), Swarnajayanti Fellowship (Dept. of Science and Technology, Govt. of India), and grants from the Department of Biotechnology, and the Department of Science and Technology, Govt. of India.

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Growth Cone Mechanobiology and the Development of Neural Circuits

Accurate pathfinding by neuronal growth cones is essential for the development of neural circuits and involves complex mechanochemical processes driven by directed cytoskeleton remodelling. Growth cone filopodia are actin-based mechanosensory structures essential for chemoreception and generation of contractile forces necessary for directional motility. However, relatively little is known about how the actin structures in filopodia influence substrate adhesions and the generation of filopodial contractility.

We show that Formin-2 (Fmn2) is a potent regulator of filopodial tip adhesions and stability of growth cone filopodia. Unlike other formins, Fmn2 localises along filopodial actin bundles and is dispensable for filopodial elongation. Fmn2 activity regulates the maturation of tip adhesions and consequently the ability of the filopodia to generate traction forces. Dysregulation of filopodia in Fmn2 depleted neurons leads to compromised growth cone motility. *In vivo,* Fmn2 is required cell autonomously by spinal commissural and hindbrain neurons for midline crossing and pathfinding. Collectively our data implicates Fmn2 as a mediator of actin bundle integrity enabling efficient force transmission to the filopodial adhesion sites.

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Connecting the Retina to the Brain: The Search for Novel Retinotectal Guidance Molecules

The ordered connections made by the retinal ganglion cells to their target neurons in the mid-brain region known as the optic tectum gives rise to a topographic map of the visual field in the brain. According to chemoaffinity hypothesis proposed by Roger Sperry, interaction between two sets of chemical tags one expressed on the retinal ganglion cell (RGC) axons and the other on the target neurons in the tectum determines the position where specific RGC axons will terminate and form synapses. One such group of topographic guidance molecules that direct the connections between the retina and the tectum are the Eph receptor tyrosine kinases and their ligands the Ephrins which are expressed in reciprocal anterior-posterior (AP) and dorsal-ventral (DV) gradients in the retina as well as the tectum. In addition to this recently there have been some reports of identification of novel topographic guidance molecules such as Wnt3a and the transcription factor Engrailed. We have carried out a microarray-based comparison between the anterior and posterior halves as well as the dorsal and ventral halves of the developing chick optic tectum to identify asymmetrically expressed genes which could potentially encode novel candidate topographic guidance molecules. We have validated the results of the microarray-based comparison using RNA in-situ hybridisation and have selected several genes expressed asymmetrically across either the AP or DV axis for functional characterisation. These include a diverse set of genes encoding for some transcription factors, signaling molecules and several molecules with unknown function. We are at present carrying out loss of function and gain of function experiments in-vivo in the chick to determine which of these may perturb the topographic order of RGC projections to the tectum.

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Structural and Functional Traces of Past Sensory Experiences in the Visual Cortex

Monocular deprivation (MD) causes profound changes in the representation of eye-specific inputs in the visual cortex. In mice, ocular dominance (OD) plasticity can be readily induced during a critical period early in life, but it persists into adulthood. Several experimental interventions, like temporary dark-rearing, have been found to boost adult OD plasticity. On the one hand, such interventions might be of clinical relevance, since the treatment of certain malfunctions, like amblyopia, could benefit from enhanced plasticity. On the other hand, these observations have aided in elucidating the mechanisms underlying OD plasticity.

We found that OD plasticity is enhanced in adult mice, which have undergone a brief MD episode earlier in life, a phenomenon akin to 'savings' as first described by Ebbinghaus. To investigate the underlying circuit mechanisms, we followed the fate of individual synaptic connections in the visual cortex using two-photon microscopy. MD caused the rapid formation of additional synaptic inputs onto many neurons, possibly reflecting the strengthening of non-deprived eye inputs. Importantly, these added synapses persisted after the end of the MD episode, despite full functional restoration of both eyes' input strengths. These surplus synaptic structures might form a structural trace that can be rapidly reactivated when the system is challenged with the same experience for a second time.

More recently, we have started assessing how individual neurons change their OD through repeated epochs of MD and recovery, using two-photon calcium imaging. As expected, we observe robust shifts towards the open eye in many neurons. Importantly, individual neurons faithfully return to their pre-deprivation OD during recovery, indicating that neurons retain a 'memory' of their initial tuning. Moreover, neurons that shifted strongly during the first MD also did so during the second MD. These data, too, support the idea that, once formed, connectivity patterns in the visual cortex are relatively stable, and can serve as traces of past sensory experiences.

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http://www.visionlab-ceu.org/

Beyond Hubel & Wiesel: Implications of a Probabilistic Approach to Visual Perception, Learning and Development

Almost 60 years ago, the seminal papers of Hubel and Wiesel on the functional architecture of the cat striate cortex opened new vistas in sensory information processing in the brain. These studies established the concepts of receptive fields, visual areas, pipeline feed-forward processing in the visual cortex, segregation of different streams of information within and across visual areas and have fundamentally determined the dominant approaches to sensory information processing in the brain for the following half century. However, after having great initial success, this framework could provide neither convincing explanations to a large number of cortical phenomena nor a satisfactory link between sensory processing and higher-level cognition, initiating a vigorous research for alternative frameworks. I will present one such framework based on the two concepts that a) the brain performs probabilistic computation to generate our perception, and b) that neural responses provide samples from a probability distribution representing the brains best estimate of the present situation. I will highlight the fundamental differences between the classical framework and this probabilistic one, discuss the implications of the probabilistic approach on learning and development in the brain and demonstrate the viability of the framework thought a number of physiological and modelling experiments. Specifically, I will show that the framework creates an essential link between perception and learning, that it implies that spontaneous activity is not noise but the brain's ongoing momentary estimate about its environment, I will demonstrate how the framework provides explanation of task-dependent correlational activity in V1 without evoking the concept of attention, and how the effect of interference with normal visual development can be captured by this framework. Together these results indicate how the probabilistic framework can offer a comprehensive treatment of perception learning and structural development in the visual system and can help developing new restorative techniques.

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Resonating Oscillators Encode Spatial Location in the Entorhinal Cortex

Coordinated spiking of neuronal populations underlies the perception of sensory stimuli, the planning of movement, and the acquisition of new memories. In the hippocampal formation, groups of neurons are transiently activated as an animal traverses its environment. The sequential patterns generated by these neurons depend, not only on environmental cues, but can also be reproduced reliably in the absence of these cues. A class of neurons in this part of the brain, called grid cells, generates spikes only when an animal is located at the vertices of a hexagonal grid in physical space. This grid provides a frame of reference, a hexagonal counterpart of the familiar Euclidean coordinate system, that the animal can use to trace its trajectory. We attempt to understand the mechanisms that lead to the formation of hexagonally symmetric patterns of activity in grid cells. Using computer models of neural networks, we show that when grid cells are driven by slow oscillations (as they are in the brain) they generate precise sequences of activity that mimic the patterns seen in experimental recordings. The ability of the system to regenerate temporal sequences despite inevitable noisy variations in input depends on the timing of the slow oscillatory drive, the precise biophysical properties of grid cells and the networks they form in conjunction with inhibitory interneurons.

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Mechanisms and Ontogeny of Multisensory Processing in Rodents

Optimal behaviour relies on the successful integration of complementary information from multiple senses. The neural mechanisms underlying multisensory interactions and their ontogeny are still poorly understood. Combining *in vivo* electrophysiology and pharmacology with anatomical tracing and behavioural assessment, we demonstrated the critical role of neural network oscillations and direct connectivity between primary sensory cortices in visual-somatosensory interactions. In adult pigmented rats, visual stimuli impact tactile processing by modulating network oscillations in the primary somatosensory cortex via cortico-cortical projections and thalamocortical feedforward interactions. Moreover, we identified the critical factors that control the development of visual-tactile processing. Transient reduction of unimodal (tactile) inputs during a short period of neonatal development prior to the first cross-modal experience affects feed-forward subcortico-cortical interactions by attenuating the cross-modal enhancement of evoked responses in the adult primary somatosensory cortex. Moreover, the neonatal manipulation alters cortico-cortical interactions by decreasing the cross-modal synchrony and directionality in line with the sparsification of direct projections between primary somatosensory and visual cortices. At the behavioural level, these functional and structural deficits result in lower cross-modal matching abilities. Thus, neonatal unimodal experience during defined developmental stages is necessary for setting up the neuronal networks of multisensory processing.

Sieben K, Roeder B & **Hanganu-Opatz IL** (2013) Oscillatory Entrainment of Primary Somatosensory Cortex Encodes Visual Control of Tactile Processing. J Neurosci 33: 5736-49.

Sieben K, Bieler M, Roeder B & **Hanganu-Opatz IL** (2015) Neonatal restriction of tactile inputs leads to long-lasting impairments of cross-modal processing. PLOS Biol 13(11): e1002304.

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Spinal Cord Injuries and Brain Plasticity

Adult mammalian brains retain remarkable plasticity, not only in areas related to learning and memory, but also in the primary sensorimotor cortices and subcortical structures. Injuries to dorsal columns of the spinal cord at cervical levels deafferent sensory inputs from parts of the body below level of the lesion. Chronic dorsal column injuries result in expansion of intact chin inputs into the deafferented hand region of the primary and secondary somatosensory cortex (area 3 and area S2), ventroposterior lateral nucleus of the thalamus and cuneate nucleus of the brain stem. Understanding mechanisms of these changes is important for preventing undesirable reorganisation and enhancing required changes for better recoveries from injuries. Evidence suggests that the key plastic change takes place in the brain stem nuclei, perhaps due to axonal growth from the trigeminal nucleus into the cuneate nucleus. This reorganisation is subsequently propagated upstream resulting brain-wide somatosensory reorganisation.

Prem Chand and Neeraj **Jain** (2015). Intracortical and Thalamocortical Connections of the Hand and Face Representations in Somatosensory Area 3b of Macaque Monkeys and Effects of Chronic Spinal Cord Injuries. Journal of Neuroscience. 35: 13475-13486.

Niranjan Kambi, Priyabrata Halder, Radhika Rajan, Vasav Arora, Prem Chand, Manika Arora and Neeraj **Jain** (2014). Large-scale reorganization of somatosensory cortex following spinal cord injuries is due to brain stem plasticity. Nature Communications. 5: 3602.

Arkadeb Dutta, Niranjan Kambi, Partha Raghunathan, Subhash Khushu, Neeraj **Jain** (2014). Large-scale reorganization of the somatosensory cortex of adult macaque monkeys revealed by fMRI. Brain Structure and Function. 219: 1305-1320.

Niranjan Kambi, Shashank Tandon, Hisham Mohammed, Leslee Lazar and Neeraj **Jain** (2011). Reorganization of the primary motor cortex of adult macaque monkeys following sensory loss due to partial spinal cord injuries. Journal of Neuroscience. 31: 3696-3707.

Shashank Tandon, Niranjan Kambi, Leslee Lazar, Mohammed Hisham and Neeraj **Jain** (2009). Large-scale expansion of the face representation in somatosensory areas of the lateral sulcus following spinal cord injuries in monkeys. Journal of Neuroscience. 29: 12009-12019.

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Neurodegenerative Changes in the Retina Could be Predictive for Abnormal Vascular Changes in Diabetic Retinopathy

Diabetic Retinopathy (DR) is a leading cause of irreversible vision loss globally affecting the entire neurovascular unit of the retina, along with gradual neuro-degeneration and neuro-inflammation. The early clinical signs of DR include microaneurysms, hard exudates, and retinal hemorrhages, which are preceded by functional changes due to neural degeneration. Experimental studies have indicated that eyes with diabetes are prone to neural apoptosis, retinal ganglion cell loss, reactive changes in the macroglia, thinning of the inner retina, glial reactivity, neurofilament abnormality and slowing of the optic nerve retrograde transport. Hyperglycemia in DR eyes alters the calcium level in microglial cells and neurons by activating purine the receptors resulting in the damage and apoptosis of the neuronal cells in the retina. Earlier studies have also demonstrated that the microglia undergo an increase in calcium flux in case of disturbances in the tissue homeostasis. We hypothesised that a quantitative estimate of microglial calcium flux may be a determinant of early neuronal damage in DR. Hence, we have established primary cultures of retinal glial (astrocyte, muller and microglia) and neuronal cells from the cadaveric eyes and exposed them to hypoxia and hyperglycemia, in order to mimic the stress conditions in diabetes. The response of these cells and their subsequent interactions were studied by changes in the calcium flux and molecular signalling by real time PCR and immunofluorescence. Our preliminary data indicated a significant increase in the glial activation as evident by the changes in the calcium flux and molecular signalling (complement activation, and HIF1 alpha). These findings provided further evidence of neuro-degeneration as a predictor for abnormal vascularisation in DR.

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Prenatal Diagnosis of Syndromes Associated with Ocular and Brain Anomalies

Sub-specialty clinics combining fetal medicine and genetic counselling have enabled accurate and early diagnosis in a number of fetal disorders including genetic syndromes. Prenatal diagnosis is possible by visualisation of the developing fetus by antenatal ultrasound scanning, by genetic testing in fetal DNA obtained from the mother's blood (cell-free fetal DNA) or by invasive testing (placental biopsy or amniocentesis). With antenatal ultrasound scans, many structural changes in the developing brain become apparent in the second half of pregnancy. With ocular anomalies, structure of the eyelids, positioning of the globe (hyper- and hypo-telorism), globe size and symmetry and lenticular anomalies are detectable on antenatal scanning. The more severe the abnormality, the earlier in pregnancy can it be detected (e.g., anencephaly by 11-12 weeks gestation). Antenatal diagnosis is still mainly limited to those disorders in which a structural anomaly is obvious. In complex genetic disorders with non-structural anomalies, prenatal diagnosis relies mainly on pathological genetic variants found in a fetal sample, provided there is a preceding family history. A number of disorders with either ocular or structural brain anomalies as well as a combination of both will be discussed in the talk. Some examples include Tuberous sclerosis, microcephaly syndromes, chromosomal holoprosencephaly, X-linked lissencephaly, Fraser syndrome, and other dysmorphic syndromes. The difficulties in interpretation of a single antenatally detected abnormality such as corpus callosum agenesis, cerebellar hypoplasia and hydrocephalus will also be highlighted in the course of the talk.

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Early Life and the Programming of Psychiatric Vulnerability

Early adverse experience is associated with an increased life-time risk for the development of psychopathology. Studies with models of early adverse experience such as maternal separation, elevation of postnatal serotonin levels and maternal influenza exposure are associated with increased anxiety and depressive behaviour that often persists across the life-span. I will discuss work from our group that highlights a common role for disrupted cortical 5-HT2A receptor function in diverse early adverse experience models. Strikingly, blockade of the 5-HT2A receptor during the adverse experience is sufficient to prevent the emergence of anxiety and depressive behaviours. We hypothesise that a balance between 5-HT2A and 5-HT1A receptor mediated signalling within early life in the neocortex, particularly the prefrontal cortex, may modulate excitatory-inhibitory balance within these neurocircuits and thus contribute to the establishing of vulnerability to psychopathology.

Using pharmacogenetic strategies we have tested this hypothesis and find that early activation of specific neocortica circuits can evoke effects on adult anxiety and depressive behaviour.

These studies highlight the role of early experience and the 5-HT2A receptor is contributing to the establishment of psychiatric vulnerability.

Appendix: Resumes
(in alphabetical order)

Sripati Panditaradhyula ARUN

Arun received his B.Tech from IIT Bombay, and MS & PhD from Johns Hopkins University, all in Electrical Engineering. He completed his postdoctoral research at Carnegie Mellon University and joined the Centre for Neuroscience at IISc in 2010. His research interests are in visual perception and object recognition. His laboratory uses a combination of human behaviour and imaging, monkey neurophysiology and computational modelling to address basic questions about object representations in the brain. His recent work has focused on understanding object representations in humans using visual search, and in the monkey inferotemporal cortex using neurophysiological recordings.

Collins ASSISI

Collins Assisi completed his B.Sc. from St. Xaviers College and M.Sc. in Physics from the Department of Physics in Pune University. Following a PhD in Complex Systems in 2005 at the Center for Complex Systems and Brain Sciences in Florida Atlantic University, he moved to The Salk Institute, La Jolla, California and University of California, Riverside for post-doctoral research in Computational Neuroscience. Since August 2012, he has been an assistant professor and a Wellcome Trust -DBT fellow at the Indian Institute of Science Education and Research, Pune.

Research Description: Animals can rapidly detect changes, characterise, and respond to a constantly changing environment. The richness of this milieu is reflected in the variety of dynamic patterns that neuronal networks can generate. The goal of my research is to study how cellular and network properties constrain the generation of these spatiotemporal patterns and determine their functional role in experimentally well-constrained systems. My work addresses these broad goals within the context of two paradigmatic systems in neuroscience, the hippocampal network and the olfactory system. I construct and simulate detailed and idealised models of neuronal networks to understand the peculiarities these systems while also abstracting broad principles underlying information processing in the brain.

Dorairajan BALASUBRAMANIAN

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Professor Dorairajan Balasubramanian obtained his PhD degree in chemistry from Columbia University in 1965, and spent a year at the Minnesota Medical School as a Jane Coffin Memorial Fellow studying the structural properties of proteins. He returned to India in 1967 and first taught at the Indian Institute of Technology Kanpur (1967–77), and moved to become Professor and Dean at the University of Hyderabad in 1977. He joined the Centre for Cellular & Molecular Biology (CCMB) Hyderabad in 1982 as Deputy Director and served as its Director during 1992–1998, when he took early retirement to join the L V Prasad Eye Institute as its Director of Research, where he conducts and directs research on the biology of the eye. He is an elected Fellow of all the 3 science academies of India, and Fellow of the German National Academy of Sciences Leopoldina, the World Academy of Sciences for the Developing World (FTWAS), the American Association for the Advancement of

Science (AAAS), the African Academy of Sciences (AAS) and the Mauritian Academy of Science & Technology. His particular research interest has been the proteins of the human lens and the role they play in the development of the eye.

Upinder S. BHALLA

I did Physics as an undergraduate at IIT Kanpur and then Cambridge University, but got interested in biology. I did my PhD in experimental and computational neuroscience at Caltech in the lab of Jim Bower. I've been combining models and experiments ever since. Toward the end of my PhD I got interested in the computational possibilities of chemical signalling networks in brain function and especially memory. Entirely by accident I stumbled into modelling the chemical signalling events in synaptic plasticity during my post-doc with Ravi Iyengar at Mount Sinai. This was back in the dawn of what is now called Systems Biology. I currently work on multiscale (chemical, electrical, and network) processes in memory using experimental and computational methods. My lab is at the National Centre for Biological Sciences in Bangalore: http://www.ncbs.res.in/bhalla.

Meenakshi BHAT

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Current position: Professor and Senior Consultant in Clinical Genetics, Bangalore Fetal Medicine Centre, Indira Gandhi Institute of Child Health; and Centre for Human Genetics, Biotech Park, Electronic City Phase I, Bangalore 560100 (Tel +91 80 28521833/32; Email drmbhat@chg.res.in, bhat.meena@gmail.com)

Meenakshi Bhat is a clinical geneticist and evaluates families with a genetic disorder, including detailed phenotyping, testing and genetic counselling. Her main interests are in clinical dysmorphology, genetic counselling in prenatal and postnatal disorders, lysosomal storage disorders, syndromes with congenital heart disease and public education in genetics. She is also part of a number of teaching programmes in clinical genetics and has served as member, task force on Genetics, Dept of Biotechnology, Taskforce on LSDs, ICMR and as clinical expert, Dept. of Science and Technology, India. She is a university gold medalist in both MBBS (Mysore) and MD (Mumbai).

Rui COSTA

Dr. Rui Costa received his D.V.M. from the Technical University of Lisbon in 1996. He entered the GABBA graduate program from University of Porto in 1997, and performed his Ph.D. studies with Dr. Alcino Silva at UCLA from 1998 to 2002 followed by postdoctoral work with Dr. Miguel Nicolelis at Duke University. Dr. Costa became a Section Chief at the National Institutes of Health in 2006 and in 2009 became an Investigator of the Champalimaud Neuroscience Program. In 2010, he received a European Research Council Starting Grant, and the Seeds of Science Prize for Life Sciences. In 2012, he became an International Early Career Scientist of the Howard Hughes Medical Institute, and received the Young Investigator Award from the Society for Neuroscience. In 2014, he was elected a member of EMBO, received the Silver Medal for distinct services from the Ministry of Health,

Portugal, and was awarded the Order of Sant'Iago da Espada from the President of the Republic, Portugal. He was also awarded a Consolidator ERC grant and the Young Investigator Career Award from the Jean-Louis Jeantet Foundation. He served as Deputy Director of the Champalimaud Neuroscience Programme from 2011 to 2013, and became a Director of CF Research in 2014. He is the President of the American-Portuguese Biomedical Research Fund and Vice-President of the Portuguese Society for Neuroscience. His laboratory studies the neurobiology of action in health and disease. To study actions is to study the way we do things, which is different than studying how to remember stimuli, or facts and events. Some actions are innate or prewired (such as swallowing or breathing), but most are learned anew throughout life, likely through a process of trial and feedback. Dr. Costa's laboratory uses genetic, electrophysiological, optical, and behavioural approaches to investigate the mechanisms underlying the generation and learning of novel actions.

Koel DAS

Koel Das has obtained her PhD in Electrical and Computer Engineering from University of California, Irvine. Subsequently she was a postdoctoral fellow at University of California, Santa Barbara. She was awarded the Ramalingaswami Fellowship and joined IISER Kolkata as an assistant professor. Koel's research aim is to gain an understanding of human neural function in relation to cognitive and behavioural performance in real world tasks. A fundamental goal of cognitive neuroscience is to understand how the human brain processes and represents the environment and how these representations are used to guide adaptive behaviour and decision making process. She is interested in applying state-of-the-art pattern recognition tools to explore the neural dynamics underlying the complex process of cognition. She is especially interested in the analysis of EEG and fMRI signal in the context of computational neuroscience.

Selected Relevant Publications and Abstracts:

K. Das, B. Giri, A.S. Chowdhury, S. Chakravarty, "Manipulating Perceptual Decisions Using Input From Others", 15th Vision Sciences Society Annual Meeting, 2015.

T. Preston, F. Guo, K. Das, B. Giesbrecht, and M.P. Eckstein, "Neural Representations of Contextual Guidance in Visual Search of Real-World Scenes", 33(18), pp. 7846-7855, 2013.

F. Guo, T. Preston, K. Das, B. Giesbrecht, and M.P. Eckstein, "Neural mechanisms for target detection in scenes", Journal of Neuroscience 32(28), pp. 9499-9510, 2012.

M.P. Eckstein, K. Das, B. Giesbrecht, B.T. Pham, M.F. Peterson, C.K. Abbey, and J.L. Sy, "Neural decoding of collective wisdom with multi-brain computing", NeuroImage, 59(1), pp. 94-108, 2012.

K. Das, B. Giesbrecht, and M.P. Eckstein, "Predicting variations of perceptual performance across individuals from neural activity using pattern classifiers", NeuroImage, 51(4), pp. 1425-1437, 2010.

K. Das, D. Rizzuto, and Z. Nenadic, "Mental State Estimation for Brain Computer Interface", IEEE Transactions on Biomedical Engineering, vol. 56(8), pp. 2214-2111, 2009.

K. Das and Z. Nenadic, "An Efficient Discriminant-based Solution for Small Sample Size Problem", Pattern Recognition, vol. 42(5), pp. 857-866, 2009.

Jozsef FISER

Dr. Fiser obtained his Diploma in Electrical Engineering from the Technical University of Budapest in 1986, earned his M.A. in Psychology in 1992 and Ph.D. in Computer Science in 1997, both from the University of Southern California. With a 3-year McDonnell-Pew Postdoctoral Fellowship in Cognitive Neuroscience between 1997 and 2000, he studied awake neurophysiology, low level psychophysics, computational modelling and infant research at the University of Rochester. He was a postdoc and a research associate between 2000 and 2005 at the Center for Visual Science, University of Rochester, funded by Schmitt Program on Integrative Brain Research Interdisciplinary Post-Doctoral Fellowship and the Center for Visual Science Postdoctoral Fellowship. Between 2005 and 2012, he was a junior faculty in the Department of Psychology and the National Volen Center for Complex Systems at Brandeis University, USA. Meanwhile he habilitated at the University of Pecs, Hungary in 2004, and became a Grant Doctor of the Hungarian Academy of Sciences in 2007. He also received an Honorary Doctorate from the University of Szeged, Hungary in 2007. Since 2012, he is an Associate Professor at the Department of Cognitive Science at the Central European University, Hungary. Dr. Fiser's research programme focuses on how structured visual information is acquired and converted into complex internal representations for controlling cognition and behaviour. His publications are evenly distributed between behavioural studies in human perception, learning and development, theoretical/computational studies on neural coding and visual processing, and physiological studies fusing low- and high level cortical processes from a functional point of view.

Raghavendra GADAGKAR

Raghavendra Gadagkar is Professor at the Centre for Ecological Sciences and Centre for Contemporary Studies, Indian Institute of Science, Bangalore; President, Indian National Science Academy, New Delhi; and non-resident permanent Fellow of the Wissenschaftskolleg zu Berlin. He is a Foreign Associate of the National Academy of Sciences, USA, and Member of the German National Academy of Sciences Leopoldina. Gadagkar's interest is in the area of animal behaviour, ecology and evolution. He has spent most of his career working on an Indian social wasp with the aim of understanding the evolution of sociality in animals. In addition to over 200 papers and articles, Gadagkar has authored two books, 'Survival Strategies' and 'The Social Biology of Ropalidia marginata' both published by Harvard University Press.

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Karl R. GEGENFURTNER

Karl Gegenfurtner studied Psychology at Regensburg University. Subsequently he obtained a Ph.D. degree from New York University, where he also spent his first PostDoc. In 1993 he moved to the Max-Planck-Institute for biological cybernetics in Tuebingen, where he obtained his Habilitation in 1998 and a Heisenberg-Fellowship in the same year. In 2000 he moved to the University of Magdeburg and in 2001 to Giessen University, where he since then holds a full professorship for Psychology. The emphasis of Karl Gegenfurtner's research is on information pro-

cessing in the visual system. Specifically, he is concerned with the relationship between low level sensory processes, higher level visual cognition, and sensorimotor integration.

Karl Gegenfurtner is the head of the DFG Collaborative Research Center TRR 135 on the "Cardinal mechanisms of perception".

Aurnab GHOSE

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Education:

1996 BSc (Hons), Presidency College, University of Calcutta, India
1998 MSc, Department of Genetics, University of Leicester, UK
2001 PhD, Beatson Institute for Cancer Research, University of Glasgow, UK

Professional Experience:

2002–2007 Postdoctoral Research Fellow, Dept, of Cell Biology, Harvard Medical School, USA.
2008–present Assistant Professor, Indian Institute for Science Education and Research (IISER), Pune

Research Interests:

The lab of Prof. Dr. Ghose is exploring the development, design and plasticity of neuronal circuits.

Professional Memberships:

Member, Indian Society for Cell Biology, 2008–present
Member, Indian Academy of Neurosciences, 2012–present
Member, Society for Neurochemistry (India), 2012–present
Member, Society for Neuroscience (USA), 2014–present
Member, Indian Society for Developmental Biology, 2015–present

Rainer GOEBEL

Rainer Goebel studied psychology and computer science in Marburg, Germany (1983–1988) and completed his PhD in 1994 in Braunschweig, Germany. In 1993 he received the Heinz Maier Leibnitz Advancement award in cognitive science sponsored by the German minister of science and education for a publication on the binding problem and in 1994 he received the Heinz Billing award from the Max Planck society for developing a software package for neural network modelling. From 1995–1999 he was a postdoctoral fellow at the Max Planck Institute for Brain Research in Frankfurt/Main where he founded the functional neuroimaging group. In 1997/1998 he was a fellow at the Berlin Institute for Advanced studies. Since January 2000, he is a full professor for Cognitive Neuroscience at Maastricht University, Netherlands. He is founding director of the Maastricht Brain Imaging Centre and the driving force of the

recently established ultra-high field imaging center housing 3, 7 and 9.4 Tesla human MRI scanners. Since 2008 he is also team leader of the "Modeling and Neuroimaging" group at the Netherlands Institute for Neuroscience in Amsterdam. He has served as chair for the Organization for Human Brain Mapping (2006–2008). His main interests are unravelling coding principles in the visual cortex, methods and clinical applications of real-time fMRI/EEG/fNIRS and modelling of visual perception. He received many grants including an Advanced Investigators Grant from the European Research Council and a competitive grant from the Human Brain Project. He is also founder of the company Brain Innovation. Since 2014 he is member of the Royal Netherlands Academy of Arts and Sciences.

Joerg HACKER

From 1970 to 1974, Prof. Dr. Dr. h. c. mult. Joerg Hacker studied biology at Martin Luther University Halle, where he also obtained his PhD in 1979. From 1980 to 1988 he worked at the Department of Microbiology at the University of Wuerzburg, where he was promoted to Professor in 1986. His research focussed on the molecular analysis of pathogen bacteria and host-microbe interaction. Starting 1988, Joerg Hacker worked as Professor at the University of Wuerzburg and from 1993 onward also led the Wuerzburg Institute for Molecular Infection Biology. In 2000 and 2005, Joerg Hacker did his research at the Pasteur Institute in Paris as a visiting researcher. Furthermore, he taught at Tel Aviv University as guest professor in 2006. From 2003 to 2010, Joerg Hacker was Vice President of the German Research Foundation (DFG) and from 2008 to 2010 he was President of the Robert Koch Institute. Since March 2010, Joerg Hacker has been President of the German National Academy of Sciences Leopoldina. He received numerous awards and honours and is honorary citizen of his hometown Grevesmuehlen. Joerg Hacker is member in national and international academies, scientific societies and committees. Recently, he has been appointed to the new Scientific Advisory Board, which has been set up by the UN Secretary-General Ban-Ki Moon.

Ileana L. HANGANU-OPATZ

Ileana Hanganu-Opatz studied Biology and Biochemistry at the University of Bucharest (Romania). In 2002 she received her PhD at the University of Duesseldorf (Germany). After a postdoctoral stage at the University of Mainz (Germany) and INMED / INSERM Marseille (France) as research fellow of the German Research Foundation (DFG), she was awarded in 2008 with a grant of the German Ministry of Education and Research (BMBF) and in 2009 with an Emmy Noether grant of the DFG for building her own lab. Since 2009 she holds a professorship for Developmental Neurophysiology at University Medical Center Hamburg-Eppendorf. Combining electro- and optophysiology with behavioural assessment and imaging, Ileana Hanganu-Opatz investigates the ontogeny of cognitive and multisensory processing in health and disease.

Ileana Hanganu-Opatz is member of the Kavli FENS Network of Excellence and was awarded 2008 with the Du Bois Reymond-Prize of the German Society of Physiology.

Mark HUEBENER

Mark Huebener is head of the "Visual System Plasticity" lab in the Department Synapses – Circuits – Plasticity at the Max Planck Institute of Neurobiology in Martinsried, Germany. He is also Affiliate Professor of Neurobiology at the Ludwig-Maximilians-University of Munich. After studying Biology in Tuebingen and Hamburg, he carried out his PhD work with Juergen Bolz on structure-function relationships in the visual cortex of cats and monkeys at the Miescher Lab of the Max Planck Society in Tuebingen. In 1993, he joined the Department of Tobias Bonhoeffer at the Max Planck Institute of Neurobiology, where he has been a group leader since 2002. For several years, he served as one of the Directors of the Cold Spring Harbor Course on "Imaging Structure and Function in the Nervous System". He has made important contributions to our understanding of the diversity of morphological cell types in the visual cortex. His group has pioneered functional imaging from mouse visual cortex and superior colliculus employing intrinsic as well as two-photon calcium imaging. His main interests are the functional and structural determinants of plasticity in the visual system.

Neeraj JAIN

Dr. Neeraj Jain is Professor and Senior Scientist at National Brain Research Centre, Manesar, Gurgaon. He obtained his Bachelors and Masters degrees from Panjab University, Chandigarh, and Ph.D. from IARI, New Delhi. His Post-Doctoral training was with Prof. Jon Kaas at Vanderbilt University, USA, where he continued to work as Research Assistant Professor. While at Vanderbilt University he was awarded Young Scientist Award by John F Kennedy Center for his work on the effects of spinal cord injuries on the brain. Prof. Jain was awarded an International Senior Research Fellowship by the Wellcome Trust, UK, to set up his laboratory and continue his research work in India. Major focus of his research is on information processing in the brain and organisation of the brain circuits that enable tactile perception, and how spinal cord injuries affect the brain.

Inderjeet KAUR

Dr Inderjeet Kaur is a research scientist at L V Prasad Eye Institute, Hyderabad. Her research contributions are in the area of genomics of complex diseases like Age-related Macular Degeneration (AMD), Diabetic Retinopathy (DR) and Retinopathy of Prematurity (ROP). Her prior works on AMD using the linkage-disequilibrium mapping and haplotype comparisons have provided major indicators of genetic commonality and clues for undertaking predictive testing. She has also identified novel susceptibility genes in ROP and characterised the immune dysregulation in disease progression. Currently, she is involved in identifying markers that predict neurodegeneration and neovascularisation in DR.

Inderjeet was trained in India and also at the Tokyo Medical Centre, Japan, National Eye Institute, NIH, and the Massachusetts Eye and Ear Infirmary, Boston, USA. She has published in several peer reviewed journals including the PNAS, USA, Human Molecular Genetics and IOVS. She is currently on the Editorial Board of Journal of Genetics and an ad-hoc reviewer for several journals. She is a recipient of the BM Birla Young Scientist (2010), DBT Crest (2010), Asia ARVO

Young Investigator (2007) and the Amzad Rahi (2003) awards. Her research is largely funded through extramural grants of the DBT, DST and CSIR (Government of India).

Sir Peng KHAW

[Source: https://iris.ucl.ac.uk/iris/browse/profile?upi=PTKHA24, last accessed on 4 December 2015]

Professor Sir Peng Tee Khaw is Professor of Glaucoma and Ocular Healing at the UCL Institute of Ophthalmology and Consultant Ophthalmic Surgeon at Moorfields Eye Hospital, London, UK. He is also Director of the National Institute for Health Research Specialist Biomedical Research Centre in Ophthalmology at Moorfields Eye Hospital and UCL Institute of Ophthalmology; Director of Research and Development at Moorfields Eye Hospital; President of the Association for Vision Research in Ophthalmology and the UK Paediatric Glaucoma Society; and an NIHR Senior Investigator.

Professor Sir Peng Tee Khaw has a special interest in the surgical and medical treatment of the refractory glaucomas, particularly paediatric glaucoma. His group undertakes research into new surgical techniques and new treatments to prevent scarring and encourage regeneration of tissues after ocular surgery and disease. They have developed inexpensive single applications of intra-operative anti-metabolites that have been tested in clinical trials across the world, and have also developed new surgical techniques, including the Moorfields Safer Surgery System, dramatically reducing bleb related complications worldwide. They are developing drug delivery systems, stem cell therapies and a new single application anti-scarring treatment.

Professor Sir Peng Tee Khaw has delivered over 20 national and international named lectures, won numerous awards including the first international ARVO Pfizer Translational Medicine Prize.

Academic Background:

1994 PhD, Doctor of Philosophy – Medicine, University College London
1980 BM, Bachelor of Medicine – Clinical Medicine, University of Southampton

Vijayalakshmi RAVINDRANATH

[Source: http://www.insaindia.org/detail.php?id=P05-1399, last accessed on 4 December 2015]

Vijayalakshmi Ravindranath earned her BSc and MSc degrees from Andhra University and PhD (Biochemistry) in 1981 from Mysore University while working at Central Food Technology Research Institute (CFTRI). She was a Postdoctoral Fellow at the National Cancer Institute, USA (1982–85) and joined the National Institute of Mental Health and Neurosciences (NIMHANS) at Bangalore upon returning to India. She continued working in various capacities at NIMHANS till 2000 when she took over as the Founder Director of National Brain Research Centre (NBRC), an autonomous institute of the Department of Biotechnology. She continued as Director till April 2009, when she returned to Bangalore as Professor and Chair of the newly created Centre for Neuroscience at the Indian Institute of Science.

Professor Ravindranath has made pioneering contributions in understanding the metabolism of psychoactive drugs at the site of action in brain. She was the first to demonstrate the capability of the human brain to metabolise psychoactive drugs to pharmacologically active and inactive metabolites by pathways which are different from those that occur in liver, the major organ involved in drug metabolism. Her other research interests include understanding the molecular mechanisms underlying the region and cell-specific neuronal dysfunction in neurodegenerative disorders, such as Parkinson's disease (PD) and Alzheimer's disease with a goal to identify drug targets that may help slow down the progression of the disease.

Brigitte ROEDER

Brigitte Roeder studied Psychology at and received her PhD from the University of Marburg (Germany). After her postdoc time at the University of Oregon (U.S.) she was awarded an Emmy-Noether grant of the German Research Foundation (DFG). In 2004, she moved to the University of Hamburg, where she since then holds a full professorship for Biological Psychology and Neuropsychology with a second affiliation at the Medical Faculty of the University of Hamburg. Brigitte Roeder's research interests comprise multisensory processes and age-dependent neuroplasticity. Her main research methods include behaviora, electrophysiological techniques and brain imaging.

Brigitte Roeder is member of the German National Academy of Sciences Leopoldina and of the Academy of Sciences in Hamburg. Her most important awards are the Leibniz Award of the German Research Foundation and an Advanced Grant of the European Science Foundation.

Frank ROESLER

Frank Roesler studied Psychology at the University of Hamburg. He received his Ph.D. in 1975 from the Christian-Albrechts-University of Kiel (Germany) where he also finished his second dissertation (Habilitation) in 1983. After research visits in the USA and Australia and a substitute professorship at the University of Hamburg, he became a full professor for Experimental and Biological Psychology at the Philipps-University Marburg (Germany) in 1986. After retirement in 2010 he served for 3 years as a Senior Professor for Experimental and Biological Psychology at the University of Potsdam (Germany). Since 2013 he is Senior Professor at the unit for Biological Psychology and Neuropsychology at the University of Hamburg (Germany). His research interests focus on biological correlates of perception, memory, language, and development by using electroencephalography and MRI to monitor brain activity. Frank Roesler is member of the Berlin-Brandenburg Academy of Sciences and of the German National Academy of Sciences Leopoldina. Among others he received the Wilhelm-Wundt Medal of the German Society for Psychology (DGPs), the Max-Planck-Prize for International cooperation, and he was honoured with the Life-time award of the German Society for Psychology (DGPs). Currently he is member of the executive committee of the German National Academy of Sciences Leopoldina.

Bruno ROSSION

Bruno Rossion received his PhD in Psychology from the University of Louvain in Belgium before moving to Brown University (U.S.) for a two years postdoc. He is currently director of research at the National Research Fund in Belgium, University of Louvain. He has authored over 150 scientific publications in international peer-reviewed journals on the topic of face perception, using a diversity of approaches: psychophysics, human electrophysiology (ERPs, EEG), neuroimaging (PET, fMRI), eye movements, single-case studies of brain-damage patients (prosopagnosia), behavioural and EEG studies of infants and children, and human intracerebral recordings and electrical stimulations (http://face-categorization-lab.webnode.com//). Over the past few years, thanks to a consolidator European Research Council (ERC) grant he has developed an approach based on fast periodic visual stimulation to understand visual perception of complex visual scenes, face identity and perceptual integration.

Premnandhini SATGUNAM

PremNandhini Satgunam completed her Bachelor's in Optometry from Elite School of Optometry, BITS Pilani. She worked as a clinical faculty at Elite School of Optometry, Sankara Nethralaya before pursuing her Master's and PhD from Ohio State University. Her graduate research work involved studying conjugate and disconjugate eye movements. In her postdoctoral research work at Schepens Eye Research Institute, Harvard medical school, she studied techniques for evaluating and improving visual performance in adults with vision impairment. Presently she is a Research Optometrist at L V Prasad Eye Institute. She teaches at Bausch & Lomb School of Optometry and pursues research in vision rehabilitation.

Jonaki SEN

Associate Professor, Laboratory No. 11, Biological Sciences and Bioengineering Department, Indian Institute of Technology Kanpur, UP, India 208016 (Tel +91 5122594054; Fax +91 5122594010; Email jonaki@iitk.ac.in)

Education:

- Ph.D., Department of Molecular Genetics, Albert Einstein College of Medicine of Yeshiva University, New York, USA, April 2000.
  Dissertation title – Follicle cell expression of the *Drosophila pipe* gene defines dorsal-ventral polarity in the embryo.
  Advisor – Dr. David S. Stein
- M. Biotechnology, All India Institute of Medical Sciences, Delhi, India, 1994.
- B.Sc. (Hons.) Human Biology with specialization in Biochemistry, All India Institute of Medical Sciences, Delhi, India, 1992.

Research Profile: I am primarily interested in investigating the molecular mechanisms that regulate various events occurring during development of the vertebrate nervous system. Within this broad area, I am particularly interested in studying the role of signalling molecules in regulating 1) the birth of new neurons from progenitor cells (neurogenesis), 2) the acquisition of characteristics of mature neurons (differentiation), 3) migration of new-born neurons to their appropriate location in the brain, and 4) the formation of appropriate synaptic connec-

tions between neurons (axonal guidance and synaptogenesis). For this purpose, I utilise chick and mouse embryos as model systems to identify and functionally characterise the molecules that regulate the above-mentioned phenomena in various contexts within the developing central nervous system.

Honours and awards: The Julius Marmur Research Award for outstanding performance in Academic Ph.D. research. Awarded by the Sue Golding Graduate Division, Albert Einstein College of Medicine, New York, USA, on March 25th, 1999.

Subrata SINHA

[Source: http://www.nbrc.ac.in/director.php, last accessed on 4 December 2015]

Professor Subrata Sinha assumed charge as Director of the National Brain Research Centre, Manesar in June 2010.

Professor Sinha has been working on the molecular and cell biology of glial tumours and has made several important contributions in understanding of this fatal brain disease. His research contributions include understanding the molecular biology of glial tumor progression, studying genomic instabilities that may contribute to alterations in tumor phenotype which in turn may confer drug resistance; study of cellular responses to stress including hypoxia, transcriptional gene silencing and its implications in tumor biology and therapeutics. He is also working on the development of recombinant antibody methods for potential use in oncotherapeutics.

Decorated by several research felicitations at national and international levels, Prof. Sinha's research contributions have been well respected in the field. Early in his career, Prof. Sinha graduated from India's premier institution, the All India Institute of Medical Sciences (AIIMS) at New Delhi. He was awarded MBBS (1980) and MD Biochemistry (1983) from AIIMS and PhD (1989) from the MRC Toxicology Unit, Carshalton, UK. Prof. Sinha was an ICMR Talent Search Scheme Fellow at the Department of Biochemistry, AIIMS (1984) and at National Institute of Immunology (1987–1988). He was a Smith and Nephew fellow (1984–1985) and Non-Clinical Scientist (1985–1986) at the MRC Toxicology Unit, Carshalton, UK. He joined the faculty of the Department of Biochemistry at AIIMS in 1988, was appointed as Professor in 1998 and was Head of Department from 2003 to 2010.

Shubha TOLE

Prof. Shubha Tole obtained her BSc in Life Sciences and Biochemistry from St. Xavier's Mumbai (1987). Her MSc and PhD are from Caltech, USA. She worked at the University of Chicago as a post-doctoral fellow, and then joined the Tata Institute in Mumbai, India as a faculty member.

Tole has been awarded the Infosys prize in Life Sciences (2014), the Shanti Swarup Bhatnagar Award in 2010; the Research Award for Innovation in Neurosciences (RAIN) by the Society for Neuroscience in 2008, which is given for innovative work regardless of age or nationality. She received the National Woman Bioscientist award by the Department of Biotechnology, Govt. of India (2008), the Swarna-

jayanti Fellowship by the Department of Science in Technology, Govt. of India (2005), and the Wellcome Trust Senior International Fellowship (1999). Tole actively engages in public outreach via workshops in schools and colleges and writes blogs for the indiabioscience.org site.

Vidita VAIDYA

Vidita received her undergraduate degree from St. Xavier's College, Mumbai in Life sciences and Biochemistry. She obtained her doctoral degree in Neuroscience at Yale University. Her postdoctoral work was done at the Karolinska Institute in Sweden and at the University of Oxford in UK. She joined the Dept. of Biological Sciences, TIFR, in March 2000. She has been a Wellcome Trust Overseas Senior Research Fellow and an Associate of the Indian Academy of Sciences, and a Fellow of NISA. Her publications and lab works include (a), Understanding the neurocircuitry of emotion, (b) its modulation by experience, and (c) the alterations in emotional neurocircuitry that underlie complex psychiatric disorders.

The organisers INSA and Leopoldina kindly thank the L V Prasad Eye Institute for the conceptual and organisational support as well as for hosting the symposium. They also thank the ERC for additional financial support.

European Research Council
Established by the European Commission

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German National Academy of Sciences Leopoldina

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The Indian National Science Academy (INSA)

The Indian National Science Academy (INSA), established in 1935, is an apex body of Indian scientists representing all branches of science with the objectives of promoting science in India and harnessing scientific knowledge for the cause of humanity and national welfare, safeguarding interests of Indian scientists, establishing formal linkages with international bodies, promoting international collaborations and giving opinion on national issues after debate and discussions.

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