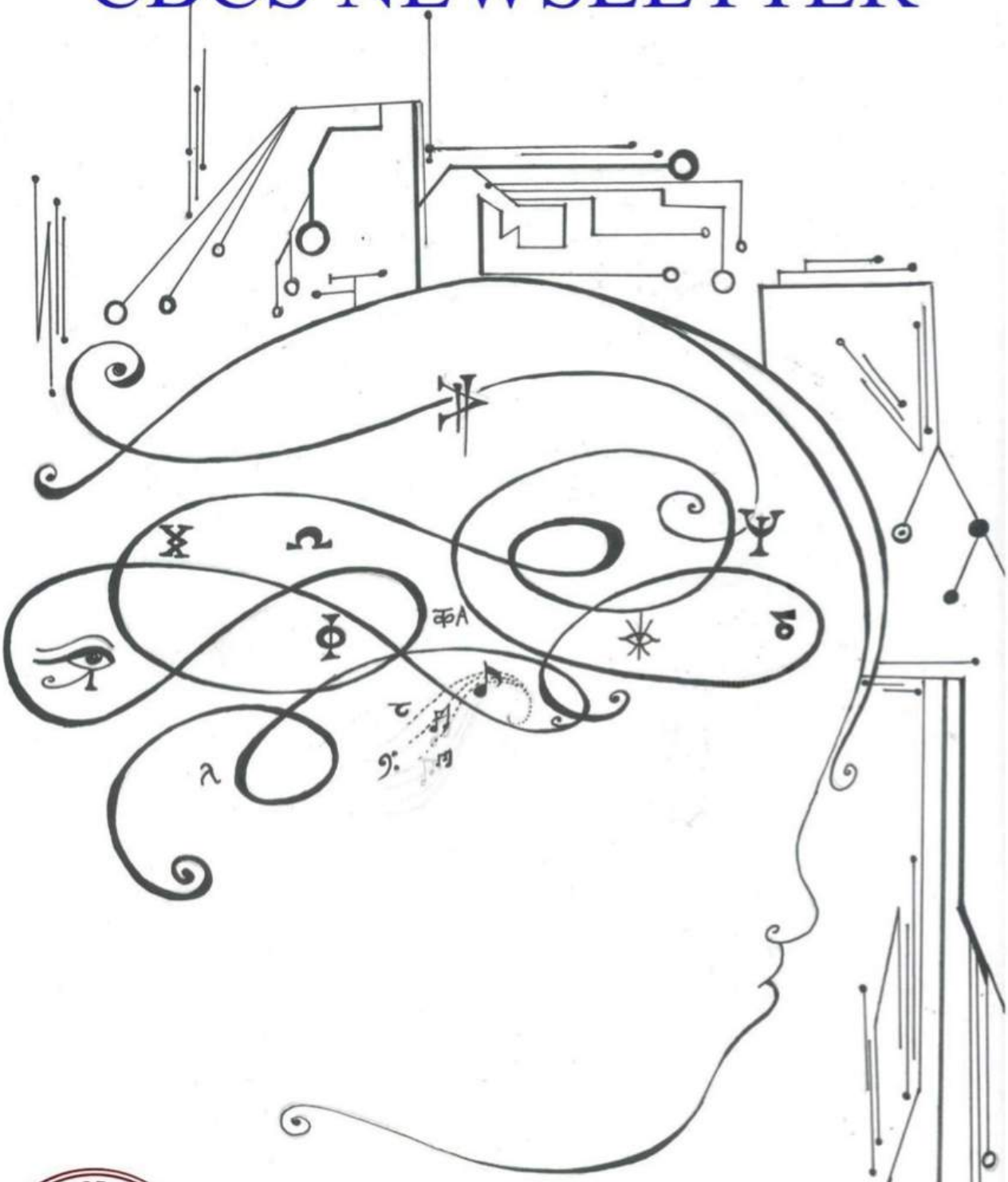
CBCS NEWSLETTER



UNIVERSITY OF ALLAHABAD
QUOT RAMI TOT ARBORES

CBCS

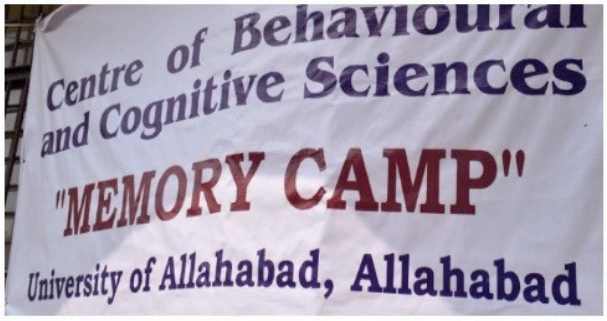
About CBCS

Prof. Bhoomika.R.Kar,
Head, CBCS

Centre of Behavioural and Cognitive Sciences has been a UGC Centre of excellence for the past 18 years and has contributed towards the growth of the discipline of Cognitive Science in India with more institutions starting the masters program in Cognitive Science; the most recent addition is IIT Delhi. The Centre has been focused towards quality teaching and research and it reflects in the placements of students' post-masters or post PhD. In the past one year, our postdoctoral fellows and students have been offered faculty positions at institutions like IIT Delhi, IIIT Delhi, IIT Roorkee; postdoctoral positions at prestigious Institutions like Brown University, European University, Florence, Italy and IIT Bombay; admission to doctoral programs at Institutions like Michigan State University and Clemson University, USA, IIT Kanpur and NIMHANS, India. Research at the Centre focuses on many interesting areas such as attention, consciousness, meditation, decision making, actions, language processing, cognitive development, cognitive and affective control and bilingualism using different methodologies like EEG/ERP, eye tracking, virtual reality, and computational modelling. The Centre faculty and students have also initiated a few studies using the fMRI facility established recently (with the support from the Department of Science and Technology, Govt of India). The Call for proposals to conduct research using the National Neuroimaging Facility is available on the CBCS website to encourage researchers across the country to access the facility, http://cbcs.ac.in/wp-content/uploads/2019/12/Proposal-Form_NNF_Final_Dec_2019.pdf. The Centre plans to conduct a workshop on Neuroimaging research design and analysis early next year focusing on hands on training with the fMRI facility at the Centre. With these advanced research facilities, the Centre strives to contribute meaningfully to science and society. We also have an Outreach Centre with regular outreach activities including encouraging young students towards the fascinating field of cognitive science/neuroscience as well as activities for human welfare such as memory camp for elderly and cognitive assessment and remediation for children with developmental disorders. In addition to learning and getting trained in cognitive science our students also nurture their talents including writing poetry, artwork and photography providing a nice learning environment for all of us at the Centre.

Memory Camp, 19th October, 2019

The **Centre of Behavioural and Cognitive Sciences, University of Allahabad** organized Memory Camp, 2019 in Allahabad on the **19thof October.** This camp was set up to provide a detailed record of memory and general cognitive functions through formal evaluation. People in the age group of 40 - 75 years participated and got a complete evaluation of their memory and general cognitive health. This was an outreach initiative of CBCS for screening age related problems in memory and cognition. The camp began at 9.00am and was held till 4pm. The pre-registered



participants were called one by one and were assessed individually in the respective labs at CBCS for general cognitive health and memory. In all 24 participants registered out of which 16 participated in the camp. A detailed report with individual feedback was provided to each participant after the conduction. This initiative is an attempt to make people aware of issues associated with aging and memory/ general cognitive health. CBCS will continue to organize such outreach activities in future for awareness related to cognitive aging.

Foundation Day Lecture: "Splitting Attention into its Atomical Components" by Dr.Sridharan Devarajan, Centre for Neuroscience, Indian Institute of Science, Bengaluru– 30th October, 2019

The Centre of Behavioral and Cognitive Sciences, University of Allahabad celebrated its 18th Foundation Day on October, 30th 2019.

The accomplishments of the Centre during the past year were summarized by the Head of Centre, Dr. Bhoomika Kar after which Prof. Janak Pandey, Founder Head CBCS and Prof. K.S. Misra, University of Allahabad, addressed the gathering. Every year to celebrate this occasion the Centre organizes lectures by eminent psychologists, cognitive scientist, philosophers and neuroscientists. This year's foundation day lecture was delivered by Prof. Sridharan Devarajan, Centre for Neuroscience, Indian Institute of Science (IISc), Bengaluru. Prof. Devarajan leads a team of researchers at IISc who work primarily in Selective Attention using methods of large scale neural modelling and computational neuroscience.The title of his talk was "Splitting Attention into its Atomical Components" where he explained how attention is not in fact, an atomic (singular) phenomenon. He explained recent experiments in the lab that confirm that attention affects behaviour through one of two component processes: one that enhances "sensitivity", by improving the perceptual clarity of relevant information, and one that enhances "bias", by prioritizing only the most relevant information for decision-making.

Welcome New People

D.Phil. Students 2019-batch

Sanchita Mohindru

Sanchita did her masters is in Cognitive Science from Centre of Behavioural and Cognitive Sciences, University of Allahabad. Her topic of research was 'Global- local bias mediates the effect of sadness on global local attention' during her master's programme.She is working under Dr. Bhoomika.R.Kar.

Sachin K.C.

Sachin had pursued his M.Sc. from Cognitive Neuroscience from J.S.S University, Mysore. The areas that intrigue him are situated cognition, attention, perception and planning. He hopes to study them using behavioural experiments, EEG and other brain imaging techniques. He joined the doctoral program in 2019 as a UGC Junior Research Fellow.

Technical Support Staff

Dr. Abhishek Soni

Dr. Soni joined the National Neuroimaging Facility, Centre of Behavioural and Cognitive Sciences, University of Allahabad as MR Physicist in August, 2019. He has obtained Master degree (M.Sc.) in Physics from Department of Physics, University of Allahabad and doctoral degree (Ph.D.) in Applied Physics from IIT (ISM), Dhanbad. He has published more than thirty research publications in different reputed journals.

Mr. Diwakar Singh Yadav

Mr. Diwakar Joined the National Neuroimaging Facility, Centre of Behavioural and Cognitive Sciences, University of Allahabad as Radiographer/MR Technician

Congratulations!

Faculty Positions

Dr. Sonia Baloni Ray

Dr. Sonia Baloni Ray has joined as Assistant Professor in Indraprasth Institute of Information Technology, Delhi. She worked as a Postdoctoral Fellow at CBCS where she studied: "*Role of attention in visual processing and mechanisms underlying emotion and motion perception*". Her project was funded by the Department of Science and Technology, Gov. of India under the Cognitive Science Research Initiative scheme and University Grants commission under the CPEAPA scheme.

Dr. Sujith Thomas

Dr. Sujith Thomas has joined as Assistant Professor in the Department of Computer Science and Information Systems at Birla Institute of Technology, Goa. Dr. Thomas worked as Postdoctoral Fellow at Centre of Behavioural and Cognitive Sciences where he worked on a project titled *"Effect of learning methods and cognitive load on visual category learning and generalization"*. His project was funded by the Department of Science and Technology, Gov. of India under the Cognitive Science Research Initiative scheme.

Postdoctoral Position

1. Dr. Mukesh Makhwana, Perception, Action and Cognition Lab, Brown University, USA

PhD programmes

1. Abhilasha Jagtap, Michigan State University, USA
2. Vinay Venkata Krishna, IIT Bombay
3. Arjun Mitra, IIT Kanpur
4. Revati Shivnekar, IIT Kanpur

Industry

1. Priyanka Parihar, Neuromarketing research, Thimus Srl, Italy

Research positions

1. Mahek Kirpalani, Centre for Neuroscience, IISc Bangalore
2. Aswini M and Christelle Maria Lewis, Centre for creative cognition, SRM college of engineering, Warangal

Research Article

Does Conentrative Meditation Expand Perceived Time?

Dr. Amrendra Singh
Postdoctoral Fellow, Centre of Behavioral and Cognitive Sciences, University of Allahabad

Time is a fundamental aspect of our conscious experience. Previous studies have shown that the perception of time varies as a function of cognitive processes, such as memory and attention. Different models have been proposed to explain time perception. The most commonly used model of time perception is the pacemaker-accumulator based internal clock model which consists of a pacemaker, a counter, and a comparator. The pacemaker produces a regular series of pulses that is counted by the accumulator and transferred to the comparator. The comparator presumably has information about the correspondence between the pulse count and verbal labels. Two factors, arousal and attention, have been argued to influence the subjective experience of time in the framework of the internal clock. This model has been to widely used to explain the role of attention in perception of time intervals.

The last few decades have witnessed an overwhelming interest in investigation of different types of meditation practices and their influence on brain and behaviour. There is a wide variety of meditation techniques but they are typically classified on the basis of the type of attentional training it involves i.e. Focused Attention or concentrative meditation and Distributed attention or open monitoring meditation. In concentrative meditation, also known as focused attention meditation (FAM), the practitioner is trained to focus attention on some internal (breathing) or external object and to maintain the focus and bring the focus back to the object whenever the attention wanders from it. It is expected that long-term practice of concentrative meditation results in better perception through changes in attention.

While the effects of meditation practice on cognitive processes, such as memory and attention have been widely investigated, only a few studies have looked at the effect of meditation on perception of time. These include studies on the phenomenology of temporal experience and time perception measured using psychophysical tasks. Previous studies investigating the effects of concentrative meditation techniques on time perception have been mostly inconclusive. Hence, we performed this study with a concentrative meditation called Sahaj-Samadhi (SS) meditation using a temporal bisection task. In a typical temporal bisection task participants are first trained with short and long anchor duration. In the test phase they are presented with different durations and they are asked to report weather a particular duration is close to short or long anchor duration. The bisection task is widely used to study time. We hypothesized that the changes in attentional mechanisms achieved through long-term concentrative meditation practice would lead to subjective expansion in concentrative meditation practitioners

We used a blue square (14.4 cd/M2) for the bisection task which was presented on a 17" monitor with 100-Hz refresh rate. A total of 34 participants from an SS meditation group (N = 14, and an age matched group of non-meditators (N = 20) participated in the experiment. The experiment consisted of two blocks: an easy block with a discrimination ratio of short and long

duration 1:2 and a difficult block with a discrimination ratio of short and long duration 2:3. The range for the easy task and difficult task was 4–8 s and 4–6 s respectively. The seven discrimination durations used in the experiment were 4000, 4670, 5330, 6000, 6670, 7330, and 8000 ms for easy task, and 4000, 4330, 4670, 5000, 5330, 5670, and 6000 ms for the difficult task.

Proportion of long responses (p(long)) as well as bisection point was calculated. The Bisection Point (BP) is a point of subjective equality, i.e. the stimulus for which the participant responds short and long with equal frequency (p(long) = .50). When individuals obtain a lower BP value in one condition than in another, this suggests a lengthening effect, with the participant responding long more often for one and the same stimulus. The proportion of long responses were fitted against the actual test durations using S LOGISTIC1 function and point of subjective simultaneity (PSS) for each participant for both the easy and difficult task condition was calculated.

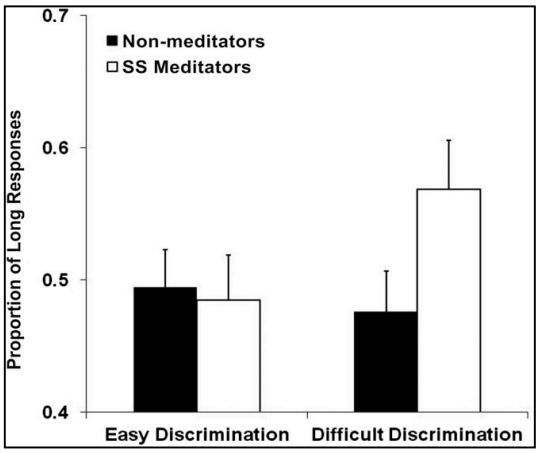


Fig. 1

Both the measures i.e. the p(long) (see fig. 1) as well as bisection point (see fig. 2) indicate towards a subjective expansion of time for SS-meditators compared to non-meditators. The findings of the study are in line with previous studies which have shown subjective expansion of time for mindfulness meditators (Berkovich-Ohana et al., 2011; Kramer et al., 2013; Droit-Volet et al., 2015). The findings of the this study suggests that the improved attentional abilities due to long term SS-meditation practice leads to longer perceived durations in a high attention demanding task but not in a task with low attentional requirements.

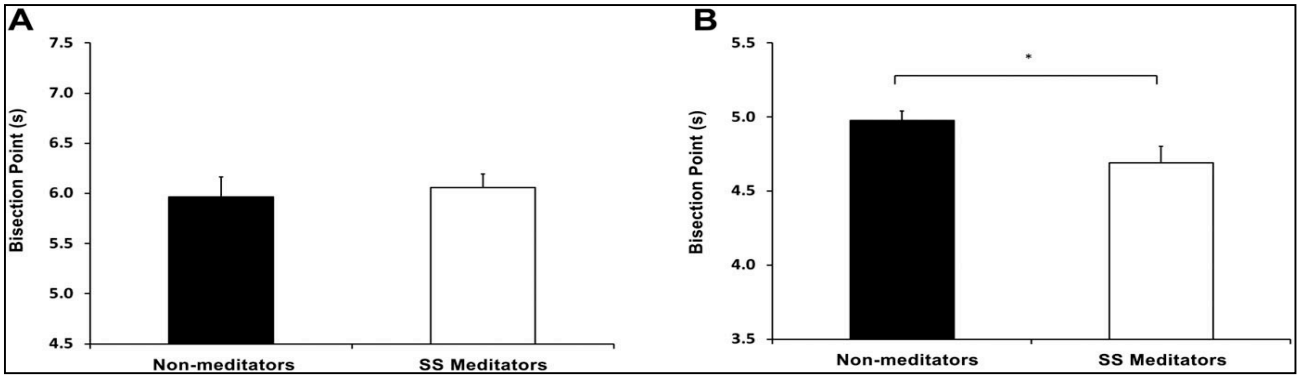


Fig. 2

These findings provide supportive evidence for the role of attention as a limited resource factor influencing subjective experience of time in the context of a clock-based model. The difference in BP in our study indicates that the subjective expansion with the difficult task in concentrative meditators is possibly due to changes in the attentional mechanisms achieved through long term practice of meditation.

Source Article

Singh & Srinivasan (2019). Concentrative (Sahaj Samadhi) Meditation expands subjective Time. *PsyCh Journal, 8*(1), 28-35.

Applying Cognitive Science Problem: Climate Change

Amita Basu
PhD Scholar, Centre of Behavioral and Cognitive Sciences, University of Allahabad

At CBCS, most of our research is done in labs. Participants sit before a computer, the screen flashes stimuli far removed from real-life, and participants press keys to respond. But the science of human cognition and behaviour is essential to solving real-world problems. A key problem is climate change.

Experts call climate change the gravest security threat of our times: graver than terrorism and nuclear weapons. Climate change exacerbates regional and global conflict: civil wars, unrest, and interpersonal violence have all been linked to the extreme weather events, rising temperatures, and resource scarcity. Most of this burden falls on poor people, whose contribution to the current problem is miniscule; wealthy nations and individuals, who're primarily responsible, are shielded by privileged access to the global supply-chain. This is unfair. This is why Richard Lazarus (2009) calls climate change a "super wicked problem." Deaths and property damage from hurricanes and wildfires, floods and desertification causing crop failure, and mass displacement – these are part of the human costs of this ongoing disaster. A human-inflicted disaster. Climate scientists agree that anthropogenic climate change (ACC) is happening; is severe; and needs immediate, drastic, concerted global action. So – "why do we defer action on climate change?"

This is the title of Varun Dutt's doctoral thesis (2011). Prof. Dutt, now at IIT-Mandi, studies some of the psychological reasons why, in the face of clear proof that the problem is real, we prefer to "wait-and-see" – to carry on with business-as-usual, hoping for the best. Dutt's work examines the implications of the fact that the catastrophic impacts of climate change are not certain but probabilistic. Cities may/may not be flooded. The flooding may/may not happen by 2025. I may/may not be affected. Dutt applies theory and paradigms from the study of decision-making under risk to study problems related to how we (mis)understand climate change. Dutt explores questions like:

1. What kind of mental models do laypeople have of the climate? Why are these models inaccurate? How can climate scientists better communicate the facts to allow us to update our faulty mental models of how the climate works and how it's changing?
2. How do we process information about the probabilities associated with negative events – when these events are large in impact ("Most of India will be flooded") but have a low probability of occurring ("p=.008")? In what format can climate scientists best represent probability information to allow the lay public to take appropriate action to reduce the chance that these negative events will actually happen?
3. How does the delay in negative climate outcomes affect the rate at which we discount them?

Discounting occurs when an outcome loses value. An outcome (Fact: "Most of India will be flooded") can be discounted (Response: "I don't care") for several reasons. The outcome may be

delayed instead of immediate ("The flooding will start in 2050"), may be probabilistic instead of certain ("The chance of flooding is 8/1,000"), or may be happening to people who are far away and/or unlike us ("I'm a German living in Minnesota, so I don't care if India gets flooded.") These are some other reasons why we defer action on climate change: the negative outcomes are discounted in multiple ways. "India is flooding today" scares us Indians into taking action. "India has an 8/1,000 chance of flooding 31 years later" scares nobody. We close our eyes, hope for the best, and wait and see.

Climate change is not just a "super wicked" problem. It's also exactly the wrong kind of problem for human cognition. We have evolved to deal with problems on a short-to-medium timescale (Run away from this lion, Save some potatoes for the winter), problems that are well-defined (I'm hungry), problems we diagnose based on recent trends (Another herd of wildebeest is migrating: the rains are coming) and problems whose solution brings a gain (If I eat, I'll feel good). Climate change as a problem is: on a long timescale (The worst damage may have already been done, but the worst effects will come decades later), ill-defined (How do we balance economic development vs. conservation?), hard to diagnose from short-term trends (Hey it's really cold this winter. Global warming must be a false alarm. Whew! That's one less problem on my plate), and a problem whose solution is costly and will bring no gain – only escape from impending loss.

Don't Even Think About It: Why Our Brains are Wired to Ignore Climate Change (Bloomsbury, 2014) explores in depth a number of problems in our cognition of climate change:

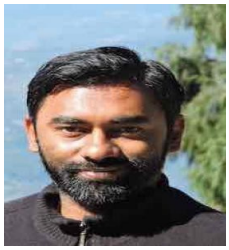
1. How climate change became politicised: Human behaviour is changing the climate. This is a fact. This is a problem that needs a solution. So how did climate change become a political debate? Even as new evidence for ACC pours in, why do some individuals and governments passionately deny what's happening? Climate scientist Stephen Schneider has received death threats from neo-Nazi climate deniers. Why does ACC invoke such intense affective responses?
2. Why does climate change fail to activate threat mechanisms? This section draws on research by Paul Slovic, a psychologist who's spent decades studying risk perception.
3. Why do we refuse to discuss climate change? Even victims of natural disasters don't want to acknowledge what's happening. What are the mechanisms by which we diffuse responsibility for climate change? This section contains a chilling account of how, in the early 2000s, Coca-Cola and other massive corporates shifted the onus of climate change action onto us as individual consumers. Generating the infamous mantra: Reduce, Reuse, Recycle.

Climate change is a problem of superhuman scale. But cognitive scientists are gradually mounting a concerted attack on the biases, cognitive flaws, and inertia that keep us, as individuals and nations, locked in a track headed for doomsday. Nudge-based projects, pioneered by Nobel-Prizewinner Richard Thaler, show promise in reengineering choice architectures to steer us towards behaviours that we collectively recognise as desirable. The tide is turning: we see, now, that the onus of action cannot lie primarily on us as individual consumers. The problem is too big: we need big solutions. As individuals across the world take up advocacy to demand that governments and corporates align their behaviour with our priorities, cognitive scientists are rising to the biggest challenge of our times.

Achievements

Ishan Singhal, PhD scholar, attended the "Modelling Consciousness" workshop in Dorfgastein, Austria. He gave a presentation on "Temporal properties of consciousness". His travel was partially funded by Leibniz University, Hannover.

Dr. Manish Asthana joined as Assistant Professor in the Department of Humanities and Social Sciences, Indian Institute of Technology, Roorkee.
Dr. Asthana did MSc in Cognitive Science from CBCS in 2009.



Dr. Sumitava Mukherjee joined as Assistant Professor in Department of Humanities and Social Sciences, Indian Institute of Technology, Delhi. He completed his MSc in Cognitive Science from CBCS in 2010.

Prof. Narayanan Srinivasan

Invited talks

- Cognitive science of mindfulness, Invited talk, Mindfulness India Summit, Mumbai, India, 2019.
- Consciousness without content or minimal content: A look at evidence and prospects, Invited talk, International Conference on Neurophysiology of Silence – ICONS, San Biagio Monastery, Italy, 2019.
- Event control, self and agency, Invited talk, International Workshop on Perspectives on Consciousness, Hebrew University, Jerusalem, Israel, 2019

Prof. Bhoomika R. Kar

- Invited as an expert to participate in the STRIDE Proposal Evaluation meeting under the Scheme for Transdisciplinary Research for India's Developing Economy launched by the UGC.

Research Grants

DST - CSRI-PDF Fellowship: Dr. Saraswati Yadav was awarded with the postdoctoral fellowship from the Department of Science and Technology (DST) for the Project titled: "Modulatory effect of reward prospect on the characterization of trait anxiety".

Publications

Makwana, M., & Srinivasan, N. (2019). Self-associated stimuli produce stronger intentional binding. *Journal of Experimental Psychology: Human Perception and Performance*, *45*(11), 1436.

Ranjan, S., & Srinivasan, N. (2019). Sense of agency in future directed intentions: Intentional binding for intermediate outcomes. *PsyArXiv*. https://DOI.ORG/10.31234/OSF.io/qa93k

Bandyopadhyay, D., Pammi, V. C., & Srinivasan, N. (2019). Incidental positive emotion modulates neural response to outcome valence in a monetarily rewarded gambling task. *Progress in brain research*, *247*, 219-251.

Tarai, S., & Srinivasan, N. (2019). Emotional prosody Stroop effect in Hindi: An event related potential study. *Progress in brain research*, *247*, 193-217.

Kar, B. R., Nigam, R., Pammi, V. S. C., Guleria, A., & Srinivasan, N. (2019). Neurocognitive mechanisms of affective conflict adaptation: An event related fMRI study. *Progress in brain research*, *247*,149-167.

In Conversation

With Dr. Pulkit Agarwal
Interviewed by Sahithyan Sukumaran
Masters 2nd Year, CBCS

Assistant Professor, Department of Electrical Engineering and Computer Science (EECS) at MIT. His lab is part of the Computer Science and Artificial Intelligence Lab (CSAIL) at MIT and affiliated with the Laboratory for Information and Decision Systems (LIDS).

Q1. You started as an electrical engineer, what motivated you towards Artificial Intelligence?

I started as an electrical engineer when I believed that the brain is a bunch of neurons that are made basically like circuit elements, you can string them together and then you can just make electrical circuits (brain like). So, I believed if I can study how electrical circuits are built then I can actually build a brain. So that's how I started doing electrical engineering but then I took the first course in electronics and realised that I need to know what the system needs to do and then design it. That is when I lost interest in electronics and moved towards AI.

Q2: Please elaborate on your current research interest and what you will be working on?

I think the primary interest is to go after what we call as "common sense" in humans. What is "common sense"? In some ways common sense is a knowledge that we acquire from our daily interactions and are able to use it to go to a new situation and solve the new situation. Even if we have not seen anything before, for example consider that there's a door that needs to be opened, some doors which you can open with a key, which goes in and you rotate the key and the door opens. Then these days you have more modern keys e.g. Radio Frequency Identification (RFID) based locking system or the locking systems where you have to insert a card. Even if you have not seen any of those systems before, the moment someone hands you a card , you know that this is the thing which allows you to open the door and then you might do some experiments to figure-out how to use that object to open the door. But you have this prior knowledge that door needs to be opened to go inside. That is according to me is the heart of the problem in AI today. All we can do is to build these task specific systems which are very good at one particular task but they are unable to transfer knowledge from one task to another. So, the main direction in research now is how to build systems which can transfer knowledge.

Q3: What are the main challenges in the field of AI?

There are two streams within AI -one is AI as a field in terms of research and the other is AI as a technology which is being deployed. It would be interesting to look at them individually as there are challenges in both the cases. In AI deployment for example, the biggest challenge is transferability

or in other words practical scalability. The current models which work very well in internet data but the moment you try to apply them on real world data, the performance significantly degrades. So that is a big challenge because in real world data becomes very expensive. For example, if you want to do anything in medicine you have to get labelled data and when doctors have to label, it is going to be very expensive.

Second challenge is accountability or liability. If an AI system makes a decision and something goes wrong then who is to be blamed. However, now people talk about explainable AI systems but then again it depends on what is explainable. You could now construct systems which are explainable by design, for example, you could make a modular system and then say one module computes something and another module computes something else. That way you can point out which module actually broke down.

And the third challenge is data and data privacy. With more data, AI systems can infer a lot more about people compared to what you could infer before with lesser data. So, with whom will the data live and how can we self-preserve privacy. How will the notion of privacy evolve in this age where we are going to get many more features at the cost of privacy. But we should remember that AI is a solution to a problem, and AI shouldn't become a problem.

Now. when we come to AI as a stream of research, we face similar problems. According to me people historically have built systems which are experts at doing one particular task. So, it is necessary to draw a clear distinction between AI as an engineering discipline to solve real world problems that exist today vs AI as a pursuit of what we might mean by "human-like-intelligence" which brings the challenge of human bias. As we know intelligence is different for different organisms. So, it's really important to think about what exactly is intelligence. One definition that I find useful is the definition of transfer, which refers to 'can I do something in the world or can I explore the world, be in the world, and learn something about the world which helps me solve tasks faster as I spend more time in the world'.

Q4. What are the limitations of AI? What can we look forward to in the field of AI that can help people in real life?

There is AI in daily life, for example, speech recognition systems and language translation systems that are becoming live. But these systems currently have limitations because they work in English or the major languages. So currently such a limitation poses an open challenge to develop these systems in the Indian context where there are so many languages and/or dialects. Similarly, starting AI companies or making AI products is not a short-term solution. Because you have to gather data and no one will allow you to obtain the data if you don't have a solution. So you first need to find a valuable position that you can still offer to a customer without doing much fancy machine learning by using some heuristics and that will allow you to gather data which then could help you train a better machine learning system resulting in better performance. AI's limitations are more pronounced and obvious in case of medicine, agriculture, education etc. I think these things will take time just because getting data is not so easy and then even when you have to get data, you have to conduct multiple studies to show that the system that you are proposing is actually doing what you want it to do. The accuracy of 90% might not be sufficient if you are dealing with saying someone has a tumour or not. You have to be much more accurate and you have to create a system which the doctors can actually trust. There are people working on it but it will take time before we start seeing some of these things.

Q5. Cognitive science being such a diverse multidisciplinary field, what are the career opportunities, training and prerequisites as a guide for students entering into cognitive science?

Yes, it's a diverse field which concerns neuroscience, psychology, AI etc. I think these days, in all of these fields computation is a very important aspect and having a basic idea of statistics and programming are prerequisites for being able to conduct experiments. Being comfortable with cloud infrastructure is a necessity.

Cognitive science being as diverse as it is the only thing I would say is, you should not narrow yourself too soon. I mean when given a problem, it is good to ask the question - how would a neuroscientist think about it? how would a cognitive scientist think about it? how would a computer vision person think about the same problem? And then you will get a different perspective. Even if you are doing, for example neuroscience we can ask what form of an answer am I looking for? Because, we can say I am trying to understand how the brain works, but what do we mean by understanding? This is important because two scientists with the same goal of understanding the brain may have different ideas about what they mean by understanding. This is a hard question but cognitive science trains you to look at it with diverse perspectives.

Prof. Madhura Ingalhalikar
Associate Professor, Symbiosis Institute of Technology at SIU

Interviewed by Niyatee Narkar
MSc II year, CBCS

Q1. Please give some insight into the work happening in your lab and your current research.

Symbiosis Center for Medical Image Analysis works on problems that strive to understand and quantify the complex information conveyed by medical images with a focus on images of the brain. We develop modern computational techniques that extract diverse and complex information from imaging data and apply these to a plethora of clinical studies. These techniques not only support precise quantification but also overcome the limitations of subjective visual interpretation. Ongoing projects include clinical studies on Parkinson's disease and other movement disorders, as well as studies on brain tumor segmentation and classification to support neurosurgical planning.

Q2. Enlighten us about the different modalities of neuroimaging.

Neuroimaging although a focused area, can be divided into multiple modalities. As a primary division, we can delineate based on the type of image acquisition. This includes CT, MRI, PET, EEG, MEG, SPECT etc. Another way to divide can be based on what the images are mapping : function or structure. Functional imaging which include fMRI, EEG, MEG, PET, Perfusion MRI and MR Spectroscopy while structural imaging consists of T1-weighted MRI, diffusion MRI etc.

Q3. How did you start working with DTI over all the other modalities, was it a happy coincidence or a conscious choice?

My paternal grandmother who died at an age of 80 suffered from Alzheimer's disease. In her last few years, I lived with her and saw the agony of what Alzheimer's could do to the patient. It was heart-breaking to see that she could not recognize me or my sibling. That is when I started wondering about the mysteries of the brain and how I could utilize my education and knowledge towards understanding the intricacies of brain wiring and disconnectivity. I was fortunate enough to get an opportunity to work in the area of neuroimaging during my PhD work with Dr. Magnotta at the University of Iowa. Having a background in engineering, I was best placed working on the image processing and analysis aspects to support clinical outcomes in psychiatry and neurology. Dr Magnotta introduced me to both diffusion MRI and functional MRI, however, the problems in diffusion image registration and analysis were unsolved at that point and therefore working on DTI was more crucial.

Q4. Your work has majorly focused on development of the modality of DTI itself as well as more application based research such as use of DTI to categorise and identity patterns or markers for several disorders/conditions. Which line of work

do you personally prefer and which do you think requires more attention in research currently?

I will answer you second question first. When I moved back to India I realized that we as a country have a huge burden of illnesses due to infection, cancer as well as various brain related disorders that are not psychiatric in origin. To this end, my effort has been to answer clinical questions through innovative quantitative image analysis. For example we have started working on brain tumors where we build algorithms to support non-invasive diagnosis as well as predict growth, recurrence and survival. My expertise in diffusion MRI helps neurosurgeons plan the resection and the complete treatment thereafter as we can illustrate what fiber tracts pass close to the tumor with modern diffusion MRI models which the diffusion tensor imaging cannot capture. Another project that we work on is to predict the focus of focal cortical dysplasia (epilespy) in children which again can support the treatment plan and its efficacy. Overall, the impact of my work drives me to do better and I don't think there's an issue of preference of modality here, as an optimal solution for the problem is what is required.

Q5. What kind of analytical techniques do you use for the DTI data? Please suggest some resources for the same.

We use a lot of homegrown scripts to compute connectivity etc. However, you can always rely on standard software such as FSL, AFNI etc for diffusion processing and analysis.

Q6. Throughout the years of your engagement in research, what work has excited you the most?

Unfortunately I cannot discriminate as every problem has its own challenges and when you solve those- that's the high you get.

Q7. How important do you think is the integration of different modalities when it comes to validation of results obtained in one modality?

Every modality provides a different facet of information. It is therefore extremely crucial that you take information from all possible modalities to complete the jigsaw puzzle. Multi-modal characterization is therefore far more powerful than only understanding a single aspect of the pathology under consideration.

Q8. In application based research, the trend is to be able to estimate some predictive markers for disorders which would aid in early diagnosis and intervention. So, do you think Machine learning is the best approach to go about it and should it be consequently pressed upon in current research more than other kinds of work?

Every problem has a unique solution. It therefore depends on the problem you are solving as to what quantitative technique is the most appropriate. Machine learning and deep learning are state-of-art methods that can certainly help in predicting outcomes. However, these have their own limitations such as these can overfit on small datasets which is usually the case in neuroimaging. For example in tumors, in some cases , first order texture features may be sufficient to delineate the type and advanced deep learning models may not be required

Q9.Given the newly and rapidly growing interest in modelling neuroimaging data, what do you think are some risks associated with using retrospective data? Would you like to issue some precautions that researchers must undertake?

Retrospective data may not be designed as a research project and many times the biggest challenge we face is that demographic information, clinical and neuro-psychological scores of these patients are missing. Moreover, the scans are acquired using lower resolutions most of the times in 2D with clinical protocols. The images may contain head motion issues and other artefacts which are fine for visual inspection by the radiologist but do not work in a quantitative framework. Newer 3T scanners may also use techniques like compressed sensing for faster acquisition, where we are unsure what effect it may have when quantifying the images. It is therefore important to understand the acquisition techniques, their implications and availability of demographic and clinical markers before analyzing retrospective data.

Q10.What is the scope of deep learning in neuroimaging research beyond disease prediction and how can young researchers get trained in this line of work?

Deep learning has already proven to be useful in image processing such as in segmentation tasks as well as in image registration. Fiber tractography and clustering techniques based on DL models have shown higher reproducibility and sensitivity. DL is also used to optimize the image acquisition as well as reconstruction at the scanner level. Thus, I think the applications of DL reach far beyond prediction of disease. To train yourself in DL the best way is to take an online course from Andrew Ng or Geoffrey Hinton followed by diving into a project that requires DL. If you don't have any project to work on at your institute - you can enter Kaggle competitions where you can download datasets and solve the problem yourself and try to get on the leader board.

Q11. What do you think are some of the challenges in the field of neuroimaging and what are some upcoming new approaches?

The area of neuroimaging strives to alleviate clinical issues, support neurosurgical planning and gain insights into neuro-anatomical or functional changes that occur in pathology. The biggest challenge that we face in India is that we still do not create image repositories collected at different centers and hospitals that the researches across can access. It is vital to have these to develop better techniques and also to characterize the Indian pathology which may be different from other ethnicities.

Alumni Corner

Dr. Shivangi Jain

Postdoctoral Associate
Brain Imaging & Analysis Centre, Duke University Medical Centre

When I joined CBCS in 2008 to purse my master's I was absolutely sure I wanted to study cognitive psychology but couldn't explain why. I still can't answer what pushed me into this area of research. But the love affair that started with cognitive research (specifically working memory) continues till now. For me, CBCS was the perfect steppingstone to venture into the world of cognitive science research. The basics of research that I picked up at CBCS helped me carve a niche for myself not just during grad school at Georgia Tech (Atlanta, USA), but even now as a postdoc at Duke University (Durham, USA). For my master's thesis (completed at CBCS) I studied the effect of aging on working memory consolidation, which acted as a segue for my dissertation on understanding the subcomponents of working memory and their malleability to training. In brief, I wanted to see which components of working memory show the benefit of cognitive training and whether that benefit can be seen in increase in performance on other cognitive tasks. In addition, during my PhD, I also explored the complex interaction between attention, working memory and emotion. My overarching goal is to further research in the area of cognition and plasticity and its underlying brain mechanism. I also want to translate this research to improve cognition in healthy aging. To be better equipped to answer questions in this research area, I took a postdoctoral position in a neuroimaging lab. In this position, I have been learning how to conduct fMRI research, relate functional connectivity and structural connectivity to cognition, study white matter integrity and aging as well as explore the relation between iron deposits and aging to name a few. Currently I am working to see how resting state brain connectivity is related to task related brain connectivity and how they mediate the age-cognition relationship. A very interesting side project which I just finished was to study plasticity and brain reorganization after hand transplantation. Brain's ability to wire and rewire is beyond fascinating and it was a privilege to study this fascinating process in play. For more information please see-
https://www.tandfonline.com/doi/pdf/10.1080/13554794.2019.1667398

Maruti Mishra

Postdoctoral Fellow
Harvard Medical School, Boston, USA

As a Doctoral student at CBCS, I got the opportunity to work with Prof. Srinivasan on attention and visual awareness, more specifically how different attentional manipulations affect processing of emotional information from faces. During my PhD, I learnt psychophysical and electrophysiological techniques to address relevant questions in cognitive neuroscience. Over the years, I got more interested to know how the brain can process information from faces so efficiently, and this led me to pursue further research in face perception as a postdoctoral fellow at Harvard Medical School/ VA Boston healthcare, Boston, USA.

I am excited to work with Prof. DeGutis and his team (https://www.bu.edu/ballab/), where we study face recognition in specific group of individuals who have reported life-long difficulty in recognizing people by their faces- termed as 'face blindness' or 'Developmental prosopagnosia' (DP's). People with face blindness have difficulty recognizing their friends, family members, or sometimes even themselves by looking just at the faces. But over the years, DP's develop strategies to overcome this limitation and recognize people by using information from external features like hairstyle, gait, voice etc. Hence, when shown pictures of faces with all the external information removed, they have difficulty to match any two faces and demonstrate poor recollection of familiar faces.

In my lab here, we use behavioural, eye tracking and multimodal neuroimaging approaches like fMRI, Diffusion tensor imaging (DTI) and structural imaging to understand the nature of face specific impairment in DP's. As a part of this group, my current research involves identifying and characterizing subtypes of DP as well as examining their electrophysiological differences in face processing. In addition, using DTI analysis, I am also examining the structural connectivity/ white matter tract alterations in different brain areas involved in face processing in DP's and Controls.

One of the important realizations that I have had when interacting with DP's is knowing that what we take for granted-that anyone can recognize people by faces- is after all not so trivial. You can look at an interesting self-reflection by one of our participants (https://www.washingtonpost.com/news/magazine/wp/2019/08/21/Feature/my-life-with-face-blindness/). I am grateful to my current lab and my years at CBCS for helping me improve day by day in research and in life.

Thank You!

Maruti V Mishra,

BALLAB, Harvard Medical School/VA Boston Healthcare, Boston, USA.

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