
BIOGRAPHICAL SKETCH

NAME: Khushbu Agarwal

POSITION TITLE: Scientist III/Assistant Professor, National Brain Research Center, NH-8, Manesar, Haryana, India

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE	START DATE MM/YYYY	COMPLETION DATE MM/YYYY	FIELD OF STUDY
Amity University, Noida, Uttar Pradesh, India	BSc (H)	05/2005	05/2008	Biotechnology
Mody Institute of Technology and Science (MITS), Rajasthan, India	MSc	08/2008	08/2010	Biotechnology
All India Institute of Medical Sciences, New Delhi, India	PhD	08/2011	01/2018	Nuclear Magnetic Resonance Imaging/Spectroscopy
Section of Sensory Science and Metabolism (SenSMet) NIAAA/NINR, Bethesda, Maryland, USA	Postdoctoral Fellow	02/2020	01/2025	Chemosensation and Neuroimaging in Addiction

* Maternity/childcare leave, 2018 – 2020

A. Personal Statement

I have recently joined as an Assistant Professor at the National Brain Research Center, NH-8, Manesar, Haryana, India, where I work on “Effects of odor simulated virtual reality therapy on relieving craving symptoms in alcohol use disorder”. The goal of my lab is assess olfactory dysfunction in patients with alcohol use disorder and comorbid anxiety and mood disorders.

My doctoral training focused on using a multiparametric magnetic resonance imaging (MRI) approach to study the structure, tissue characteristics, and metabolic states of various disease conditions. During my doctoral training at the All India Institute of Medical Sciences I had the great opportunity to lead many interdisciplinary projects examining tissue structures and metabolic changes in patients with cancer and brain disorders under the supervision of Prof. N. R. Jagannathan. These projects gave me clinical expertise in various MR-based approaches to disease diagnosis and therapeutics, as well as management and communication skills in an interdisciplinary environment. My background in using various MR-based techniques and the study of clinical diseases, including psychiatric disorders, and my interdisciplinary work experiences will help me successfully complete my proposed clinical trainings in addiction research.

After completing my PhD, I moved to Sweden with my husband and took childcare/maternity leave between 2018 and 2020 to care for my newborn, who was critically ill during that period. This personal responsibility influenced the timing of my career trajectory, and I chose to pursue a postdoctoral fellowship later in my career than is typical. Despite being on childcare leave, I remained academically engaged and focused on publishing papers stemming from my PhD research, several of which are reflected in the *Contributions to Science* section below.

Once my child’s health stabilized after the first year, I actively sought opportunities to return to research and continue building my expertise. In February 2020, I joined the laboratory of Dr. Paule Joseph co-mentored by Dr. Nora Volkow at the National Institute on Alcohol Abuse and Alcoholism (NIAAA), NIH, as a postdoctoral fellow. During this time, I expanded my research into chemosensation and its neural underpinnings, integrating my prior expertise in neuroimaging with novel approaches to understanding brain correlates of chemosensory cues and reward sensitivity in alcohol-drinking individuals, both with and without comorbid high BMI or obesity. Using functional MRI (fMRI) and structural MRI techniques, I investigated how

chemosensory signals interact with reward-related neural circuits, thereby advancing a deeper understanding of mechanisms underlying alcohol use disorder (AUD). My work was supported by the prestigious Center for Compulsive Behaviors Fellowship (2021–2025) and the NIH K99/R00 Pathway to Independence Award (2024–2025). Although I secured a tenure-track position at the UTHealth Houston Department of Psychiatry to continue my R00 research, I chose to return to India to pursue an independent faculty position, where I now serve as an Assistant Professor and Ramalingaswami Fellow at the National Brain Research Centre (NBRC).

At NBRC, I am building an independent interdisciplinary research program centered on the neurobiological mechanisms of AUD, with a focus on clinical chemosensory research and non-pharmacological interventions. My work integrates:

- Patient-engaged olfactory and chemesthetic assessments,
- Clinical evaluations paired with odor-cue-based fMRI paradigms, and
- Development of immersive therapeutic tools, including a novel odor-stimulated Virtual Reality (VR) therapy to modulate craving and relapse risk.

This research program is strengthened by active collaborations with leading addiction specialists Dr. Yatan Pal Singh Balhara and Dr. Siddharth Sarkar at All India Institute of Medical Sciences and National Drug Dependence and Treatment Center. They have been supporting my research by helping with subject recruitment, clinical assessments, and translation of findings into practice. The broader vision of my work is to establish chemosensation not only as a tool to understand AUD but also as a foundation for innovative interventions that extend to co-occurring psychiatric disorders. By positioning olfactory and chemesthetic processing as key entry points into brain-behavior relationships, I aim to broaden the scope of non-pharmacological treatment strategies in psychiatry.

The **India Rise Fellowship** will play a critical role in facilitating the establishment and expansion of this research program at the National Brain Research Centre (NBRC). It will provide me with the support needed to integrate advanced neuroimaging, chemosensory science, and translational clinical approaches, ultimately contributing to impactful, patient-centered solutions for addiction and mental health disorders.

B. Positions and Scientific Appointments and Honors

Positions and Scientific Appointments

- 2020 – 2024 Postdoctoral Researcher, Section on Sensory Science and Metabolism Unit (SenSMet), Division of Intramural Clinical and Biological Research (DICBR), National Institute on Alcohol Abuse and Alcoholism (NIAAA), Biobehavioral Branch/National Institute of Nursing Research (NINR), NIH
- 2011 – 2013 Predoctoral Fellowship for Research, Junior Research Fellow, Department of Science and Technology, Government of India, New Delhi, India
- 2014 – 2018* Predoctoral Fellowship for Research, Senior Research Fellow, Indian Council of Medical Research (ICMR), New Delhi, India
- * Maternity/childcare leave, 2018 – 2020.

Other Experience and Professional Memberships

- 2020 – present Ad hoc journal reviewer for *Clinical Nutrition*, *Translational Psychiatry*, *Journal of Psychiatric Research*, *Alcohol and Alcoholism*, *Frontiers in Endocrinology*, and *Scientific Reports*
- 2022 – present Member, Society for Neuroscience (SfN)
- 2021 – present Member, Association of Chemoreception Sciences (ACheMS)
- 2021 – present Member, Research Society on Alcoholism (RSA)
- 2020 – present Member, The Obesity Society (TOS)
- 2012 – 2017 Member, International Society for Magnetic Resonance in Medicine (ISMRM)
- 2012 – 2017 Member, World Molecular Imaging Society (WMIS)

Honors

- 2024 NIH Summer Intern Mentor Award
- 2024 NIAAA Daniel Hommer Outstanding Fellow Award
- 2024 American College of Neuropsychopharmacology (ACNP) International Global Scholarship
- 2022-2024 Center for Compulsive Behaviors (CCB), NIH Research Fellowship

2022	Travel grant from Association of Chemoreception Sciences (AChemS)
2022	Child Care Grant, AChemS
2021	Scholarship to attend Keystone Symposium 2021
2016	Student Grant for International Society for Magnetic Resonance in Medicine, ISMRM 2016, Singapore
2015	International Travel Grant by Department of Science and Technology, Government of India
2015	Highlighted presentation in World Molecular Imaging Conference (WMIC), 2015
2015	Student Grant for International Society for Magnetic Resonance in Medicine, ISMRM 2015, Ontario, Canada
2010	Qualified Council of Scientific and Industrial Research (CSIR) National Eligibility Test (NET), India
2011	Qualified Graduate Aptitude Test in Engineering (GATE), India

C. Contributions to Science

1. Magnetic Resonance Imaging and Spectroscopy in Breast Cancer. During my PhD studies, I obtained basic training in magnetic resonance imaging (MRI) and spectroscopy (MRS) and their implications in understanding disease processes, including cancer and brain disorders. I worked in the application of MR modalities, including dynamic contrast-enhanced (DCE) MRI, diffusion-weighted imaging (DWI), and MRS, to evaluate the potential of estimating the apparent diffusion coefficient (ADC), total choline (tCho) concentration, tumor volume, fat content, and DCE curve type in differentiating various breast tissues (malignant, benign, and healthy) and later to assess the decrease in numbers of false negative and positive cases in breast cancer diagnosis. Quantitative DWI was found to be a useful guide in defining cancer-free margins and the extent of residual disease while planning breast conservation surgery. I gained statistical data analysis exposure and knowledge by analyzing my project data sets using various statistical methods, including building regression models and sensitivity (ROC) analysis. Results from my research provided new details on MR and molecular biomarkers for breast cancer diagnosis and treatment.

- Agarwal K**, Sharma U, Sah RG, Mathur S, Hari S, Seenu V, Parshad R, Jagannathan NR. Pre-operative assessment of residual disease in locally advanced breast cancer patients: A sequential study by quantitative diffusion weighted MRI as a function of therapy. *Magnetic Resonance Imaging*, 2017; 42:88-94.
- Agarwal K**, Sharma U, Mathur S, Seenu V, Parshad R, Jagannathan NR. Study of lipid metabolism by estimating the fat fraction in different breast tissues and in various breast tumor sub-types by in vivo ¹H MR spectroscopy. *Magnetic Resonance Imaging*, 2018; 49:116-122.
- Agarwal K**, Hariprasad G, Rani K, Sharma U, Mathur SR, Seenu V, Parshad R, Jagannathan NR. Is there an association between enhanced choline and β -catenin pathway in breast cancer? A pilot study by MR spectroscopy and ELISA. *Scientific Reports*, 2017; 7:2221.
- Sharma U, **Agarwal K**, Sah RG, Parshad R, Seenu V, Mathur S, Gupta SD, Jagannathan NR. Can multi-parametric MR based approach improve the predictive value of pathological and clinical therapeutic response in breast cancer patients? *Frontiers in Oncology*, 2018; 8:319.

2. Brain Disorders and MR Imaging. The neuroscience research I conducted during my PhD studies focused on understanding the structural and metabolic changes in reward-specific brain regions, including the nucleus accumbens, caudate nucleus, and orbitofrontal cortex, in different psychiatric illnesses, such as obsessive-compulsive and bipolar disorders. I conducted MRI/MRS and estimated the metabolite levels in different brain regions through advanced MR spectrum-processing LC Model software. Working on these projects sharpened my technical skills in the field of neuroimaging and spectroscopy and led to my interest in brain studies.

- Parmar A, Sharan P, Khandelwal S, **Agarwal K**, Sharma U, Jagannathan NR. Brain neurochemistry in unmedicated obsessive compulsive disorder patients and effects of 12-week escitalopram treatment: A ¹H-magnetic resonance spectroscopy study. *Psychiatry and Clinical Neurosciences*, 2019; 73:386-393.
- Gnanavel S, Sharan P, Subbiah V, **Agarwal K**, Sharma U, Jagannathan NR. Inflammatory cytokines and glutaminergic excitotoxicity in patients with obsessive compulsive disorder. *Journal of Neurochemistry*, 2015; 134:350-351.

3. Reward Sensitivity and Neural Correlates in Addiction. I extend my MR expertise and knowledge in brain disorders to studying brain function in addictive conditions, such as substance use disorders and

obesity. I have several research projects and protocols examining different aspects of brain function and behavior in addiction. In some of my previous studies we have shown the overlaps in the reward pathways that lead to AUD and obesity, both of which have been linked to the hedonic pathway, and impairments in decision making have been repeatedly demonstrated in addiction. To this end, I conducted fMRI study using the large clinical data sets from the Human Connectome Project (HCP) and the longitudinal Adolescent Behavioral, Cognitive, and Development (ABCD) Study to explore reward sensitivity alterations and cognitive deficits in adults and adolescent populations through imaging and behavioral measures. The HCP data set yielded findings relating functional and cognitive alterations in reward-specific regions that influence the decision-making ability of individuals with high risk for AUD and comorbid high BMI compared to their counter groups with low AUD risk and low BMI. From a developmental perspective, my research focuses on identifying risk factors for drug use in children and adolescents. My work using the ABCD Study data set revealed the most discriminative among a range of social, demographic, nutrition, and behavioral variables in development of maladaptive behaviors in children, including a wide range of childhood exposures. I built addiction high, medium, and low risk groups using baseline measurements and then tested differences in neural and behavioral indices across these risk groups based on 2-year follow-up neural activation and behavioral measurements. In a separate pilot study, I also investigated the connection between the brain and the gut in patients with obesity following two different types of bariatric surgery procedures, to determine if changes in reward-specific neural correlates and cognition are related to changes in the gut microbiome or hormone levels. Interestingly my studies on understanding brain connectivity patterns via the resting state functional MR imaging has led to some very important findings: a) Body mass index moderates the relationship of early life stress events and salience network seed brain connectivity in AUD, b) specific patterns of brain connectivity associated with taste and olfactory perception may serve as predictors of alcohol consumption behaviors in young adults. Additionally, I wrote some review articles highlighting the use of neuroimaging measures, such as fMRI and PET, in a) identifying the inflammation markers in substance use and comorbid mood disorders, b) assessing neuroinflammation as a key pathophysiological process contributing to cognitive decline during aging and its significant role in the development of Alzheimer's disease and related dementia (ADRD).

- a. **Agarwal K**, Demiral SB, Manza P, Volkow ND, Joseph PV. Relationship between BMI and alcohol consumption levels in decision making. *International Journal of Obesity (London)*, 2021; 45:2455-2463.
- b. **Agarwal K**, Manza P, Tejeda HA, Courville AB, Volkow ND, Joseph PV. Risk Assessment of Maladaptive Behaviors in Adolescents: Nutrition, Screen time, Prenatal Exposure, Childhood Adversities - ABCD Study. *Journal of Adolescent Health*. 2023 Oct 7:S1054-139X(23)00443-3. doi: 10.1016/j.jadohealth.2023.08.033. Online ahead of print.
- c. **Agarwal K**, Joseph PV, Zhang R, Schwandt M, Ramchandani V, Diazgranados N, Goldman D, Momenan R. Early Life Stress and Body-Mass Index Modulate Brain Connectivity in Alcohol Use Disorder. *Translational Psychiatry*, 2024 Jan 20;14(1):43. doi: 10.1038/s41398-024-02756-8.
- d. **Agarwal, K.**, Chaudhary, S., Tomasi, D. *et al.* Prediction of alcohol intake patterns with olfactory and gustatory brain connectivity networks. *Neuropsychopharmacol.* **50**, 1167–1175 (2025).
- e. Chaudhary S, Chao HH, **Agarwal K**, Gupta S, Li CSR. Alzheimer's disease and related dementia: A comprehensive review. *Neuroscience & Biobehavioral Reviews*. Volume 176, September 2025, 106270.
- f. **Agarwal K**, Manza P, Chapman M, Nawal N, Biesecker E, McPherson K, Dennis E, Johnson A, Volkow ND, Joseph PV. Inflammatory markers in substance use and mood disorders: A neuroimaging perspective. *Frontiers in Psychiatry*, 2022; 13:863734.

4. Chemosensation and Addiction. I also explore the bidirectional relationship between chemosensation (smell and taste perception) and addictive behaviors. To understand the role of chemosensory perception in detail and how it sensitizes neural mechanisms in addiction, I conducted an extensive literature search and summarized the findings as a scoping review and a book chapter. I also contributed to a recent systematic review that details the neural and biological mediators of smell and taste alterations and conducted and contributed to several research projects on the role of chemosensation in altering consumption behaviors, and self-reported alterations of chemosensory perception in excessive alcohol drinkers [using the ongoing longitudinal COVID-19 impact on alcohol drinking (C-19 PIA) NIAAA data set]. My recent work has shown that prenatal caffeine exposure is associated with structural alteration in the

central taste processing region, reward sensitivity, and elevated BMI in adolescents from the ABCD Study. This work was selected as a finalist for the 2023 Top 20 Clinical Research Achievement Awards (<https://www.clinicalresearchforum.org/page/TopTen>).

- a. **Agarwal K**, Manza P, Leggio L, Livinski AA, Volkow ND, Joseph PV. Sensory cue reactivity: Sensitization in alcohol use disorder and obesity. *Neuroscience and Biobehavioral Review*, 2021; 124:326-357.
- b. **Agarwal K**, Luk JW, Manza P, McDuffie C, To L, Jaime-Lara RB, Stangl BL, Schwandt ML, Momenan R, Goldman D, Diazgranados N, Ramchandani VA, Joseph PV. Chemosensory alterations and impact on quality of life in persistent alcohol drinkers. *Alcohol and Alcoholism*, 2023; 58:84-92.
- c. **Agarwal K***, Chaudhary S, Volkow ND, Joseph PV*. Prediction of Alcohol Intake Patterns with Olfaction and Taste Brain Connectivity Networks. 2025. *Neuropsychopharmacology*. Accepted. *Co-corresponding author.
- d. **Agarwal K***, Luk JW, Stangl BL, Schwandt ML, Momenan R, Goldman D, Diazgranados N, Ramchandani VA, Joseph PV*. Parosmia is positively associated with problematic drinking, as is phantosmia with depressive symptoms. *J Addict Med*. 2024 May 22. doi: 10.1097/ADM.0000000000001332. Online ahead of print. *Co-corresponding author.
- e. **Agarwal K**, Schaffe-Odeleye T, Marzouk M, Joseph PV. Diminished Bitter Taste Perception, Enhanced Salt Taste, and Appetitive Odor Identification in Individuals at Risk for Alcohol Use Disorder: National Health and Nutrition Examination Survey (NHANES) 2013-2014. *Journal of Studies on Alcohol and Drugs*. 2024. DOI:10.15288/jsad.24-00104.
- f. Goldschlager J, Cintron C, Hall L, Shields T, **Agarwal K***, Joseph PV. Taste processing in autism spectrum disorder: A translational scoping review. *Neuroscience & Biobehavioral Reviews* Volume 170, March 2025, 106031. *Co-corresponding.
- g. **Agarwal K***, Chaudhary S, Parma V, Balhara YPS, Sarkar S. Anxiety Modulates Odor-Linked Brain Connectivity and Alcohol Dependence Risk. *Brain Communications*. 2025. Submitted. *Corresponding.

Complete List of Published Work in My Bibliography:

<https://www.ncbi.nlm.nih.gov/myncbi/collections/mybibliography/>

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing

Ramalingaswami Reentry Fellowship from Department of Biotechnology, India 2025

Completed

- a) K99 phase of K99/R00 NIH Grant number (1 K99AA031243-01). K99 phase activation date June 1st, 2024.
- b) Center for Compulsive Behaviors (CCB) Fellowship, NIH, 2022-2023 (\$30,000 annually)
- c) NIH/NIAAA-Intramural Research Program (IRP), P.I.: Dr. Paule V Joseph.
- d) Junior Research Fellow (JRF), Department of Science and Technology (DST), New Delhi, India; P.I.: Prof. N. R. Jagannathan, PhD; 2011-2013.
- e) Senior Research Fellow (SRF), Indian Council of Medical Research (ICMR), New Delhi, India; P.I.: Prof. N. R. Jagannathan, PhD; 2014-2018.