IITB-Monash Research Academy

An Indian-Australian research partnership

Indian Institute of Technology Bombay | MONASH University

Project Title:	**Sleep Intraindividual Variability: Effects on Emotional Responses and Cognitive Functions**	
Project Number	**HSS1277**	
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Research Clusters: **Research Themes:**

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*		**Highlight which of the Academy's Theme(s) this project will address?** *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*	*1*	*Artificial Intelligence and Advanced Computational Modelling*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*	2	*Circular Economy*
3	*Math, CFD, Modelling, Manufacturing*	3	*Clean Energy*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*	4	***Health Sciences***
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*	5	*Smart Materials*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*	6	*Sustainable Societies*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng* ***HSS****, Design, Management*	7	*Infrastructure*
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The research problem

Sleep is fundamental to emotional regulation and cognitive performance, influencing positive and negative affect, as well as cognitive functions such as attention, response inhibition, and memory/learning. While average sleep metrics (e.g., mean duration or quality) have been widely studied, intraindividual variability (IIV) in sleep—night-to-night fluctuations in sleep duration, timing, or quality—has received less attention. Emerging evidence suggests that sleep IIV may disrupt emotional responses and cognitive functions more significantly than stable but suboptimal sleep patterns, potentially due to its impact on circadian rhythms and sleep homeostasis. However, there is a lack of integrated research examining how sleep IIV affects both emotional and cognitive outcomes in young adults (18–30 years) and adults (30–60 years), two groups prone to variable sleep patterns due to differing lifestyle demands. Additionally, the relationships between emotional regulation and cognitive performance in the context of sleep IIV remain poorly understood, and there is a scarcity of standardized methods to assess sleep IIV or interventions to mitigate its effects.

This PhD project aims to address these gaps by investigating the impact of sleep IIV on emotional responses and cognitive functions, identifying relevant markers, and developing a targeted intervention to reduce sleep IIV and improve outcomes in these populations.

Project aims

Investigate the Impact of Sleep IIV*: To examine how intraindividual variability (IIV) in sleep (night-to-night fluctuations in duration, timing, and quality) affects emotional responses (positive and negative affect) and cognitive functions (attention, response inhibition, memory/learning) in young adults (18–30 years) and adults (30–60 years).*

Identify and Validate Markers*: To develop and validate a demographic screening tool and assessment protocols to identify individuals with varying sleep patterns and quantify sleep IIV, while establishing reliable markers for emotional regulation and cognitive performance in the context of sleep variability.*

Explore Interrelationships*: To investigate the correlations between emotional regulation and cognitive performance in individuals with high versus low sleep IIV, elucidating how these domains interact and whether emotional dysregulation mediates cognitive deficits.*

Develop and Test an Intervention*: To design and evaluate a 6-week intervention program aimed at reducing sleep IIV through sleep hygiene education, cognitive-behavioral strategies, and mindfulness techniques, assessing its effectiveness in improving emotional responses and cognitive functions in participants with high sleep IIV.*

How skills/experience of the IITB and the Monash supervisor(s) support the proposed project

The skills and experience of the IITB and Monash supervisors will greatly support the proposed project aiming to investigate and mitigate sleep IIV's effects on emotional responses and cognitive functions. Dr. Rashmi Gupta (IIT Bombay) and Dr. Joshua Wiley (Monash University) provide complementary expertise to support the proposed PhD project on sleep intraindividual variability (IIV). Dr. Gupta's expertise in cognitive neuroscience, affective processes, and neuroimaging aligns with the project's focus on assessing emotional and cognitive outcomes, while Dr. Wiley's specialization in sleep dynamics, actigraphy, and behavioral interventions supports the study's sleep monitoring and intervention design.

What is expected of the student when at IITB and when at Monash?

When at IITB, the student is expected to conduct experimental research using equipment such as EEG, FMRI, fNIRS, Eye Tracker and behavioral testing tools to collect empirical data on cognitive functions and emotional responses, guided by Dr. Rashmi Gupta's expertise in cognitive neuroscience. During the stay at Monash, the student will focus on intervention development, actigraphy-based sleep monitoring, and advanced statistical analysis, leveraging Dr. Joshua Wiley's expertise in sleep research and behavioral interventions. This division of tasks ensures a comprehensive approach, combining empirical and intervention-based research while utilizing the unique strengths of both institutions.

Expected outcomes

The PhD project on "Sleep Intraindividual Variability: Effects on Emotional Responses and Cognitive Functions" is expected to yield the following outcomes:

Empirical Insights into Sleep IIV Effects*: The study will provide evidence on how sleep intraindividual variability (IIV) impacts emotional responses (increased negative affect, reduced positive affect) and cognitive functions (impaired attention, response inhibition, and*

memory/learning) in young adults (18–30 years) and adults (30–60 years), with potential age-specific differences identified.
***Validated Assessment Tools and Markers**: A demographic screening tool and standardized protocols (using actigraphy, cognitive tasks, and emotional scales) will be developed and validated to measure sleep IIV and its effects, establishing reliable markers for emotional regulation and cognitive performance.*
***Clarified Interrelationships**: The project will elucidate correlations between emotional regulation and cognitive performance in the context of sleep IIV, with mediation analyses revealing whether emotional dysregulation drives cognitive deficits in high-IIV individuals.*
***Effective Intervention**: The 6-week intervention (sleep hygiene, cognitive-behavioral strategies, mindfulness) is expected to reduce sleep IIV, leading to improved positive affect, reduced negative affect, and enhanced cognitive performance, with sustained effects at 3-month follow-up. Young adults may show greater improvements due to flexible schedules, while adults may benefit from work-related strategies.*
***Scientific and Practical Contributions**: The project will produce peer-reviewed publications and conference presentations, advancing knowledge on sleep IIV's impact. The intervention's findings will inform scalable strategies for managing sleep variability, benefiting diverse populations with high sleep IIV.*

How will the project address the Goals of the above Themes?

The proposed research is highly interdisciplinary and sits at the disciplines of the humanities and social sciences and the intersection of Neuroscience and Psychology by elucidating how sleep IIV disrupts attention, emotional regulation, and cognitive performance, optimizing engagement and learning through an intervention program (sleep hygiene, cognitive-behavioral strategies, mindfulness).

How well the IITB and the Monash supervisor(s) know each other

The collaborators know each other well.

Potential RPCs from IITB and Monash

Prof. Neeta Kanekar: Expert in Cognitive Science
Prof. Malhar Kulkarni: Expert in Experimental Science
Prof. Shanthakumar Wilson Rajaratnam: Expert in Sleep Research

Capabilities and Degrees Required

Students who have completed a Master program in Cognitive/Behavioural Sciences or related disciplines including Psychology, Neuroscience, Biological Sciences, Engineering (e.g., Computer Science, Electronics & Communication, Electrical Engineering), are eligible to apply for admission to the Doctoral Program. Applicants familiar with the knowledge of eye-tracker EEG/ERP/fMRI/TMS and/or cognitive/ neuropsychology/ would be encouraged.

Necessary Courses

Introduction to Psychology

Introduction to Cognitive Sciences
Introduction to Affective Neuroscience

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.
Dr. Matthew P. Walker , University of California, Berkeley
Dr. Michael W.L. Chee, National University of Singapore (NUS) Medicine
Dr. Russell Foster, University of Oxford, Nuffield Department of Clinical Neurosciences
Dr. Ricardo S. Osorio, NYU Langone Health, Department of Psychiatry

K**eywords** relating to this project to make it easier for the students to apply.

Sleep Intraindividual Variability (IIV), Cognitive Functions, Emotional Regulation, Actigraphy, Sleep Hygiene, Attention, Response Inhibition, Memory and Learning, Neuroscience, Behavioral Intervention